International Council on Education for Teaching

Improving educational experience and outcomes in all parts of the world

The 63rd ICET World Assembly 2019

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MESSAGE FROM THE CHAIR OF THE ICET BOARD OF DIRECTORS

Dear ICET Delegates

As the Chair of the ICET Board of Directors, it is a pleasure to welcome everyone to our 63rd International Council on Education for Teaching (ICET) World Assembly in Johannesburg, South Africa. We specifically want to thank the University of Johannesburg, Vice-Chancellor Professor Tshilidzi Marwala, Dean, Professor Sarah Gravett, its Faculty of Education and the Department of Curriculum and Education Studies in Auckland Park. We particularly want to thank Professor Maropeng Modiba and Associate Professor Joseph Divala as the host and co-chairs of this year's ICET world assembly, as well as all of their conference planning committee members. The focus and theme of this year's world assembly is on "Reconceptualising Teacher Education for the Fourth Industrial Revolution and Knowledge Democracy: Teaching Beyond the 3Rs". This will be an exciting and intellectual theme that will push us to think beyond our traditional forms of thinking about education to include a fusion of technologies, including the physical, digital and biological spheres.

ICET is an international non-governmental organisation (NGO) that brings together teacher educators from various parts of the world. We share and present best educational practices, and discuss innovation in teaching and research from a global perspective. We seek challenges and opportunities and see how they are dealt with differently across international borders and contexts. ICET is known for its networking, it is inclusive, and the opportunities it affords us to meet in different parts of the world each year allows us to learn from one another and learn about education and teacher preparation from a global context.

I hope you attend future ICET world assemblies as they are held in an exciting place every year where both cultural and academic learning takes place. I highly encourage you to learn more about ICET as an organisation by talking to current and past board members as well as many delegates who have been attending ICET for many years. We hope you attend the welcome reception scheduled for Tuesday, 9 July at the Johannesburg Civic Centre where you can learn about ICET and meet its board of directors.

The ICET 63rd World Assembly Gala will take place on Wednesday evening – it is an event not to miss! Last, we look forward to seeing everyone on Thursday at ICET's business meeting to update you on organisational programmes we are involved in. We hope you take advantage of these networks so you may meet new colleagues from throughout the world.

On behalf of the ICET Board of Directors, I wish you have an engaging and fruitful conference. While you are here at the conference, take time to explore the beauty of South Africa, its people as well as the natural wonders for everything they have to offer!

Thank You!- Ngiyabonga!
Reyes L. Quezada, Ed. D., Chair, ICET

PRESIDENT'S MESSAGE

It is my great pleasure and privilege to welcome you to the 63rd World Assembly of the International Council on Education for Teaching hosted by the University of Johannesburg. I would like to thank Professor Maropeng Modiba, Associate Professor Joseph Divala and all those who have contributed to the planning and hosting of the World Assembly. We come together to discuss how teacher education will respond to preparing teachers for a Fourth Industrial Revolution – characterised by deep learning, critical thinking, global communication, social networking and new technologies. In line with tradition I would like to share two stories about the history of ICET before concluding with some insights into what lies ahead for ICET.

When did the ICET form? What does the name mean?

ICET as a concept began during an international teacher congress held in Copenhagen in August 1952. Key events during the congress included the formation of the World Confederation of Organisations of the Teaching Profession (WCOTP) and a commitment to form a group to prepare summary reports of opinions and current practices with regard to selected topics, including Education for Teaching. In 1953, a small group of teacher educators attending the WCOTP Assembly in London formed the International Council on Education for Teaching (ICET). Over the next five years, the group continued to meet during WCOTP Assemblies. Dr William J. Haggerty, President of the State University of New York at New Paltz, was elected president of the organisation for a three-year term in 1958. Haggerty described the purpose of ICET in 1961 as to bring persons interested in teacher education together and to publish material about the way teachers are prepared in different parts of the world.

Why meet in Africa and why are we talking about the Fourth Industrial Revolution?

The Fourth Industrial Revolution provides a major challenge for teacher educators in Africa, the world's largest continent comprising 54 countries. They now need to build the capacities of future teachers to integrate new technologies and online connectivity in order to continue delivering a relevant education to today's students. Artificial intelligence, Big Data, the internet of things, driverless cars, drones, 3D printers, nanotechnology and virtual reality, are emerging realities in societies across Africa yet these concepts have yet to find their way into teacher education and school curricula. Educators of Africa and beyond play a central role in transforming societies across the globe. Their learners will become the architects, policymakers and citizens who determine how the Fourth Industrial Revolution will impact the quality of lives and living for generations to come.

What lies ahead

As President of ICET, I am committed to working with the board to sustain the traditions established during the last 62 world assemblies. ICET will continue to host world assemblies to provide a forum for persons interested in teacher education to come together to share knowledge about the way teachers are prepared in different parts of the world. During these assemblies, we will continue to foster international cooperation and increase access to resources for improving the quality of recruitment, preparation and support efforts for teachers. In closing, I would like to remind all that the secret to the sustained success of ICET lies in the strength of the ties formed during and between world assemblies. I encourage you to use this week to reconnect with old friends and reach out to make new friends. Approach our board members to learn about board membership. Finally, I challenge you to continue to develop and share your knowledge as we all play a role in transforming societies across the globe.

James O'Meara Ed. D., President, ICET

KEYNOTE SPEAKERS

PROFESSOR TSHILIDZI MARWALA

Professor Tshilidzi Marwala was born in Venda (Limpopo, South Africa) has been the vice chancellor and principal of the University of Johannesburg since January 2018. Previously he was the deputy vice-chancellor for Research and Internationalization and the Executive Dean of the Faculty of Engineering and the Built Environment, both at the University of Johannesburg.

From 2003 to 2008, he progressively held the positions of associate professor, full professor, the Carl and Emily Fuchs Chair of Systems and Control Engineering as well as the SARChI Chair of Systems Engineering at the Department of Electrical and Information Engineering at the University of the Witwatersrand. From 2001 to 2003, he was the executive assistant to the technical director at South African Breweries. From 2000 to 2001 he was a post-doctoral research associate at the Imperial College (then University of London). He holds a Bachelor of Science in Mechanical Engineering (magna cum laude) from Case Western Reserve University (USA) in 1995, a Master of Mechanical Engineering from the University of Pretoria in 1997 and a PhD specialising in Artificial Intelligence and Engineering from the University of Cambridge in 2000.

Professor Marwala completed the Advanced Management Program (AMP) at Columbia University Businesses School in 2017 and completed a Program for Leadership Development (PLD) at Harvard Business School in 2007.

Professor Marwala is a registered professional engineer, a fellow of TWAS (The World Academy of Sciences), the Academy of Science of South Africa, the African Academy of Sciences and the South African Academy of Engineering. He is a senior member of the IEEE (Institute of Electrical and Electronics Engineering) and a distinguished member of the ACM (Association for Computing Machinery).

His research interests are multi-disciplinary and they include the theory and application of artificial intelligence to engineering,

computer science, finance, social science and medicine. He has an extensive track record in human capacity development having supervised 47 master's and 28 doctoral students to completion. Some of these students have proceeded with their doctoral and post-doctoral studies at leading universities such as Harvard, Oxford, Cambridge, British Columbia, Rutgers, Purdue, Chiba and Waseda. He has published 14 books on artificial intelligence, one of which has been translated into Chinese, over 300 papers in journals, proceedings, book chapters and magazines and holds four patents. He is an associate editor of the *International Journal of Systems Science* (Taylor and Francis Publishers). He has been a visiting scholar at Harvard University, University of California at Berkeley, Wolfson College of the University of Cambridge and Nanjing Tech University as well as member of the programming council of the Faculty of Electrical Engineering at the Silesian University of Technology in Poland.

He has received more than 45 awards including the South African Order of Mapungubwe and was a delegate to the 1989 London International Youth Science Fortnight (LIYSF) when he was in high school. His writings and opinions have appeared in the magazines *New Scientist*, *The Economist* and *Time Magazine*.

For Professor Marwala's presentation, please see:

https://link.springer.com/chapter/10.1007/978-981-13-0194-08

Response to Professor Marwala's Keynote Address: "Adopt fast, adapt Quick: Adaptive approaches in the South African contex.t"

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Wits School of Education, University of the Witwatersrand, Johannesburg, South Africa

Professor Nazir Carrim is professor of sociology of education and was the head of department of the Education Studies Division in the Wits School of Education. He was also head of the Education Studies Department at the Faculty of Education of the University of the Western Cape. His latest publication is a co-edited book entitled *Learning to Teach in Post-apartheid South Africa* (Cape Town, SUN Media) which he co-edited with Sayed, Y, Badroodien, A, Singh, M and McDonald, Z. His research interests and teaching are in the area of sociology of knowledge, educational technology, and identities and policies in education as well as processes of educational reform. He is also the current chair of the Research Committee at the Wits School of Education and serves on the Research Ethics Committee at the Wits School of Education.

It is an absolute pleasure and true privilege to be invited to act as respondent to this keynote address at this important 63rd World Assembly of the International Council on Education for Teaching. I am humbled by the invitation and thank you for it.

As a sociologist of education my response to this interesting and significant paper on the Fourth Industrial Revolution (4IR) and Higher Education in South Africa is about the recognition of the 4IR as an important emerging sociological phenomenon that has the potential to reconfigure societies and people throughout the world in ways that have not been experienced before. My response, however, is also about some of the educational implications of what the 4IR could mean for education practice. The features that characterise the 4IR are clearly identified in the paper and there is no need to repeat them here.

The first part of my response addresses what I regard as some of the key assumptions that are being made in the construction of the discourse about 4IR. There are four (no pun intended) key assumptions that I focus upon, and these are: inevitability, STEM matter, instrumentalism and benevolence.

The second part of my response deals with the persistence and increase in polarisation and inequality globally, and from the viewpoint of education in South Africa. I then also address the teaching and learning assumptions that are assumed and/or implied in the discourse of the 4IR and I look at Bloom's taxonomy and the skills sets as identified by the World Economic Forum (see Schwab, 2016). I then highlight the contradictions and inconsistencies that seem to be at work in these and point to the serious educational problems and challenges that may be facing us in the 4IR.

My purpose in this response is, thus, not only in relation to Professor Marwala's paper but also to assist the conference in what I hope is a generative way to allow for deeper engagement with the theme of the conference which is "Reconceptualising teacher education for the Fourth Industrial Revolution and knowledge democracy: Teaching beyond the 3Rs".

The Discourse of the 4IR

Inevitability

The discourse of the 4IR as it stands currently tends to project the 4IR as if it is inevitable. 4IR is here, it is happening, it will increase exponentially, and it is inevitable. In this regard, what is generally done to indicate such an inevitability is the tracing of industrial revolutions of the past and to indicate that that technology is growing from where it began to where it is going. The First, Second and Third Industrial Revolutions are described in various ways to show that the First was steam engine led, the second was electricity based and the third was digitally based. The 4IR follows these previous industrial revolutions bringing in Big Data, AI and robots, inter alia. For some like Marwala et al. the new and critical resource of the 4IR is data resources. Others like Gleason (2018) view such resources of the 4IR as "cyber-physical systems". Such differences aside, the inevitability of the 4IR is still assumed. It is as if there is no human intervention that is creating such conditions. It is as if there is no agency among people and the 4IR will happen, nonetheless. Such assumptions of the inevitability of the 4IR, thus, remove human agency in the development of 4IR and accords the 4IR as if it is a force on its own. In the process in whose interests 4IR is constructed to serve, where and how 4IR is being made into what it is, which forces are being configured to propel it get to be ignored. 4IR is instead projected as if it is a force on its own, with an historical determinism that cannot be stopped.

STEM matter

The discourse about the 4IR also consistently foregrounds STEM learning areas (science, technology, engineering and mathematics). On the one hand, this is understandable due to the emphasis on robots, data and the use of sophisticated scientific approaches. This not only privileges STEM but also does not indicate what would happen to other areas such as the humanities and liberal arts. At the same time the emphasis on STEM also reinforces and consolidates a distinctly positivist paradigm which assumes that only scientific approaches are valid and worthwhile for the 4IR future. This allows the historical marginalisation of non-STEM-related areas to be perpetuated and does not take into account that education does much more than only teach STEM subjects. In addition, theoretical perspectives that have historically significantly critiqued the positivist and scientific paradigm are almost conveniently ignored. There is no recognition of paradigms such as interpretivism, critical theory, postmodernism, critical realism and postcolonialism, to name a few, and how such perspectives have contributed to our understanding ontologically and epistemologically about the dynamics in education.

Instrumentalism

The emphasis on STEM, however, is also linked to the assumption of instrumentalism. The discourse about the 4IR assumes that if something cannot lead to actual practice, where practice is usually assumed to be the new demands that would arise in the wake of the 4IR, it is not instrumental. Constant upgrading, through lifelong learning, to become high skilled to function in the 4IR global economy is consistently emphasised. From an economic perspective such instrumentalism, which is aimed at meeting and fulfilling the demands of the 4IR global economy, is probably anticipated. However, from an educational point of view this is seriously myopic and problematic. This is the case because not all of education is meant to lead to practice or action in a one-to-one correspondence way. Education also attempts to develop deep learning and engagement with knowledge which do not necessarily lead directly to any action or practice. Such deep learning and engagement with knowledge develop in people a deeper appreciation of knowledge. Deep learning can benefit one significantly but in largely unseen ways and much later in life as opposed to when one first acquired such knowledge. An educated person is thus not only one who is equipped to fit into the economy, but one who is equipped with a critical, non-superficial and deep understanding of society, people and the ways they dialectically relate to and influence each other; to release their potential as human beings on earth, as opposed to only being participants in an economy.

Benevolence

The discourse about the 4IR also tends to project the 4IR as benevolent. It will free people from dangerous jobs, it will make people's lives easier, it will do away with jobs people do not want to do and, overall, it will free people to pursue higher levels of being and evolve. The 4IR, thus, is a good thing and will be good for people. In this regard, it not indicated who these people would be. Would everybody globally be able to grow and develop in these ways? Would this be the case for only a few, and if so, who might they be? Such framing of the 4IR as a benevolent force also does not sufficiently address the impact the 4IR would have on deskilling, reskilling and rendering some people and jobs as obsolete. It also does not adequately deal with the high level of industrial unrest that is likely to result from people being rendered unemployed due to changes in the economy. This being the case despite clear indications from the World Economic Forum that such economic instability and social

unrest is likely with the advent of the 4IR. Can one then simply assume that the 4IR is something one needs to "adapt" to "quickly" and "adopt fast"? It seems that we need to be more critical in our engagement with the 4IR, than to adapt to it and adopt it because the consequences could be dire on a global scale.

The 4IR and education

In the second part of my response I want to focus more on the educational implications of the 4IR. The discourse of the 4IR assumes that high level skills and knowledge will be required in the 4IR economy, and schools and teacher education need to reconfigure themselves to ensure that such high knowledge and skills will be developed through education. In this regard, the infusion of technology in teaching and learning is taken as given. In addition, new knowledge areas such as data science and coding are also proposed. The question, however, is, where is education now, and whether such changes in education would in fact be viable is important to look at.

Using South African education as a lens, where South Africans sit at the bottom 5% in international literacy and numeracy tests, and where almost 80% of learners in Grade 4 cannot read for comprehension, it is questionable whether the high skills and high knowledge of the 4IR are achievable. What seems to be more the case is that developed country contexts which have adequate baseline numeracy and literacy (including computer literacy) levels may be able to develop such high skills and knowledge, but in developing country contexts where these do not exist it will be more difficult.

Exposure to computer technology in schools in the global South is also lacking. In South Africa, the majority of schools do not have computers, internet access or adequate infrastructure. Although wealthier schools in South Africa do have such access, this is not the case for the many. Computer literacy is also, as a result, not quite as developed in most South African schools as one would hope. However, this points to the persistence of inequality both within South Africa and globally.

Inequality and polarizations persist

Not only are classrooms and education with high levels of inequality but the gap between the rich and the poor is increasing globally. Some have suggested that the 4IR may offer people the opportunity to "leap-frog" into the 4IR and this may assist in reducing the gap between the rich and poor. However, it is evident that differences between the global North and global South places countries at different points in terms of their technological developments and infrastructure, and in terms of skills levels. Countries with more technological development will be advantaged in the 4IR and this will not decrease but will increase inequalities globally.

Given the points made earlier, if such inequalities increase and if economic and social instability increase, it seems that it will be the poor in developing country contexts that will be hardest hit. Gleason (2018) also notes that women, especially in developing country contexts, will be equally hard hit. South Africans, on the African continent, are also included in this group that will likely be affected. The point, though, is that it cannot simply be assumed that 4IR will reduce such inequalities on its own.

These inequalities impact schools in direct ways. Poor schools, in developing country contexts, do not have the resources and facilities available to them to enable the kind of learning the 4IR will require. Given the lack of basic facilities they lack basic skills to be able to manage the demands of the current economy. However, schools in 2019 are also experiencing major challenges in terms of

what they are expected to deal with in their classrooms. Classrooms are filled with diverse learners — racially, culturally, linguistically — and with different levels of ability. Teachers must manage such diversity in their classrooms and have to do so under conditions where polarisations between people are increasing locally and globally. Global tendencies which have been noted by political analysts indicate that polarisation and intolerance is on the rise. This is seen in the increase in fundamentalist, extremist, white supremacist and neo-Nazi groupings, and radical and militant left-leaning groupings. Parochial forms of nationalism and xenophobia are also increasing.

For schools, this means that teachers must deal with such polarisations and have to constantly manage the conflict in their classrooms and schools. In South African schools, this has been seen in the increase in the use of violence by learners in schools, with learners actually killing each other on the school premises. Placing the 4IR into schools under such conditions cannot be treated as if it will be an easy thing to do. Dealing with the level of polarisation in schools and societies needs to be addressed and to assume that technology will erode such polarisations is a problematic assumption to make. The inequalities and polarisations that persist globally raise the question about whether the conditions materially exist for the 4IR in education.

Bloom's taxonomy and WEF skills sets

The discourse of the 4IR also makes statements about the learning and skills that the 4IR will entail. Some have indicated that the 4IR will require and lead people to develop the higher order of learning in terms of Bloom's taxonomy. Bloom's taxonomy outlines the kind of learning that operates on different levels and includes comprehension (remembering), understanding, applying, analysing, evaluating, and creating. The argument here is that the 4IR will require the higher order thinking of analysis, evaluation and creation. As such, the 4IR will develop higher order thinking skills among humans. If about 80% of grade 4 learners in South Africa cannot read for comprehension, as indicated earlier, then how they will be able to get to higher order thinking skills is going to be rather difficult. Gleason (2018) also notes that higher education institutions across the globe have not been particularly good at ensuring higher order thinking skills either.

Added to this is the World Economic Forum's (WEF) skills sets for the future 4IR which indicates that complex problem solving, critical thinking, creativity, people management, coordinating with others, emotional intelligence, judgement and decision making, service orientation, negotiation and cognitive flexibility are what will be crucial. In this regard, it will suffice to point to three of these skills to indicate the difficulties associated with them.

Given the persistence of inequality and polarisation discussed earlier, intolerance rather than negotiation dominate. Intolerance and polarisation do not enable emotional intelligence to develop because rather than identifying with and relating to how "the other" feels, "the other" is pushed further away and bordered with surrounding "walls". It is also not clear what exactly is meant by cognitive flexibility. Are people expected to simply switch on and switch off their cognitions at will? Can this be done? Can people actually change their cognitive structures? What does cognitive flexibility actually mean?

Inconsistencies and contradictions

The 4IR discourse also raises inconsistencies and contradictions. On the one hand, educationally the 4IR promotes individualised, customised and learner active and learner centred approaches. Getting learners to work autonomously needs to be understood as being in competition with robots that can

work autonomously in the 4IR. On the other hand, given the WEF's skills sets learners are expected to work collaboratively, coordinating with others. How these are to be balanced with each other is unclear and contradict each other in practice.

At this point it is also important to indicate that assuming that what has been done in the 3IR and the infusion of digitalising and technology in education, which include blended learning, e-learning, and online learning are not quite the same as what would be expected in the 4IR. The 4IR is unique and distinct, and to assume that it will be continuous with what exists is mistaken. The 4IR will bring "cyber-physical systems" into play which will entail an interface between humans and machines in ways that we have not even imagined. It is therefore important to note that 4IR will be new and will require new approaches.

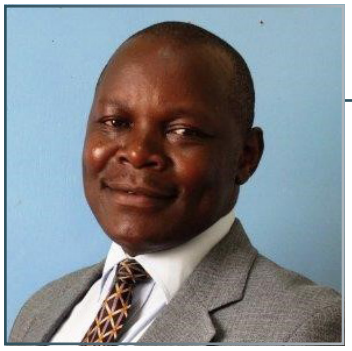
Finally, and for a conference like ICET, what the 4IR will require for teacher education is unclear. Deep thinking, which is seen to be linked to higher order thinking skills, is not what is acquired in pieces and the short course, bits curriculum that is suggested in the 4IR discourse does not develop such deep thinking. Existing teacher education programmes have noted that deep thinking and deep knowledge happens after a considerable amount of time and cumulatively develops through a structured immersion in disciplinary based knowledge. The 4IR emphasises deep thinking and knowledge yet it suggests bits and pieces and customised forms of curriculum. If not viewed critically such 4IR curricula will not only erode disciplinary knowledge bases and thereby reduce possibilities for deep thinking to develop, they will also potentially take away the disciplinary bases of teachers' knowledge.

In conclusion, I need to point out that my response is not anti the 4IR or anti-technology. Technology is a tool in the hands of humans and how we use it will determine its outcome. My response is meant to highlight the need to engage with the 4IR critically and to be clear about what it would mean in relation to where we are and what will be required of us educationally to ensure that it is us, as humans, who direct the ways the 4IR will unfold rather than technology directing the way we need to think and be.

References

Gleason, N. (Ed.) (2018). *Higher Education in the Era of the Fourth Industrial Revolution* (Springer Palgrave MacMillan, Singapore).

Schwab, K. (2016). *The Fourth Industrial Revolution: What is means and how to respond.* Available at: https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond.



PROFESSOR WINSTON JUMBA AKALA

Professor Winston Jumba Akala PhD, Dean – School of Education, University of Nairobi is a Fulbright scholar and professor of Research in Education and curriculum studies at the University of Nairobi, Kenya. He is a member of the Kenya National Institute of Curriculum Development (KICD) Management Council where he serves as the Chairman of the Technical Committee on Curriculum. He is an Alumni of the University of Illinois at UrbanaChampaign, USA where he studied education (curriculum research).

He has lectured at the Catholic University and University of Nairobi in the areas of curriculum studies, civic education, research methodology and education statistics for many years. He has also supervised academic research, in addition to carrying out consultancies in research and evaluation of programmes at local, national and international levels. Professor Akala has also worked as the Director of Quality Assurance at the Catholic University of Eastern Africa where he created systems and procedures as the management representative steering the university to ISO certification status.

Akala is a member of the International Association of Educators (INASED) and representative for Kenya and Eastern Africa. His latest publications include among others: Influence of peers on talent identification for players in rugby clubs in Kenya; Challenges facing the effective implementation of Artisan and craft courses in Catholicsponsored community colleges in Nairobi, Kenya (with Peter C. K. & Joash M.W.). *Journal of Research and Methods in Education* (IOSR-JRME); Involving police officers in formulation of Information Communication Technology policies and ICT integration in in-service training programmes: A case study of Kenya Police Service. *Journal of African Interdisciplinary Studies* (JAIS).

Technology flight in the Fourth Industrial Revolution: Coup humbles teaching again!

Winston J. Akala

Abstract

The flight of technology and the gasping struggle by the academy to integrate it in teaching has been consistent in the last three decades. Learning institutions continue to consume rather than innovate and produce technology. It seems that industrial hubs — a few of which are attached to universities in the developed world — continue to be the centres where research and innovation in technology retain dominance in the creation of knowledge. This has posed not only the greatest challenge to teaching but has also led to fresh questions about the role of the academy in educating. As a result, the role of

the teacher as a facilitator of learning appears to be an obsolete and back-peddling endeavour. This paper therefore seeks not only to question the authenticity of teaching in its current variants, but more importantly to propose the need for a radical shift in teaching. The shift should take the trajectory that characterises teaching/learning as a co-creation partnership between teachers and learners, but also a renaissance in the struggle to reinstate and characterise the academy as the default source of knowledge and all associated technologies targeted at not only providing interventions but also designing and creating new knowledge and products.

Introduction

The First Industrial Revolution was characterised by the move to steam-powered factories spearheaded by developments in agriculture and mining. In the Second Industrial Revolution, efficiency and mass productions dominated the scene. To cut costs and increase efficiency and profitability, the Third Industrial Revolution was marked by developments in digitization of information and processes. Currently underway, the Fourth Industrial Revolution, which is the main focus of this presentation, focuses on technologies, such as artificial intelligence and genome editing, among others. It integrates electronic, digital and information technologies in ways that decimate the traditional boundaries between physical phenomena, location, digital and biological spaces within the manageable universe with a studious stare on the rest of the universe (Pyka 2017). Here is where the challenge arises threatening a completely uncertain world given the huge polities that have already experienced a myriad of education-related problems with the superhighway referred to as the internet which arrived in the Third Industrial Revolution. Thus whereas critical and controversial issues that arose in the previous technology epochs remain unresolved, the academy is fast being required to prepare and cope with more complex realities in the Fourth Industrial Revolution.

Already significant debate and research is underway on how the revolution will affect governance, business and legal provisions and systems as variously determined by different jurisdictions. In academia, research parks are already perfecting some innovations that could be introduced in schools. The greatest puzzle is nevertheless what educationists are currently doing in preparation and/or taking lead in realising the revolution. In a nutshell, the puzzle of whether teachers in the academy will again cross into the Fourth Industrial Revolution gasping to cope with reality in teaching. According this paper navigates through but is not restricted to the following key questions that the academy needs to address in confronting the Fourth Industrial Revolution:

- Which one should inform the other? Teaching or technology?
- Does technology proposed in the Fourth Industrial Revolution find Africa and generally the South already overstretching the tenets and practice of the Third Industrial Revolution?
- Are schools ready for the Fourth Industrial Revolution? And in any case, would readiness be the perquisite to embrace it?
- What political socio-cultural and economic ramifications does the Fourth Industrial Revolution portend for teaching and learning?
- What is the fate of the mobile school concept in pastoralist communities in Africa in the face of the Fourth Industrial Revolution?

The use of technology to diminish and remove the gap between digital, physical and biological spaces and dimensions of humanity characterises the Fourth Industrial Revolution significantly. This is happening at a time when the academy, which is expected to lead the way, continues to gasp for breath in integrating technology in teaching and learning.

The struggle to integrate technology in teaching is the greatest puzzle to teaching in the 21st century. Whereas technology enhances and eases the learning process and helps teaching to achieve learning objectives expediently and timely, most technology and start-ups that create memorable impacts in education almost entirely originate from industrial innovations away from the academy. Some universities, notably in the West, have developed research and industrial parks around universities to incubate and encourage innovation. Examples of these include the Silicon Valley in California, and the University of Chicago preparatory school.

The preconditions facing teaching as the Fourth Industrial Revolution emerges

Apparently, the oldest idea of a model linking teaching to practice on one hand and to innovation on the other was demonstrated by Socrates (the questioning philosopher), John Pestalozzi, Maria Montessori and John Dewey, among others. In the 19th and 20th centuries some extremely innovative intellectuals with foresight on the fate of teaching including Samuel Crowther Ajayi, Peter Abrahams (author of *Mine Boy*), Julius Nyerere, Ngũgĩ wa Thiong'o, Wole Soyinka and Chinua Achebe, among others turn out a wealth of literary representations of African reality that is about to be put on unprecedented test in the Fourth Industrial Revolution. These scholars worked in unique circumstances that prompted them to see education through the lens of societal realities, problems and needs, leading them to innovate contextually responsive interventions, sometimes in the form of memoirs, diaries or extremely complex literary plots.

Johann Henrich Pestalozzi (1746—1827) posited that education was a social construct expected to develop the head, heart and hands in which technology and manipulation of knowledge to solve problems is implied. Thus he emphasised active and participatory rather than passive learning which described the role of the teacher as facilitative in nurturing already innovatively unfolding learner talent.

Paulo Freire (1921—1997) theorised that string of education for critical consciousness, pedagogy of the oppressed and the pedagogy of hope punctuate the consistent struggle by the Brazilian school system's critic in demonstrating that dictation and indoctrination rampantly used in the academy as teaching strategies already killed creativity and any hope of innovation. Accordingly he advocated for liberating pedagogy that would provide space for teachers and learners to productively and innovatively engage.

The magnitude of ignorance, war, conflict and economic crime prevalent in many African countries not only poses tricky questions about the type and nature of education but also the manner in which the commensurate knowledge, skills and values are imparted. It is not an understatement to mention that a significant part of Africa have not reached the upper levels of the Third Industrial Revolution. Their advent and participation in the Fourth Industrial Revolution is thus an endeavour that must be meticulously planned and executed. The role of the academy and teaching is crucial in facilitating the leap to the Fourth Industrial Revolution!

Talent identification and teaching appears to be less important because most higher education programmes target marketability of programmes and content therein. The counselling and career guidance units within the universities also concentrate on channelling graduates in the various marketable courses. Limited interest and attention is given to talent as the basis for channelling learners in the various fields. Currently a check on education programmes in 104 top African universities did not reveal a single university offering a course in talent identification theory and strategy in the teacher education programme or any other. As a result most educators in the academy tend to be masters of content which they try to pass on using the pedagogies and technology they understand best.

The diverse socio-cultural contexts from which technologies emerge often influence teaching beyond the catchment cultures. This has been responsible for the cultural shock and resistance to innovative ideas (Williams 2001, Swadener 2001, Akala 2007). The application of the Fourth Industrial Revolution must make greater sense if deliberate and innovative strategies can be mooted within the academy to customise it tenets and practice to the diverse and unique contexts in which teachers and learners live and operate.

Although the education policy of self-reliance established by Julius Nyerere failed, it bequeathed certain social values among the Tanzanian population that form a solid basis in entrenching the Fourth Industrial Revolution. The policy systematically informed and influenced education, particularly pedagogic skills employed by teachers. Its quest for African solutions to situations and problems that face Africans effectively solved the problems associated with many ethnicities and languages through the popularisation of one African language — Kiswahili. A similar situation engendered in Ethiopia through the widespread use of Amharic can trace it origins from the rule of Emperor Haile Selassie. It is important to note that the use of indigenous languages will play a significant role in domesticating the tenets and ideals of the Fourth Industrial Revolution. Innovations and practices packaged in familiar and home-grown languages will not only be accessible but also will appeal to local communities thereby expediting adoption.

Furthermore, language is the undisputed tool and medium through which various forms of learning, disciplines and general knowledge innovation about innovation is packed and delivered. There is almost no doubt that sections of the populations in the Anglophone, Francophone and Lusophone Africa will take a while to fathom a revolution largely packaged in a foreign language. This means the academy burdened by the struggle to interpret, translate and implement the ideals of the Fourth Industrial Revolution needs not wait long before mooting adoption strategies. Most African countries have diverse linguistic richness associated with their various ethnicities but have hardly tapped into ways these indigenous languages could be the basis for sprouting and/or domesticating technological advances to the local level.

Excessive theorizing with limited attempt to link theory to reality in schools and communities

Taking the challenge of the Fourth Industrial Revolution: Strengthening ingenuity in teaching

- Education should link teaching to the industry in a seamless manner to leave no gap in educating. The academy should now take the lead in mooting and disseminating technology. This can be enhanced through collaborative action between the school and the industry. Deliberate and close work between the teachers and learners with the actual industry out in the community and the expansion of curricula to include service learning is likely to perpetuate the culture envisaged in the Fourth Industrial Revolution. This strategy is already operating efficiently in its rudimentary form in Rwanda, yet it is already the best action ever observed on African soil after the collapse of the Ujamaa villages in Tanzania in the 1980s. The Rwandan variant in which all citizens participate is popularly known as Umuganda, meaning "coming together in common purpose to achieve an outcome".

The logic of Umuganda was to engender peace, unity and prosperity throughout the nation as a strategy to fumigate the past and ensure that Rwanda changes for the better. It nevertheless is turning out to be the platform and model for joint action in innovating interventions to national and local challenges. This in my view is a ready and willing platform for teachers — who have already integrated it in the school curriculum — to now load on it the tenets and practices envisaged in the Fourth Industrial Revolution.

Talent identification and nurturing should be integrated in teacher education programmes. Apparently instances where talent has been identified, it turned out that the innovators indeed never studied in fields where they acquired fame.

At the University of Durban — a master's degree thesis for a student was commuted into a PhD dissertation because of originality.

In May 2019 a collaborative action of 16 innovative students at the University of Nairobi working on their own project sponsored by UNESCO developed an application that can be used on phones and other electronic gadgets to help youth to deal with sexuality related issues and problems. Surprisingly, none of the 16 students was studying or being guided by staff from the school of computing and informatics. They all hailed from fields of economics, humanities and social sciences where social problems form one of the major areas of academic immersion and research.

It is also notable that Socrates, Pestalozzi and Maria Montessori were never trained to be educators – a field in which their greatest impact has been realised. Thus, turning away from the concept of improvisation to embrace locally developed start-ups in teacher education and methodology, note that the nascent stage of innovation is improvisation and this should never have been referred to as the lesser alternative to actual technology, thereby impeding free proliferation of locally developed innovations:

- Reinvent collaborative teaching to negotiate creativity beyond support and peer assessment and evaluation
- Reinvigorate action research in teaching
- Develop and equip centres of excellence in teacher education modelled around universities. These should include fully fledged and adequately funded schools/faculties of education with model kindergarten, primary, secondary and high schools attached to ensure creativity in teaching is adequately incubated and tried out at the teacher development stage.
- There is a need to provide reassurance to parents and other stakeholders on the technology component particularly the internet and its robust likelihood of exposing children to harmful literature. In accordance with Kwame Nkrumah's education philosophy of transformative, humanistic and systematic or otherwise Ubuntu.
- Advocate for greater funding for research on teaching and teacher education with a greater focus on teacher formation. Such funding would ensure continuous research not only on the efficacy of teaching activities in schools but it also will provide evidence to form the basis for review of teacher education programmes and review of policies on teacher education (Kodama & Shibata, 2017).
- Empower professional teacher organisations and other interested associations and societies operating in the education sector to play an active role in the development and implementation of teacher education policy.
- Greater puzzles face the work of the teachers and educators managing education among populations that are constantly migrating in the wave of the Fourth Industrial Revolution. These include the Pokot, Turkana Masai and Samburu in Kenya, Karamojong in Uganda, Fulani in West Africa and Cushitic communities in living the horn of Africa, among others.
- Given that peer reviewed research journals are the greatest platform for disseminating innovative ideas from the academy, there is a need to expand space in these journals to include polemic articles that provoke the members of the academy to think and act outside the box.
- It is worthwhile for the teachers and educators to suffer as a result of their activism to reform teaching and position themselves in readiness to confront the Fourth Industrial Revolution than to simply wish all will be well using the current pedagogies the same way to retain peaceful co-existence with governments.

When all these are done, they will enhance the achievement of the ICET mission and goals set out as follows:

- To foster international cooperation for improving the quality of recruitment, preparation and support efforts for teachers, administrators and other education specialists through the development of national, regional and international networks.
- To promote cooperation between higher education institutions, government and the private sector to develop a worldwide network of resources for innovative programmes linked to the recruitment, preparation and retention of motivated and effective educators.
- To provide an international forum for the exchange of information and the discussion about the way educators are recruited, prepared, certified and supported in different parts of the world.

Conclusion

It is already clear that teaching leading to rote learning in schools viciously perpetuates regurgitation and reproduction. As a result the free spaces offered by mostly greedy investors at industries away from the academy continue to prey on the initially untapped talent graduating from our schools full of untapped but scantily developed potential.

Although the academy lost the game when it failed to retain its pedestal as the spawning ground for innovative technology usable in educating, the struggle to integrate existing technology need not continue for long. The academy still reserves the right and boasts the ability to re-invent pedagogies in such a manner so as to re-engineer innovations in teaching that will facilitate not only the production, use and sale of technologies but more importantly release to society readymade innovators in the form of talented graduates.

References

Aggarwal, J.C. (1991). *Theory and principles of education: Philosophical and sociological bases of education*. New Delhi: Vikas Publishing House PVT LTD.

Assensoh, A.B. (1998) *African Political Leadership: Jomo Kenyatta, Kwame Nkrumah, and Julius K. Nyerere*. New York: Krieger Publishing Co.

Freire, P. (1995). *Pedagogy of hope*. New York: Continuum.

Helleiner, G. (2002). The legacies of Julius Nyerere: An economist's reflections. Toronto. Available at: http://www.queensu.ca/snid/helleiner.htm

Kassam, Y. (1995). Julius Nyerere. In Z. Morsy (ed.) *Thinkers on Education*. Paris: UNESCO Publishing.

Kodama, F. and Shibata, T. Beyond fusion towards IoT by way of open innovation: An investigation based on the Japanese machine tool industry 1975—2015. *J. Open Innov. Technol. Mark. Complex*. 2017, 3, 23. [CrossRef]

Njoroge, R.J. & Bennaars, G.A. (1994). *Philosophy and education in Africa: An introductory test for students of education*. Nairobi: Transafrica Press.

Nyerere, J.K. (1978). Development is for Man, by Man, and of Man: The Declaration of Dar es Salaam. In B. Hall and J.R. Kidd (eds.). *Adult Learning: A design for action*. Oxford: Pergamon Press.

Pyka, A. (2017). The transformation towards a knowledge-based bioeconomy. In Dabbert, S., Lewandowski, I., Weiss, J., Pyka, A., (Eds.) *Strategies for Knowledge-Driven Developments in the Bioeconomy — An International and Interdisciplinary Perspective*.. Springer: Heidelberg, Germany; New York, NY, USA.

Reagan, T. (2000). *Non-Western education traditions: Alternatives and approaches to educational thought and practice* (2nd ed.). New Jersey: Lawrence Erlbaum Associates, Publishers.

Rifkin, J. (2011). The Third Industrial Revolution: How lateral power is transforming energy, the economy, and the world. Palgrave Macmillan: New York, NY, USA, 2011.

Schwab, K. (2017). *The Fourth Industrial Revolution*. Crown Business: New York, NY, USA.

Ströker, E. (1977). *Philosophische Untersuchungen zum Raum*. Vittorio Klostermann: Frankfurt, Germany. Volume 25.

Sifuna, D.N., & Otiende, J.E. (1994). *An introductory history of education*. Nairobi: Nairobi University Press.

Smith, M.K. (2002). Julius Nyerere, lifelong learning and informal education. Available at: http://www.infed.org/thinkers/et-nye.htm.

Taylor, D.W., Berry, P.C. and Block, C.H. Does group participation when using brainstorming facilitate or inhibit creative thinking? Adm. Sci. Q. 1958, 3, 23–47. [CrossRef]

Response to Professor Winston Jumba Akala, ICET July 2019

Professor Fred Msiska
Mzuzu University, Malawi

Fred Gennings Wanyavinkhumbo Msiska obtained his Doctor of Philosophy (Education) from Bristol University in 1991. He is currently deputy vice-chancellor of Mzuzu University in Malawi. At Mzuzu University he has also served as UNESCOCommonwealth of Learning Chair/Professor of Open, Distance and eLearning, Quality Assurance and Enhancement Manager and co-developer of the Qualifications Framework. He is the first director of the Open, Distance and eLearning Directorate of the university.

He has worked as a project administrator of the University Partners in Institutional Capacity-Advanced Degree Activity. The project involved the University of Massachusetts at Amherst and the Faculty of Education at the University of Malawi where he served as dean from 2001 to 2004. His current research interests are in quality assurance and open, distance and elearning. Fred Gennings Wanyavinkhumbo Msiska has published widely, including book reviews in the *International Review of Education: Journal for Lifelong Learning*.

In his keynote address at the 63rd Annual Conference of the International Council on Education for Teaching, Professor Winston Akala contends that "the flight of technology and the gasping struggle by the academy to integrate it in teaching has been consistent in the last three decades. Learning institutions continue to consume rather than innovate and produce technology. It seems that industrial hubs – a few of which are attached to universities in the developed world – continue to be the centres where research and innovation in technology retain dominance in the creation of knowledge. This has posed not only the greatest challenge to teaching but has also led to fresh questions about the role of the academy in educating. As a result, the role of the teacher as a facilitator of learning appears to be an obsolete and back-peddling endeavour."

I want to make it very clear that Professor Akala's contribution to the discourse on the Fourth Industrial Revolution is nothing more than a point of view (perspective) and as such it is neither correct nor wrong. It only serves to remind us of the several considerations that need to be factored in as we discuss the pros and cons of this revolution. All the same, I would like to make a few quick comments on his position. First, most people will agree that production of technology is a function of the deliberate effort to provide solutions to the attendant functional problems. Second, indeed the teacher's role must truly change from provider and owner of content to organiser of content so that the learner achieves the intended learning outcomes more effectively. It does not make a teacher more effective by struggling to recreate knowledge which is readily available on the internet. Use of technology achieves this more cost-effectively and consistently over time and across a variety of groups of learners. I agree with Akala that technology has indeed changed teaching in many ways, including making content readily available and accessible to the learners at their will, space and time. Technology has also made learning portable, hence it is possible to argue that the need for radical shift in teaching is mandatory as a result of the Fourth Industrial Revolution.

From the foregoing, it is possible to surmise that most people agree that technological revolution is a complementary breakthrough as opposed to an overthrow of the process of teaching and learning. Technology is a platform for facilitating teaching and learning, a pedagogic option for carrying content and associated assessment techniques, and a means of quality assurance in that the same content is delivered to a variety of learners in the same matter, unlike in a situation where teachers of varying abilities teach different students. The real issue here is the necessity of adaptability and purposefully integrating technology in the process of teaching and learning. It may be a futile endeavour imagining that technology can be optional in education. As a matter of fact, learners, in higher education institutions particularly, have since left the traditional classroom. What this suggests is that to keep pace with such learners, teachers will have to deploy technologies in the process of teaching and learning or else risk being obsolete and irrelevant.

While it is fine for us as individual actors in the higher education system to say what we think ought to be the desirable situation, we may need to accept that our desires will always be modulated by the higher education operational logic(s) on which our institutions are grounded. Michael Crow and Derrick Anderson (2018) define operational logics as a system of principles, reasons and arrangements through which desired results of a higher education institution come. Consequently, they identify four operational logics which a higher education institution could pursue as follows:

	Academic logic	Academic bureaucracy logic	Market logic	Academic enterprise logic
Animating purpose	Enlightenment of individual students	Organisational preservation	Profit maximisation for owners and shareholders	Social transformation
Path to achieving success	Immersive instruction	Efficiency in the achievement of state-specified goals	Efficiency and cost reduction	Connecting instruction and knowledge generation at society-impacting scale

	Academic logic	Academic bureaucracy logic	Market logic	Academic enterprise logic
Organisational scale of impact	Individual or groups of individuals	Community or state	Indeterminate, any scale from which profit can be derived	Society-wide, national and global reach
Faculty self-concept	Self-governing professionals	Administrative functionaries responding to rules	Commodity labourers	Knowledge entrepreneurs
Assumptions of management	Management is drawn from and blended with faculty	Traditional public managers are distinct from faculty	Professional management is distinct from faculty and acting entrepreneurially	Management is drawn from and blended with faculty but acting entrepreneurially
Accountability mechanisms	Faculty and management professionalism	Audits, public reporting, standardised testing	Student choice, standardised testing	Demonstrated economic and social progress
Primary funding mechanisms	Enrolment funding from state, endowments	Enrolment funding from state	Vouchers, performance-based funding from state	Diverse sources arising from industrial entrepreneurship

Source: Michael Crow and Derrick Anderson. (2018). "Higher Logic", *Trusteeship Magazine*, Summer 2018, Arizona State University, USA.

The point is that while in theory it is possible for an institution of higher education to pursue only one of the above operational logics, in practice it is a blending of these that are pursued, suggesting that there will be a concatenation of operational practices. Given that every institution is concerned with efficiency and effectiveness, it is hard to accept the possibility of any institution of higher education avoiding deployment of technology in its delivery of services. If technology is synonymous with "artificial intelligence" which has taken over a great deal of what we do today, what will it take for us to push back on the immortality of technology? The answer may very well vary from one theoretical position to another, but I still feel that it very much depends on what you think is feasible and desirable for the higher education logic being pursued. It is not so much about technology having feelings and emotions if they are to take over from human beings, rather it is about higher education systems remaining relevant and meaningful to both society and learners. I agree with Professor Louis C.H. Fourie of Cape Peninsula University of Technology, Cape Town, that we need to embrace technology or else the academy risks becoming obsolete because learners have since left the traditional classroom (Fourie, Crow and Anderson, 2018).

Otherwise, Professor Akala's keynote is a constant reminder that as academics we should inform the discourse by bringing in as many perspectives as possible so that readers make informed decisions.

PROFESSOR SARAH GRAVETT

Theme of conference: Reconceptualising teacher education for the Fourth Industrial Revolution and knowledge democracy: teaching beyond the 3Rs

Toward reimagining initial teacher education for an increasingly complex and fast changing world

Keynote address 11 July 2019

The Fourth Industrial Revolution is a term coined by Professor Klaus Schwab, Founder and Executive Chairman of the World Economic Forum. He makes the case in his 2016 book, *The Fourth Industrial Revolution*, that we are at the beginning of the "new technology revolution" that is fundamentally changing our lives.

He says, "Consider the unlimited possibilities of having billions of people connected by mobile devices, giving rise to unprecedented processing power, storage capabilities, and knowledge access. Or think about the staggering confluence of emerging technology breakthroughs, covering wide-ranging fields such as artificial intelligence (AI), robotics, the internet of things (IoT), autonomous vehicles, 3D printing, nanotechnology, biotechnology, materials science, energy storage, and quantum computing, to name a few." He notes that he is aware that some consider the developments that he is referring to as a continuation of the Third Industrial (Digital) Revolution. However, he maintains that a fourth revolution has started. He argues that the breadth, depth and velocity of technology developments have a systems impact, involving the transformation of entire systems across (and within) countries, companies, industries and society as a whole.

Whether or not one agrees with Schwab about the term Fourth Industrial Revolution (4IR), or Industry 4.0, as the Fourth Industrial Revolution has become popularly known, it is indisputable that the exponential pace of technology developments will result in a future that is volatile, uncertain, complex and ambiguous, often referred to by the acronym VUCA.1

This understanding has given rise to the widespread call that education should explicitly address the skills or competencies that young people need to acquire to prepare them (as far as it is possible to do so) for the future. These competencies are generally referred to in the education literature as 21st century (C21) skills/competencies. Frameworks in which these competencies are presented abound and many countries have reconsidered school curricula in the light of the changing demands of the 21st century.

1 Education and skills 2030: Conceptual Learning Framework, OECD, 2017.

But let me deviate for a moment by sharing a view that I am often confronted with as a Dean of Education in South Africa. I am often told: "Universities are not preparing students sufficiently for the demands of teaching. Teacher education graduates are not classroom ready. You are much too theoretical." Nowadays another issue is often raised: "So – what are you doing to prepare prospective teachers for the Fourth Industrial Revolution?"

So, teacher education institutions are faced with seemingly competing demands – should pre-service teachers be prepared for the schools that are or the schools that should be, or the schools of the future?

In my presentation today I choose not to address education and teacher education for 4IR, but to rather speak to the type of education and teacher education required for a rapidly changing world and uncertain future in which technology is increasingly pervasive.

My presentation does not attempt to propose a teacher education curriculum for this VUCA world, and it does not give detail on the desired teaching practices (including the important component of school practice/experience) for teacher education. I rather offer ideas and questions that may elicit conversation about whether initial teacher education requires reimagining and, if so, how. And I take it as a given that a VUCA world demands continuous development of teachers. My interest is in how initial teacher education could/should provide a solid basis for navigating future education needs.

The paper will unfold as follows: I will briefly note some of the 21st century skills/competencies frameworks. Thereafter I will mention the curriculum framework "Four Dimensional Education" developed by the Centre for Curriculum Redesign2 and will draw on the work of David Perkins, *"Future wise. Educating our children for a changing world"*.3 Though David Perkins makes it clear that his interest pertains to the school curriculum, I find his ideas powerful and provocative for thinking about curricula for teacher education.

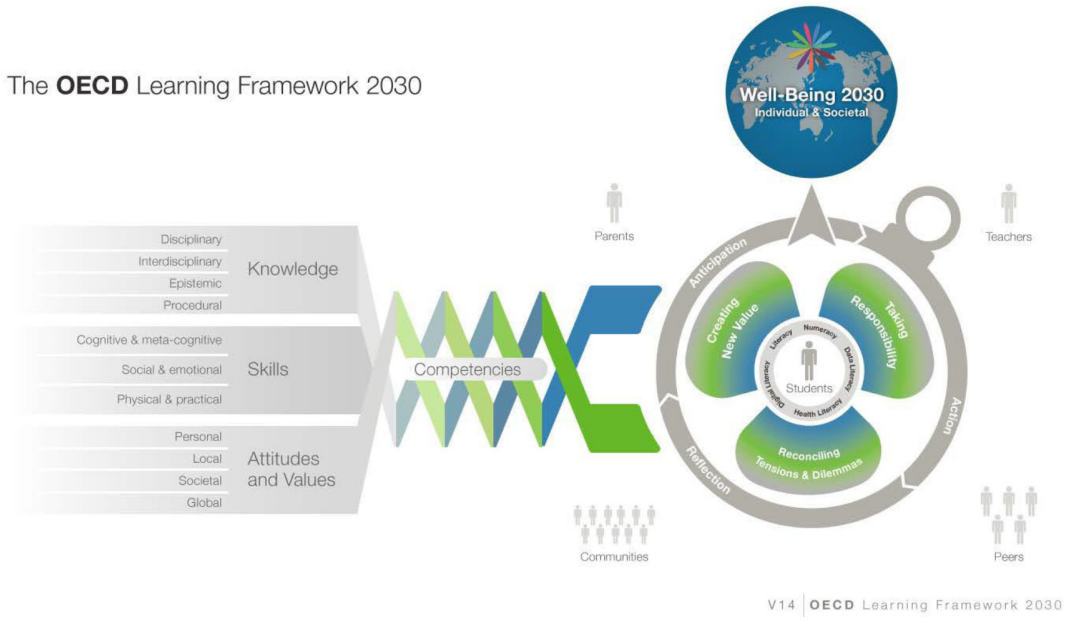
A plethora of skills/competencies frameworks for 21st century education have been developed, and a summary of some of these can be found in the 2012 article authored by Joke Voogt & Natalie Pareja Roblin, entitled "A comparative analysis of international frameworks for 21st century competences: Implications for national curriculum policies". They note that the frameworks have been developed either under the initiative of international organizations or with the support of private organizations. This indicates that there is a strong interest from society in 21st century skills. They say that from the perspective of curriculum development it is worrying that the education sector

2 Fadel, C.; Bialik, M. & Trillny, B. (2015). Four-dimensional education. The competencies learners need to succeed. Center for Curriculum Redesign, Boston, MA.

3 Perkins, D.N. (2014). Future wise. Educating our children for a changing world. San Francisco. Jossey-Bass.

does not seem to be widely involved in the 21st century initiatives or in the overall debate about these skills/competencies.

Today I briefly refer to some of the most well-known and comprehensive frameworks. The first is the "Framework of Future Competences" developed by UNESCO's International Bureau of Education. This Framework acknowledges Industry 4.0 as a formidable accelerant of change and complexity in the 21st century, and as having significant implications for school curricula. The second framework is the OECD learning compass, a product of the Organisation of Economic Cooperation and Development "Future of Education and Skills, 2030" project. The OECD describes the learning compass as an "evolving learning framework that sets out an aspirational vision for the future of education." The framework is not a curriculum framework, but provides a broad vision of the type of competencies4 that students will need to thrive in 2030 and beyond.5

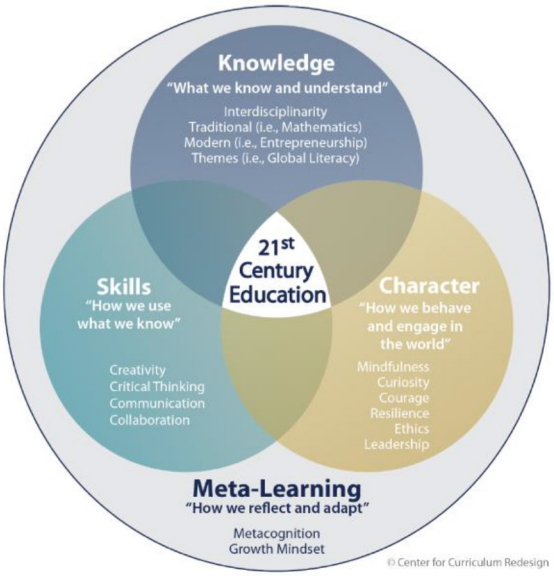


I also highlight the Four Dimensional Education Framework put forward in the book *Four Dimensional Education* authored by Charles Fadel, Maya Bialik and Bernie Thrilling. This framework aims to synthesize "existing research and best practices" (p. 29) and serves as an organising/guiding framework that can help to re-examine school curricula for 21st-century education. The framework includes four

4 According to the OECD (2005), a competency is: "more than just knowledge and skills. It involves the ability to meet complex demands, by drawing on and mobilising psychosocial resources (including skills and attitudes) in a particular context. For example, the ability to communicate effectively is a competency that may draw on an individual's knowledge of language, practical IT skills, and attitudes towards those with whom he or she is communicating" (OECD, 2005: 4).

5 OECD. (2017). Future of Education and Skills 2030: Reflections on Transformative Competencies 2030 (No. EDU/EDPC(2017)16/ANN5). Paris, France: Organization for Economic Cooperation and Development.

dimensions, namely knowledge (what we know and understand), skills (how we use knowledge – what we do with what we know), character (how we behave and engage in the world), and meta-learning (how we reflect and adapt). Though the dimensions are differentiated, they are also intertwined as the graphic representation shows.



While the many 21st-century education frameworks organise/group the desirable learner competencies in varied ways, what they all have in common is recognition of the need to develop competencies beyond the knowledge domain. The case is made for reconsidering the structure and content of school curricula to ensure that there is room to infuse competencies that are deemed crucial to survive in a VUCA world. In his prologue to the book *Four Dimensional Education* Andreas Schleicher (p.1) says: "Put simply, the world no longer rewards people just for what they know – search engines know everything – but for what they can do with what they know, how they behave in the world, and how they adapt. Because that is the main differentiator today, education is becoming more about creativity, critical thinking, communication, and collaboration; about modern knowledge, including the capacity to recognize and exploit the potential of new technologies; and, last but not least, about the character qualities that help fulfilled people live and work together and build a sustainable humanity".

So, if this is what education must deliver in schools, how do we prepare pre-service teachers for this? What is crucial for pre-service teachers to learn, taking into consideration that predictions about future education are bound to be partially flawed? What is crucial for pre-service teachers to learn to best prepare them for the future? How do we decide what to include/exclude in teacher education curricula, given the vast array of potentially significant options, which academics would uphold as vital? How do we create teacher education curricula

that will help pre-service teachers to be sufficiently versatile to succeed as teachers no matter how the world changes?

Before delving deeper, let me first make the somewhat obvious point that many of the so-called 21st-century skills are not new or 21st century at all. The desire to cultivate the four Cs – critical thinking, creative thinking, communication, and collaboration, which are widely touted as fundamental 21st-century skills, has been around for a long time. Kirchner and Stovayov6 make the point that due to the information explosion, coupled with the lack of guarantee of the reliability of that information, the skills that are truly 21st century are information literacy and information management. These authors therefore prefer the term "future-proof learning" when referring to the skills, knowledge and attitudes "necessary to continue to learn in a stable and enduring way in a rapidly changing world". Having said this, Yuval Noah Harari rightly notes in his book *21 Lessons for the 21st Century*, that education has been rather slack in deliberately cultivating the four Cs, an assertion with which I agree. I also agree with Charles Fadel, that a claim that the four Cs are prominent in a curriculum is valid only if there is evidence of deliberate, systematic and demonstrable infusion of the four Cs.7

Presently, teacher education is often criticised for not preparing pre-service teachers adequately for teaching. This is widely reported in the education literature and in social media. The criticism in social media is frequently harsh and a recurring theme is that teacher education is often driven by ideology instead of solid research and the needs of education systems. Many claim that new teachers struggle with the practical aspects of teaching because teacher education is too theoretical. Smagorinsky et al. (2003: 1400) note the perceived disconnect between teacher education and the complex world of classroom teaching as university teacher educators being "aloof within the ivory tower, espousing ideals and the principles that govern them," while teachers engage in practice "in the teeming world of the classroom".

I was confronted with this type of criticism first-hand. A group of dynamic young people who are all passionate about education meets regularly. The majority are teachers, but the group also includes others with a keen interest in education. The group invited two academics from other universities and me for a conversation about teacher education. It was a sobering conversation. The participants were unanimous in their judgement that parts of what they had encountered in teacher education programmes, particularly in the coursework, were irrelevant for the realities of teaching. To be clear, they did not claim that education theory is immaterial for teaching. But

6 Paul A. Kirchner and Slavi Stoyanov, 2018: Educating Youth for Nonexistent/Not Yet Existing Professions, Educational Policy, 1–4. DOI: 10.1177/0895904818802086.

7 Workshop with National Education Collaboration Trust (NECT) Sandbox team, Johannesburg, South Africa, 22 January 2019

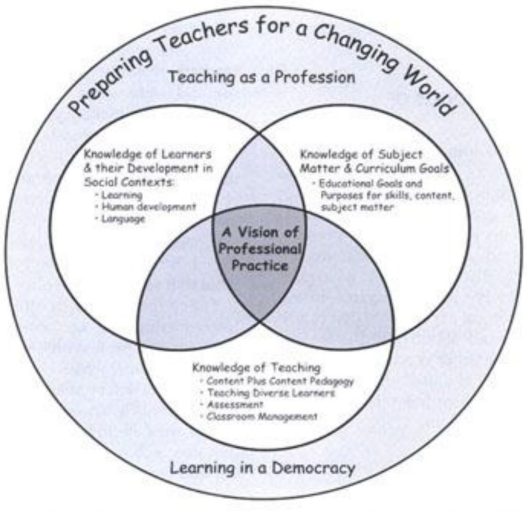
they were pleading for relevance and significance. In response to what they said, I argued that the hallmark of all good programmes preparing students for the professions, including the teaching profession, is that theory and practice are not separate, but intertwined. Theoretical perspectives are lenses through which practice is studied and practice is used to inform and probe aspects of theories. Theories are thinking tools, not abstractions without use. However, this was obviously not how they had experienced some theoretical perspectives in their teacher education programmes. Many spoke about courses/themes that reflected lecturers' personal interests or fields of expertise that had little relevance for the "teeming world of the classroom".

So, what is to be done? What does the call for relevance mean for initial teacher education – for now and for the future?

First, I will discuss the knowledge that teachers are required to possess. I will restrict the knowledge focus here to the pedagogical knowledge base of teaching/teachers, which Veloop, Van Driel and Meijer define as "the pedagogical-related knowledge that is relevant to teachers' activities in a teaching-learning situation" (2001). I will not address subject matter knowledge required for teaching. I take this as a given.

Lee Shulman's seminal categorisation (1985; 1986), which is still widely used today, proposed that the knowledge base of the teaching profession comprise the following categories: general pedagogical knowledge, content knowledge, pedagogical content knowledge, curriculum knowledge, knowledge of learners and their characteristics, and knowledge of educational contexts.

Another framework is discussed in the book *Preparing teachers for a changing world: What teachers should learn and be able to do*, edited by Linda Darling-Hammond and John Bransford (2005). This framework deals with the knowledge base that teachers need to have to teach for a changing world:



Generally, teacher education programmes address many of the dimensions noted in the Shulman categorisation and the Darling-Hammond Framework. And both the Shulman categorisation and the Darling-Hammond framework make sense to me as a teacher educator. I also suspect that the young people that I engaged with will agree on the importance of many of the categories/features. So, the relevance issue probably does not pertain to the overarching knowledge areas that are addressed in teacher education, but with the detail of learning content in courses and how the content is presented in the programme. The *what* and the *how* of the curriculum are intertwined.

This leads to questions like: On what basis are decisions made on what to include/exclude in teacher education programmes, and to what extent are these decisions based on convention/tradition? Is quality/rigor perhaps equated with quantity, so that teacher education curricula are overloaded? (As an aside, David Perkins says that curriculum often "suffers from something of a crowded garage effect: it generally seems safer and easier to keep the old bicycle around than to throw it out".) Are programmes structured to ensure coherence and cohesion in the curriculum such that it is aligned to a central vision of professional practice, or is it left to individual academics to decide?

David Perkins' book *Future Wise* provoked me to think deeply about these questions. I use some of his ideas about a future wise school curriculum to deliberate about teacher education that would potentially prepare pre-service teachers to function in a VUCA world.

Perkins talks in the opening paragraphs of his book of the irritating learner who would interrupt a lesson with the question "Why do we need to know this?". He confesses that he hates this question as a teacher, but adds that this is a crucial question, because the question is an uppity version of the most important question in education, namely "what is worth learning in school"? This appears to be the same issue that the young people that I engaged with raised, namely the irrelevance of many aspects of the curriculum content in teacher education programmes to teaching practice. To use Perkins' term, they yearned for "lifeworthy" teacher education.

Using the lens of "lifeworthiness", questions such as the following become pertinent. Which key perspectives, processes, methods and tools have especially promising payoffs in the lives pre-service teachers are likely to live as teachers? To what extent are these perspectives, processes, methods and tools likely to matter in teachers' lives? How often will they serve to inform teacher/teaching decision-making and action? With what importance? Will they remain significant over time or will they be simply forgotten?

I can hear some of my colleagues saying that I seem to be propagating a utilitarian curriculum devoid of theory. Far from it. I can also hear

them arguing fervently that particular concepts and theoretical perspectives have intrinsic value. This may be the case. However, if the pre-service teachers do not see the intrinsic value and they experience them as irrelevant for their lives as teachers, how will they feature in their lives as teachers? As Perkins (2014: 10) reminds us: "The hard fact is that our minds hold on only to knowledge we have occasion to use in some of our lives. Overwhelmingly knowledge unused is forgotten. Whatever its intrinsic value might be, it can't be lifeworthy unless it is remembered."

We need to confront and embrace the challenge of the relevance gap. We need, to use the ideas of Charles Fadel8 and David Perkins in combination, curate the learning content in teacher education programmes for relevance in relation to lifeworthiness. And we must be willing to let go and concede that our opinions as experts in our respective fields are partial and biased. Charles Fadel and his co-authors (p. 28) rightly note that experts often "feel responsible for upholding earlier standards, as they have sometimes been part of creating them and promoting their benefits. Being loyal to their field of study, they also find it difficult to discard parts of the whole cloth of their field's knowledge, even after those parts have become outdated or less useful. And their field looms more important in their eyes than any other."

Lifeworthy teacher education for a VUCA world necessitates the inclusion of newer themes/topics and 21st-century literacies. The 21st-century literacies that pre-service teachers need to acquire are digital literacy and information literacy, and my view is that these literacies should be taught explicitly as well as be embedded in the teaching practices of teacher education programmes.

Digitalisation in all areas of life is a given. Also, through digitization, information output is growing exponentially. Pre-service teachers need to learn how to search for relevant information and, "to read, interpret, make meaning of and communicate through digital texts and sources from a variety of online media."9 They also need to learn to evaluate the quality and reliability of information and how to manage information so as to enable them to also teach this in schools.

With the explosion of data and the advent of "big data", we all need to be data literate. We need to be able to read, work with, analyse and argue with data, and understand "what data mean, including how to read charts appropriately, draw correct conclusions from data, and recognise when data are being used in misleading or inappropriate ways" (Carlson et al., 2011). We also need to learn how to communicate with data.

8 Charles Fadel. Presentation on "Four Dimensional Education for the 21st Century", delivered at a discussion on "Effects of the Fourth Industrial Revolution on Education", organised by the NECT, 26 October 2017, Johannesburg, South Africa

9 OECD Future of Education and Skills 2030 Concept Note © OECD 2019

Data literacy and information literacy is related to critical thinking because analysis and evaluation are inherent to these literacies.10

Though teaching with Information and Communication Technology (ICT) cannot be considered as "new" anymore, initial teacher education programmes may not have a sufficient focus on the use of ICT for teaching. The 2019 OECD Teaching and Learning International Survey (TALIS) report indicates that only 56% of teachers reported that the use of ICT for teaching was included in their teacher education programmes, and only 43% of teachers felt well or very well prepared to use ICT in teaching when they completed their initial teacher education. Thus, it seems as if teaching with ICT is not receiving the attention that it deserves in a digital era. Importantly, I would argue that for pre-service teachers to learn how to teach with technology requires not only teaching them how to do this, but that they should also experience this type of teaching themselves.

Another aspect that will have to receive increasing attention in future is teaching with artificial intelligence (AI) – how AI can be harnessed to improve education and opportunities of learners. Some of the possible advantages of AI noted in the OECD document *Education and AI: preparing for the future & AI, Attitudes and Values* are:11 Helping everyone to know through presenting knowledge to learners in a variety of modes; providing access to knowledge and information for those with additional educational needs; personalising learning, individualising of feedback, freeing up (human) teachers to work with learners on other things; repetition, drill and practice; supporting collaboration; and assessing and monitoring learner progress.12

It is also argued that teacher education curricula have not kept up to date with new pedagogical and learning research. Van Damme (2017)13 asks the question in the introduction to the book *Pedagogical Knowledge and the Changing Nature of the Teaching Profession*: Does the knowledge base of teachers sufficiently incorporate the latest scientific research on learning? Ansari, Konig, Leask and Tokusgama14 make a convincing case for including developmental cognitive neuroscience, integrated with cognitive science and other research in the learning sciences in teacher education programmes.

10 Key Competences and New Literacies: From Slogans to School Reality. National Research University, Higher School of Economics, 2018

11 Future of Education and Skills 2030: Conceptual Learning Framework

12 Future of Education and Skills 2030: Conceptual Learning Framework, Education and AI: preparing for the future & AI, Attitudes and Values. EDU/EDPC(2018)45/ANN2

13 Guerriero, S. (ed.) (2017), *Pedagogical Knowledge and the Changing Nature of the Teaching Profession*, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264270695-en

14 Developmental cognitive neuroscience: Implications for teachers' pedagogical knowledge. In: Guerriero, S. (ed.) (2017), *Pedagogical Knowledge and the Changing Nature of the Teaching Profession*, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264270695-en

An important point to underscore is that knowledge that is lifeworthy does not necessarily end up being "life-ready" (another term that David Perkins uses). Lifeworthy knowledge for teaching becomes life-ready when pre-service teachers are able to think with a topic (instead of merely thinking about the topic) and when the lifeworthy knowledge informs appropriate action, decision-making, and problem solving. Perkins notes that lifeworthy knowledge becomes life-ready when pre-service teachers are "ready to think with it, apply it, notice when the circumstances invite it, and care about the explorations it provokes and the answers it leads you to." The latter relates to relevance – pre-service teachers must recognise and appreciate the value of the knowledge for teaching.

The four features of life-ready knowledge that Perkins notes all contribute to what is usually called transfer of learning (2014: 111). It is beyond the scope of this paper to explore the vast body of research on transfer. However, what I wish to underscore here is that the development of life-ready teaching/teacher knowledge for an unknown future requires teaching practices that have the best potential to enable knowledge transfer to new problems and situations.

The type of learning required by teachers to be able to acquire 21st-century competencies and engage in learning for knowledge transfer is "deep(er) learning", also referred to as "meaningful learning" (Pellegrino, 2017). Pellegrino (2017: 229) makes the case that "through deeper learning, individuals not only develop expertise in a particular discipline, they also understand when, how and why to apply what they know. They recognise when new problems or situations are related to what they have previously learned, and they can apply their knowledge and skills to solve them." Here I note a few teaching practices that support deeper learning to make the point that teaching for deeper learning (transfer) is time-consuming and requires repeated practice. These include teaching practices that create ample opportunities for student teachers to:

1. use the four Cs, through e.g. questioning of claims and evaluating evidence for claims, considering and evaluating alternative points of view, peer tutoring and peer assessment, projects which require collaboration and personal accountability, and tasks/projects that invoke playful learning;
2. engage in meta-learning that requires them to practise self-monitoring, reflect on their learning experience processes in relation to the learning goals, and visualise their thinking;[15]
3. explore multiple and varied representations of concepts and tasks and how they interrelate;
4. engage with content through questioning such as why, how, what if, what if not, so what;

15 Innovating Pedagogy 2019. Exploring new forms of teaching, learning and assessment, to guide educators and policy makers. Open University.

5. engage with challenging tasks and ill-structured problems aided by supportive and explanatory guidance; and
6. engage extensively with examples and cases to explore how a principle, method or perspective could be relevant to a variety of situations and when it is appropriate to use these (what Perkins refers to as noticing).

It is of course also crucial that assessment practices should be designed to support and elicit deeper learning. It is indeed the case that assessment practices signal powerfully what is truly valued in higher education. Derek Rowntree (1987: 1) argues: "If we wish to discover the truth about an educational system, we must look into its assessment procedures. What student qualities and achievements are actively valued and rewarded by the system? How are its purposes and intentions realized? To what extent are the hopes, ideals, aims and objectives professed by the system ever truly perceived, valued and striven for by those who make their way within it? The answers to such questions are to be found in what the system requires students to do *in order to survive and prosper. The spirit and style of student assessment defines the de facto* curriculum".

A few concluding remarks: The core argument in this paper is that the VUCA world in which we live necessitates that we carefully assess current teacher education curricula using lifeworthiness for the lives of teachers as a yardstick. I also argued that lifeworthy knowledge requires conversion to life-ready knowledge through creating a learning environment in teacher education that fosters deeper learning – learning aimed at transfer. Deeper learning is time consuming and cannot be supported in an overloaded curriculum.

I would argue that reimagining initial teacher education using the lifeworthy and life-ready lens will enable us to deal with the seemingly competing demand to prepare pre-service teachers for the schools that are, as well as for the education needs of/for the future. I would also claim that lifeworthy and life-ready teacher/teaching knowledge will go a far way to address the theory-practice divide that plagues teacher education.

All of this can of course not be done if teacher educators work in silos. Ensuring a lifeworthy and life-ready programme for pre-service teachers calls for teacher educators to embrace a shared vision and collaborate closely towards ensuring as much coherence and cohesion as possible. This requires open minds and, dare I say, the setting aside of academic egos.

A last point. The Faculty of Education at UJ is involved in a project spearheaded by the South African National Education Collaboration Trust (NECT) on 21st Century education. It is called the Sandbox project. Ten public primary schools (Sandbox schools) have been selected in the Waterberg district of Limpopo, a rural province of South Africa,

where a pilot is in the process of being initiated. The Funda UJabule School, a school situated on UJ's Soweto Campus, will also participate in the pilot. The pilot is meant to learn how competencies for the 21st century could be infused into schools, taking as a given that improving the universal basic skills of literacy and numeracy remains vital. They form the foundation for success in education. But concentrating on these does not need to preclude nurturing the other competencies that children would need to negotiate the VUCA world. This is to me a social justice imperative. While implementing the pilot, UJ academics and postgraduate students will also research implications for teacher education and development.

Response to Prof Sarah Gravett, ICET July 2019

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Maureen Robinson is a Professor in the Department of Curriculum Studies in the Faculty of Education at Stellenbosch University. She has worked as a high school teacher in low-income schools, and a lecturer and materials developer at the University of the Western Cape, teaching action research and curriculum innovation.

She has served as Dean of the Faculty of Education at two universities: the Cape Peninsula University of Technology (2002–2012) and Stellenbosch University (2012–2017).

She has participated in various national and international research and policy structures for teacher education, including a previous stint as Africa representative on the Board of ICET. Her research interests are teacher education, professional learning and educational reform and she has led various research projects and published on this topic. Her most recent national research project was on the establishment of Professional Practice schools in South Africa. Currently, she is responsible for undergraduate and postgraduate modules in the fields of practitioner inquiry, practical learning and curriculum change and leads a research project on connecting research, policy and practice in teacher education. Her ongoing area of interest is how teacher education can contribute to social justice in her country.

Professor Gravett's presentation provides a number of helpful frameworks to consider the vision, aims and design of teacher education, against the background of the Fourth Industrial Revolution. In essence, I think she is posing two central questions:

In the context of the fundamental societal changes being brought about by the Fourth Industrial Revolution:

- What must and should we as teacher educators hold on to, and
- What must and should we as teacher educators do differently?

I want to highlight some pointers on each of these, and then provide some closing cautionary comments.

What must and should we as teacher educators hold on to?

Professor Gravett eloquently sketches some of the enduring values that permeate the work of most teacher educators, whatever their historical and geographical context. She draws on the helpful framework for how we understand teaching, as developed by colleagues at the Centre for Curriculum Redesign in Boston. They highlight four core dimensions of what needs to be taught, whatever the historical or geographical contexts. These dimensions are *knowledge* (what we know and understand), *skills* (how we use knowledge/what we do with what we know), *character* (how we behave and engage with the world) and *meta-learning* (how we reflect and adapt). These are enduring features of education, but how should we consider these in the context of 4IR?

The question that she raises of how we prepare teachers to be versatile to succeed as teachers, no matter how the world changes, is one that all of us can relate to. Similarly, the promotion of life-ready and life-worthy knowledge can and should underpin the work of teacher educators, no matter how the world out there evolves.

So there is much that we need to hold on to. However, we cannot rest on our laurels or be complacent. Professor Gravett has alerted us to the criticism that the education sector does not seem to be widely involved in the 21st-century initiatives and in the overall debate about skills and competences for the future.

I would go further and say that our credibility as educators is at risk, for if we are not seen as ready for this world, others will fill the gap. So this means that we have to – individually and collectively – confront the question of **what must and should we as teacher educators do differently**?

At the most obvious level, as she mentions, there is the challenge of new subject content. Suddenly we are hearing about coding and robotics being introduced into the school curriculum. I am sure that there are many professors of education who will struggle to explain what coding and robotics means, let alone teach about these. This is a humbling experience for those of us who have been in education for many years.

The digital age (or the Third Industrial Revolution) has created new vistas for our students, as landscapes open via the World Wide Web, collaboration is promoted through social networks, and new forms of literacy emerge. This in itself, even before we reach 4IR, is leaving many teachers and teacher educators behind.

The notion of new jobs being created and old jobs changing creates huge challenges for us who are trying to prepare teachers who will prepare others for gainful employment. If we list the kinds of skills, competencies and attitudes, let alone knowledge, that we are being expected to develop, it is quite overwhelming – learning, innovation, information literacy, being curious, critical, analytic, working in interdisciplinary ways, teamwork, cognitive flexibility, etc. These skills and competencies cross human and technological domains and in themselves might require particular forms of pedagogy. As the first keynote speaker said, we will be requiring people with high levels of cognitive ability, people who are, as he put it, "critical thinkers with practical skills".

What challenges will this bring for teachers and teacher educators who may themselves not be ready to impart the relevant knowledge and skills? It seems to me that there will need to be a massive upskilling of educators, something which requires substantial human, technical and financial resources. Careful organisation and planning for the context is also crucial, so that one does not hear stories about tablets being donated to schools and not being used, or teachers being asked to bring

their smartphones to workshops, when they don't have smartphones.

We also need to be realistic about our role, and know that it is not only via the formal curriculum that people learn, but also through extra-curricular experiences that hopefully promote dialogue, collaboration, etc.

So I am sure you will all agree that the bells, whistles and keyboards of technology do not always make for an effective learning environment. So this is where I become conservative. I want to see new teachers prepared for a new technological world, but I also want them to be excellent educators in the traditional sense of the word – able to organise learning in systematic ways, and to motivate young people for ongoing learning towards improving their own futures as well as the futures of others. If education can sustain its work towards this one core goal, I think we can hold our own in this fast-changing and somewhat threatening world.

We need more discussion on the relationship between 4IR and the systemic problems of our global economy. In South Africa we already have a massive problem of youth unemployment and much has been written on the relationship between a learner's social background, educational opportunities, and life trajectory. Will 4IR be able to break this cycle, and if so, how?

Finally, as promised, **a few cautionary comments.**

We who are at this conference represent our particular local contexts and, simultaneously, through ICET and other forums, we participate in global networks. In both these contexts, the Fourth Industrial Revolution, and the use of technology, may not be the panacea for our problems, and may in fact create new problems.

At a local level, we know there are many children who do not have access to the basic infrastructure of classrooms, toilets, libraries, science laboratories, etc. We do not want to hear the same criticisms as those levelled at our own president here in South Africa, who called in his State of the Nation address two weeks ago to utilise smart technology to build a new modern city, when our current cities are far from functional.

Many teachers work in poor conditions – let us hope that politicians and technocrats do not leapfrog into a 4IR world before addressing the improvement of these working conditions.

At a global level, I am concerned by the loud and persistent calls of private companies who offer us commercial tools for teaching (at reduced prices for bulk purchase). Suddenly everyone is an educator, buzz words like child-friendly are in advertisements from big ICT companies, money is being spent on supposed quick-fixes for our educational problems.

At an intellectual level, we need to be careful that the hype around 4IR does not sideline other important philosophical debates about education, linked to topics like decolonisation, social justice, ethical agency, democracy and the like.

The different elements of social justice as outlined by Nancy Fraser help us here – even if technological resources become more widely *distributed* across contexts, if there is no *recognition* of the wide variety of contexts of schooling, and no *representation* of teachers from all parts of the globe in designing appropriate curricula – we may find ourselves in new forms of exploitation and colonisation, as big companies move in and take over the building of local capacity.

So I would like to end by thanking Professor Gravett for her insightful presentation, and for creating a forum for a deep and complex conversation that is likely to continue for years to come.

REVIEWED PAPERS

USING AN EMPOWERMENT EVALUATION APPROACH IN "TAKING STOCK" OF THE INQUIRY-BASED PEDAGOGY OF SOUTH AFRICAN PHYSICAL SCIENCES TEACHERS

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Abstract: The purpose of this study was to capture, portray and develop the pedagogical practice of physical sciences teachers in inquiry-based teaching using an empowerment evaluation approach. Empowerment evaluation is the use of evaluation concepts, techniques and findings to foster improvement and self-determination (Fetterman, 2001). It focuses on helping people help themselves and improve through self-evaluation and reflection. Empowerment evaluation commences with "taking stock" (Fetterman, 2002), an assessment of the teacher's pedagogical practices (their teaching methods and preferences). By "taking stock", a baseline is established to measure future progress. This is followed by "setting goals", where there is a consensual agreement between the teacher and the researcher. The third step will involve participating teachers selecting and developing strategies to accomplish the set goals. Thereafter, progress is documented and evaluated. The research reported in this paper is on the first step of empowerment evaluation, namely, "taking stock". This is a case study of three physical sciences teachers in the implementation of an inquiry-based pedagogy in South African township schools. Underlying an inquiry-based pedagogy is the assumption that science education is not merely about knowing-acquisition, but understanding how scientific knowledge is generated, evaluation of knowledge claims and conducting scientific research. Scientific inquiry has been advocated as a common curriculum goal in school science education in South Africa, and also throughout the world. Data were collected by means of semi-structured interviews, the Pedagogy of Science Teaching Test-Physical Sciences (POSTT-PS) instrument and classroom observations. The findings showed that teachers in township schools adopted a teacher-centred pedagogy in inquiry-based teaching. Teachers also prioritised the data collection phase in inquiry over other stages during their inquiry-based teaching. This pedagogical orientation that was assumed appeared to be largely influenced by factors such as a lack of resources, unprepared learners, insufficient time and the demands of summative assessment. These findings suggest that despite the strong curriculum emphasis on learner-centred inquiry, teachers are reluctant to embrace this curriculum reform due to the reality of the context in which they teach.

Keywords: inquiry-based teaching, pedagogical practice, professional development, empowerment evaluation

Introduction and background

A key curriculum goal in school science education in many countries has been to encourage science teachers to use an inquiry-based approach to their teaching, as a means to develop learner understanding of science concepts (Ramnarain, 2015). Scientific inquiry has been advocated as a common curriculum goal in science education in South Africa and this imperative is expressed in the new Curriculum and Assessment Policy Statement (CAPS) document (Ramnarain, 2016). To this end, every teacher is expected to use inquiry when teaching science (Department of Education, 2002). The theme of teaching science as inquiry probably dates back to the Heuristic Movement of the late 19th century but became a global phenomenon after the launching of Sputnik in 1957. This approach to teaching has its philosophical and theoretical roots in the work of Jean Piaget, John Dewey and Lev Vygotsky (Doolittle & Camp, 1999). Inquiry teaching is the pedagogical approach that models aspects of scientific inquiry (Bybee, 2004). A central aim of inquiry teaching is to develop learners' intellectual autonomy thus the teacher's role as expert shifts to that of facilitator or catalyst for learners' learning (National Research Council (NRC), 1996). Inquiry-based teaching, in this sense, is not merely a pedagogical technique but also entails a deep change in values embodied in education. Underlying this new pedagogy is the assumption that science education is not merely about knowledge acquisition, but understanding how scientific knowledge is generated, evaluating knowledge claims and conducting scientific research participation. In this manner, science education is more than inculcating "what we know"; it should also give learners a sense of "how we know" and "why we believe what we know over alternatives" (Duschl & Duncan, 2009). Inquiry-based learning is also key in preparing learners for the advent of the Fourth Industrial Revolution. Whereas routine skills were desirable in the past, today each person is expected to think critically, apply creativity to solve abstract problems and generate new ideas for improvement.

Inquiry-based teaching has several benefits and these include improved achievement, knowledge application, thinking and problem-solving skills, and attitudes toward learning (Saunders-Stewart, Gyles & Shore, 2012). Studies have reported that inquiry-based learning experiences enhance learners' motivation to learn science (Crawford, 2012), improve understanding of concepts (Gott & Duggan, 2002), facilitate collaboration between learners (Hofstein & Lunetta, 2004), result in greater learner achievement (Edelson, 1998) and help develop processing skills (NRC, 1996). The South African science curriculum advocates an inquiry-based approach to practical work that encourages exploration, data collection and drawing conclusions with accuracy (Department of Education, 2002). However, despite the many benefits of inquiry-based teaching in literature and the calls to implement inquiry-based teaching in their classrooms, teachers struggle to implement reform-based approaches to teaching science (Lebak, 2015).

Research worldwide has shown that inquiry-based teaching is underplayed. A study in South Africa revealed that teaching and learning were, and still are, very much content-based in a significant number of schools (Maree & Fraser, 2004:6). In the United States, Capps and Crawford (2013) found little evidence of inquiry in classrooms of even highly motivated, well-qualified science teachers. This suggests the dominance of the traditional teaching methods that are full of rote learning and memorisation of content. This may possibly be attributed to the fact that many teachers have little knowledge of inquiry-based teaching or training in how to implement inquiry in the classroom (Bybee, 2004). Furthermore, many in-service teachers have had little or no experience as learners in inquiry-oriented classrooms. Thus, they are asked to implement a strategy that is an abstract construct to them, rather than something they have personally experienced (Lotter, Harwood & Bonner, 2006). Research suggests that teachers who lack experience, confidence and general pedagogic content knowledge will resort to methods of expository teaching, rote learning and avoiding classroom situations where something might go "wrong" (Taylor & Vinjevold, 1999).

This study examines the shifts in individual teacher's pedagogical practice after undergoing an empowerment evaluation programme in the inquiry-based teaching of science. Empowerment evaluation is the use of evaluation concepts, techniques and findings to foster improvement and self-determination (Fetterman, 2001). Empowerment evaluation may be the approach that can be exploited in South African schools to facilitate on-the-job, self-initiated professional development that is environmentally aware and ongoing. It focuses on helping people help themselves and improve through self-evaluation and reflection. The use of self-evaluation as a means of assisting teachers to improve their pedagogical practices provides a non-threatening environment for reflection and experimentation.

Framework of empowerment evaluation

Empowerment evaluation is the use of evaluation concepts, techniques and findings to foster improvement and self-determination (Fetterman, 1994). It focuses on the empowering process and the outcomes. Empowerment evaluation is designed to help people help themselves and improve their programmes using a form of self-evaluation and reflection. The participants conduct their own evaluation and an outside evaluator often serves as the coach. The evaluator's role is that of a collaborator and facilitator rather than an expert counsellor. The evaluator learns about the participants through their culture, their worldview and their life struggles. The evaluator works with participants instead of advocating for them. The evaluator does not impose skills, interests or plans on the participants; rather the evaluator becomes the resource for the participants. What the evaluator does will depend on the particular place and people with whom he or she is working, rather than on the technologies that are predetermined to be applied in all situations. Interpersonal and evaluation skills are necessary, but how, where and with whom they are applied cannot be automatically assumed. The evaluator does not and cannot empower anyone; people empower themselves, often with assistance and coaching. The evaluator must work towards making evaluations, a necessary and valuable activity. The evaluator and evaluation component is a means of empowerment. Evaluation is seen as a necessary process and an integral part of any advocacy or development work.

Empowerment evaluation allows the participating teachers to craft a solution for their local problem. Empowerment evaluation commences with taking stock (Fetterman, 2002), an assessment of the teacher's pedagogical practices (their teaching methods and preferences). By "taking stock", a baseline is established to measure future progress. This is followed by setting realistic and immediate goals, where there is a consensual agreement between the teacher and the researcher. The goals must be linked to the teacher's daily activities. Individuals will set their goals, taking into consideration factors such as initial conditions, motivation, resources and programme dynamics. The third step will involve participating teachers selecting and developing strategies to accomplish the set goals. This is achieved through the process of brainstorming, critical review and consensual agreement (Fetterman, 1994:309). The final step is helping the teacher determine the type of evidence required to document progress credibly toward their goals. The research reported in this paper is on the first step of empowerment evaluation, namely, "taking stock". Research on the first step is a part of a larger study where all steps are investigated. Accordingly, the following research question guided the investigation: What is the current pedagogical practice of South African physical sciences teachers in inquiry-based teaching?

Research design and methodology

This study adopted an exploratory case study design. Case studies are detailed investigations of individuals, groups or institutions within their own unique context (Patton, 2002). Yin (2003:13) described the case study through the lens of the research process as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clearly evident". Opie (2004:74) views a case study as "an in-depth study of interactions

of a single instance in an enclosed system". This study will focus on three participants, with each participant constituting an individual case. Hence, this study constitutes a multiple-case design (Yin, 2003). Yin (2004:5) maintains that in a multiple-case design "the data from multiple cases can strengthen your case study findings and make your interpretations more robust".

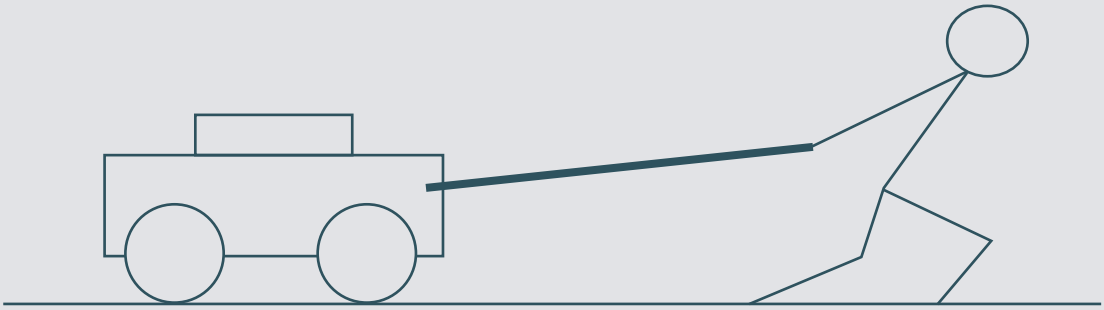
Three physical sciences teachers from a district in Gauteng province were selected for this study. Purposive and convenience sampling was used in choosing these teachers. Purposive in the sense that the researcher selected teachers from which the most can be learned (Merriam, 1998) and convenience because they were accessible in terms of travel time and distance. The three physical sciences teachers were eager to shift their practice towards an inquiry-based pedagogy. Note that each of the participants was assigned a pseudonym to protect his/her identity as required by the university's ethics regulations. Mr Charles was the most experienced of them all, with 13 years teaching experience. He holds a bachelor of education degree (chemistry) and an Advanced Certificate in Education (ACE) — Physical Sciences. ACE is a qualification for in-service teachers who hold at least a three-year teacher's qualification that was offered in South Africa in response to the demand for qualified physical sciences teachers by the Department of Education. Mr Moloku has a diploma in education from a college of education, a bachelor of education degree (physics) and a master's in science and mathematics education. He is highly qualified and has taught physical sciences for many years. He has 16 years of science teaching experience and has taught Physical Sciences for the past 11 years. Mr Kapok is the youngest of the three and holds a bachelor of education degree (natural science). He has taught physical sciences for five years. Mr Kapok had not received any in-service training on inquiry-based teaching.

In "taking stock", data on the pedagogical orientation of the teachers was collected. An instrument called the Pedagogy of Science Teaching Test — Physical Sciences (POSTT-PS) was administered (Ramnarain & Schuster, 2014). The test consists of case-based objective items based on realistic vignettes of classroom teaching situations on science topics. A typical item presents a realistic teaching scenario for a science topic, poses a question about teaching strategy, and offers response options reflecting a spectrum of teaching orientations ranging from direct instruction through guided inquiry to open inquiry. Teaching orientations refer to how a teacher tends to design and structure instruction and learning activities, and deal with common classroom events. The instrument (POSTT-PS) has responses that are classified into four main orientations, namely didactic direct, active direct, guided inquiry and open inquiry. The orientations are grouped into two groups according to their epistemologies. The first two (direct didactic and direct interactive) present science as a known product, and the last two (guided inquiry and open inquiry) present science as inquiry. This results in four main science pedagogical categories, spanning a range which we call a science teaching orientation spectrum (Ramnarain, Nampota & Schuster, 2016). In assuming a direct didactic orientation, the teacher presents and explains the science concept or principle directly to learners, and illustrates with examples and/or demonstrations. A direct interactive orientation similarly entails direct teacher exposition, but this is followed by a learner activity based on the presented science content. The activity could be a hands-on practical verification of the concept or principle. In guided inquiry, the teacher plans an activity where learners explore a phenomenon or idea and, from this, the teacher guides them to develop the desired science concept or principle. In open inquiry, learners explore a phenomenon or idea on their own, devising ways of doing so. They receive minimal guidance from the teacher, after which they report what they did and found. An example of an assessment item is provided below. Note that, for illustrative purpose, the options in this example have labels and are presented in spectrum order: didactic direct,

active direct, guided inquiry and open inquiry. The labels were omitted in practice and the options were varied from item to item.

Example item

Lesson on force and motion: Ms Brandt is preparing a lesson to introduce her 5th-grade learners to the relationship between force and motion, namely that a net force will cause an object to speed up or slow down (Newton's 2nd Law). The classroom has available a loaded wagon to which a pulling force can be applied. Ms Brandt is considering four different approaches to the lesson.



Thinking about how you would want to teach this lesson, of the following, which one is most similar to what you would do?

A. Write a clear statement of Newton's 2nd Law on the board and explain it carefully for my learners. Then I would demonstrate the law by pulling on a loaded wagon with a constant force in front of the class as they observe the motion. ***(Direct didactic)***

B. Write a clear statement of Newton's 2nd Law on the board and explain it carefully for my learners. I would then have the learners verify the law by pulling on a loaded wagon themselves and confirming what type of motion results. ***(Direct interactive)***

C. Raise the question of what kind of motion results from a constant force. I would then guide my learners to explore the question themselves by pulling on a loaded wagon and observing what happens. From the evidence, they would then propose a possible law. ***(Guided inquiry)***

D. Raise the question of whether there is any relationship between force and motion. My learners would then be free to explore this safely in the lab. Afterward, we would have a class discussion of their findings. ***(Open inquiry)***

Quantitative data in the form of responses to POSTT-PS were analysed statistically to establish the teachers' pedagogical orientation. In semi-structured interviews, the teachers were probed on their responses to POSTT-PS. The interviews were recorded and later transcribed. An open coding of the data was first completed, looking for reasons that could explain the option chosen on the test. The codes were then grouped into code families that could form themes (Creswell, 2007) on factors that influence the pedagogical orientation of teachers.

Findings

Table 1 presents results from the responses to the POSTT-PS instrument administered to the participant physical sciences teachers in the study. The table gives the descriptive statistics for teachers' pedagogical orientations. For each participant the percentage of responses for the four teaching approaches over the ten items is presented.

Table 1 Descriptive statistics on the pedagogical orientations of each participant teacher

	Direct didactic(%)	Active direct(%)	Guided inquiry(%)	Open inquiry(%)	Mean orientation	Standard deviation
Mr Charles	10	50	40	0	2.3	.64
Mr Moloku	0	20	70	10	2.9	.54
Mr Kapok	10	30	40	20	2.7	.90
Overall	6.67	33.33	50.00	10.00	2.63	.75

Overall, the participants indicated a very small percentage preference for direct didactic, with the overall percentage being around 6.67%. This was calculated from the number of responses that fell in the DD as a percentage of the total number of responses. This may suggest that direct didactic is not a preferred teaching approach for these teachers. The other teaching approach that exhibited a low percentage preference for the three participants was open inquiry. It has a low percentage (10%), although higher than direct didactic. Active direct and guided inquiry were found to be the most preferred teaching approaches by the three teachers: 33.33% and 50% respectively. This agrees with the findings by Ramnarain and Schuster (2014) in a study conducted in South Africa which regards active direct and guided inquiry approaches as the most preferred methods for township and suburban teachers respectively. Of the three teacher participant combined responses, 60% of responses were inquiry and only 40% were non-inquiry. This was calculated from the number of responses that fell into inquiry (GI and OI) and non-inquiry (DD and AD) as a percentage of the total number of responses. Mr Moloku had 80% of responses falling in inquiry, followed by Mr Kapok with 60% of responses being inquiry. It is only Mr Charles who had only 40% of his responses in inquiry.

In the interviews that followed the analysis of POSTT-PS, the participants elaborated the reasons for these choices. The data from these follow-up POSTT-PS interviews were coded and analysed to come up with reasons that account for certain teaching orientations. The individual teacher elaborations on their preferred pedagogical orientations based on interview data analysis are now presented.

Mr Charles

Mr Charles presents science as a known "product" and believes good teaching is about "making learners understand science content". Thus direct (traditional) methods of teaching are more appropriate to him. There are two variants (direct didactic and active direct) of this mode of teaching in terms of the continuum highlighted before. Of the two variants, he is seen to be inclined towards active direct. He does not want to do everything for them, but understands his critical role in supporting learning.

With this in mind, Mr Charles thinks direct didactic does not engage learners fully and using the method may be viewed as "doing everything for the learners". Despite this view, 10% of his responses to POSTT-PS in this category may mean that there are times that the method may be utilised in his teaching of physical sciences. When asked for the reasons why he selected the response in direct didactic, Mr Charles indicated that he may use direct didactic when teaching concepts that are difficult for learners. Mr Charles is exhibiting the notion that the difficult concepts may be taught through direct didactic. He claims "this approach makes the pathway to understanding smooth for the learners".

When asked to what extent he managed to implement inquiry, the following was his response:

> If you talk of inquiry when learners are in grade 12 and you started in grade 10. Yes, you can tell that you have been somewhere. But at grade 10 they are still struggling to find out; what the teacher wants us to do. After a year in grade 11, they start to see the light. In grade 12 I tell you the grade 12 that we have now, they know their business. It takes time, it's not a once-off thing then you get results.

The assumption in the excerpt above is that inquiry-based instruction needs the teacher to support learners and with time learners will acquire the necessary skills required to successfully navigate through inquiry-based lessons. Mr Charles acknowledges the need for guidance, but there must be a balance between guidance and learner input in an investigation. The other interesting feature he raises is his belief that an experiment comes after the theory lesson, thus the learners already know something about what you are about to do. Mr Charles seems to be saying he can use direct didactic strategies when the learners are quite new to the concept taught and when the content addressed is difficult for the learners to understand. He will not use direct didactic for the topics that are familiar to learners and for content learners find easy to understand. Mr Charles has a bias towards non-inquiry methods of teaching but does not believe in the teacher doing everything for the learners, thus in most cases he is left with the active direct as his most preferred method of teaching.

Mr Charles did not choose any response in the open inquiry orientation. He regards open inquiry as too difficult for the learners and believes it is meant for higher-order learners.

Mr Kapok

Ten per cent of Mr Kapok's responses were in the direct didactic orientation and 30% of his responses were in the active direct orientation, thus 40% of his responses fall in the non-inquiry orientation; 40% of his responses to POSTT-PS were guided inquiry and 20% were open inquiry. In total, 60% of Mr Kapok's responses were inquiry. An interesting observation is that only 10% of his responses were in the direct didactic orientation. Mr Kapok's espoused beliefs were against teacher-centred methods of teaching. He explained: "In this method, the teacher does all the work when the work must be done by the learners". Mr. Kapok preferred a method of teaching that was learner-centred. He considered direct didactic as a teacher-centred method and he thinks the teaching of science must be learner-centred. According to him the policy statement on the teaching and learning of physical sciences (CAPS document) encourages active learning. He explained: "The CAPS document encourages learners to be active participants in class."

When motivating why he selected guided inquiry as an option, Mr Kapok indicated "the method enforces learners to participate actively and discover things themselves. The teacher gives assistance and learners can come up with authentic conclusions. The approach has a positive effect on learners to 'think critically and explore'".

Mr Kapok had 20% of his responses from open inquiry orientation. He thinks open inquiry gives learners autonomy as they discover things on their own. The method gives the learners an opportunity to investigate their ideas and revise them before or after the teacher intervenes. He applauded the approach of allowing the teacher to be a facilitator and learners active participants. The teacher is seen in other circumstances scaffolding the learners by referring them to the internet for further research about their findings in class. This is evident in the following excerpts from the POSTT-PS:

> It encourages independent learning; critical thinking requires learners to apply scientific knowledge and also contributes to self-discovery. That's what science is all about. It makes one be aware that science is a reality. We live science. It also instils exploration where a learner has an opportunity to express him or herself, able to share to others and exchange their discovery.

However, despite this support for open inquiry he felt that it was not achievable. The teacher raised issues of safety, which is an important concern identified by other participants as well. He believes learners have difficulties when doing an experiment without laid-down procedure. I think what may be difficult would be the teacher support that goes with that. This means raising their level of awareness if they are working with harmful substances. That preparation of the learners and the environment may

be what the teacher sees as impossible, if not time-consuming. The teacher has no confidence that his learners have the necessary skill required to fulfill the demands of independent explorations.

Mr Moluku

Mr Moloku has none of his responses in the direct didactic orientation. Twenty per cent of his responses fall in the active direct orientation. One of the motivations he gave for choosing a response in the active direct orientation was: "The learners lack background knowledge of the concept to be taught, and to save time". This may suggest some contextual factors affecting his choice of a pedagogical approach. Seventy per cent of his responses were in guided inquiry orientation and the other 10% was found in the open inquiry orientation. In total 80% of his responses were in the inquiry orientation. The results from the POSTT-PS suggest that guided inquiry is his most preferred orientation, with 70% of his responses falling in this orientation. As a motivation to why he preferred guided inquiry, he said: "Learners should be involved in the designing and carrying out of the experiment."

In response to why he did not opt for many open inquiry responses, Mr Moloku is of the view that learners may not arrive at what is anticipated when left to their own devices. He explained: "To some extent there must be some guidance as to what exactly we are trying to do." When asked if the learners are not capable of doing something constructive on their own, he said: "They may come up with something constructive, depending on the ability of the learners." Here we see the teacher sceptical about the ability of his learners to do any work without teacher guidance.

Conclusion and discussion

These findings suggest that despite the strong curriculum emphasis on learner-centred inquiry, teachers are reluctant to embrace this curriculum reform due to the reality of the context in which they teach. The teachers are convinced their learners need clear instructions at all the stages of an investigation. They perceive learners as lacking the required competence and experience to navigate through investigations on their own. Teachers explained the frustration that the learners experience when planning an investigation. The planning of an investigation involves conceptualisation of the variables. Teachers indicated that many learners have difficulties identifying all the variables, and understanding the relationship between the variables explored in an investigation. They further explained that learner success in designing and performing experiments on their own is highly dependent on the learners' previous experiences with experimental work, which varies from one learner to another. However, teachers indicated that learners may design and carry out an experiment that is similar to what they have done before, especially investigations on causal relationships. All the teachers indicated that even top achieving learners may find difficulties with designing their own investigation. Other studies have also pointed to difficulties that learners have with designing and conducting investigations (Arnold, Boone, Kremer & Mayer, 2018).

Furthermore, teachers also thought clear instructions and monitoring was for the safety of the learners. Therefore, investigations which take place are largely structured investigations, with teachers providing instructions, while also monitoring, during all stages of the investigation. The findings of the current study are consistent with those of Ramnarain (2010) who found that, in South African schools where science investigations are taking place, investigations are mainly structured investigations with the teacher exercising a great deal of control during all stages of the investigation. The findings provide an informative baseline on the current practices of South African teachers in the enactment of inquiry-based learning that could inform subsequent stages in empowerment evaluation.

References

Arnold, J.C., Boone, W.J., Kremer, K. & Mayer, J. (2018). Assessment of competencies in scientific inquiry through the application of Rasch measurement techniques. *Education Sciences 8*, 184.

Bybee, R.W. (2004). Scientific inquiry and science teaching. In L.B. Flick, & N.G. Lederman (eds.). *Scientific inquiry and the nature of science*. Boston: Kluwer Academic Publishers.

Capps, D.K., & Crawford, B.A. (2013). Inquiry-based instruction and teaching about nature of science: Are they happening? *Journal of Science Teacher Education, 24*, 497—526.

Crawford, B.A. (2012). Moving the essence of science into the classroom: Engaging teachers and Students in authentic science. In K.C. Tan & M. Kim (eds.). *Issues and challenges in science education: Moving forward*. Dordrecht: Kluwer.

Creswell, J.W. (2007). *Qualitative inquiry and research: Choosing among five approaches.* Thousand Oaks: SAGE.

Department of Education. (2002). *Revised national curriculum statement for grades R-9.* Pretoria: Government Printer.

Duschl, R.A., & Duncan, R.G. (2009). Beyond the fringe: Building and evaluating scientific knowledge systems. In S. Tobias, & T.D. Duffy (eds.). *Constructivist instruction: Success or failure?* New York: Routledge.

Edelson, D. (1998). Realising authentic science learning throughthe adaptation of science practice. In B. J. Fraser, & K.G. Tobin (eds.). *International Handbook of science education* (pp. 317-331). Dordrecht: Kluwer.

Fetterman, D.M. (2001). *Foundations of empowerment evaluation.* Thousand Oaks, CA: Sage.

Fetterman, D.M. (2002). Empowerment Evaluation: Building Communities of Practice and a Culture of Learning. *American Journal of Community Psychology, 30*(1), 89—102.

Gott, R. & Duggan, S. (2002). Problems with the assessment of perfomance in practical science: Which way now? *Cambridge Journal of Education*, 183—201.

Hofstein, A., & Lunetta, V. N. (2004). The laboratory in science education: foundation for the 21 st century. *Science Education, 88*(1), 28-54.

Lebak, K. (2015). Unpacking the Coplex Relationship Between Beliefs, Practice and Change Related to Inquiry-Based Instruction of One Science Teacher. *Journal of Science Teacher Education*, 695—713.

Maree, J.G., & Fraser, W.J. (2004). *Outcomes-Based Assessment*. South Africa: Heinemann Publishers.

Merriam, B. S. (1998). *Qualitative research and case study applications in education.* San francisco: Jossey-Bass.

National Research Council (NRC). (1996). *National science education standards.* Washington: National Academy Press.

Opie, C. (2004). *Doing educational research: A guide to first-time researchers.* London: SAGE publications.

Patton, M. (2002). *Qualitative research and evaluation methods.* Thousand Oaks CA: SAGE Publications, Inc.

Ramnarain, U.D. (2010). Grade 9 teacher's and learner's appreciation of the benefits of autonomous science investigations. *Education as Chamge*, 187—200.

Ramnarain, U.D. (2015). Connecting the Hands-On to the Minds-On of South African Physical Sciences Lessons for Student Thinking. *Eurasia journal of Mathematics, Science & Technology Education, 11*(5), 1151—1163.

Ramnarain, U.D. (2016). Understanding the influence of intrinsic and extrinsic factors on inquiry-based science education at Township Schools in South Africa. *Journal of Research in Science Teaching*, 598—619.

Ramnarain, U. & Schuster, D. (2014). The pedagogical orintations of South African Physical sciences teachers towards inquiry or direct Instructional Approaches. *Research in Science Education, 44*(4), 627—650.

Ramnarain, U., Nampota, D. & Schuster, D. (2016). The Spectrum of Pedagogical Orientations of Malawian and South African Physical science Teachers towards inquiry. *African journal of Research in Mathematics, Science and Technology Education*, 119—130.

Saunders-Stewart, K.S., Gyles, P.D. & Shore, B.M. (2012). Student Outcomes in Inquiry instruction: A literature derived inventory. *Journal of Advanced Academics*, 5—31.

Taylor, N. & Vinjevold, P. (1999). *Getting learning right: Report of the President's Education Initiative Research Project.* Johannesburg: Joint Education Trust.

Yin, R.K. (2003). *Case study research.* London: Sage Publications.

Yin, R.K. (2004). *The case study anthology.* Thousand Oaks, CA: Sage Publications, Inc.

THE ROLE OF SCHOOL MANAGERS IN DECOLONIZING THE SCHOOL CURRICULUM: A CASE STUDY OF SELECTED PRIMARY SCHOOLS IN GAUTENG

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Abstract: In recent years, changes in the South African school curriculum have been made to ensure that the apartheid colonial powers, which used brutal policies to overpower the inclusion of Afrocentric elements in the curriculum, are reviewed. Within this colonised school curriculum lay the omission of authentic Afrocentric inputs, and teachers have limited exposure to multiple understandings of African philosophy and its histories. To ensure the smooth running of these institutions and for this study, curriculum leadership and school managers are given an important role not only to re-examine the school curriculum, but also pedagogy that should include Afrocentric conditions, discussions and experiences. An Afrocentric dimension, if added to the curriculum, would influence policy development and spruce up the existing curriculum. School managers, specifically those coming from a Eurocentric background, need to enable school management teams to be proactive in implementing core aspects of indigenous knowledge and Afrocentric elements into the curriculum. This study clarifies the various definitions associated with decolonisation and how it could be linked to technology. The purpose of this study was to explore the role school managers play in decolonising the primary school curriculum. The study is located in the pragmatic paradigm and utilises a mixed methods approach adopting an exploratory sequential mixed methods design genre. Data were collected through unstructured questionnaires for the qualitative method and structured questionnaires for the quantitative methodology. A total sample size of 60 participants were systematically and purposefully sampled from the primary school management teams to take part in the study. Data were analysed by means of both descriptive and inferential statistics as well as content analysis. The findings included the view that school principals have an important role to play in making sure that the school curriculum is reformed to incorporate vital Eurocentric aspects. The study concluded that unless school principals come to the party by ensuring the African elements and philosophy are included in the curriculum, the decolonisation agenda will remain only part of leap service.

Key words: decolonisation, Afrocentric, colonialism, decolonised curriculum, curriculum reform, technology and Fourth Industrial Revolution (4IR)

Introduction

The African curriculum experience stems from the early colonial period, where the school curriculum was intended to serve the interests of the colonial masters and attended missionary schools whose curriculum was informed by a Eurocentric world view (Thobejane, 2013). This Eurocentric world view continued to exist in the content taught, where the curriculum was biased in favour of urban lifestyles and Christianised mission school education (Thobejane, 2013). The curriculum is the heart of the education and training system and in the past it has perpetuated racial, gender and ethnic divisions and has emphasised separateness rather than a common citizenship and nationhood in some of the beneficiaries (Christie, 2008). It is imperative that curriculum restructuring reflects the values and principles of South Africa as a democratic society (Department of Education, 1996:1). To represent

the values and principles of democracy, the South African primary school curriculum has undergone fundamental changes in the last two decades, some of which included C2005, RNCS, NCS and the current CAPS curriculum adopted in the schools (Heleta, 2016). However, the change in curriculum does not fully represent a decolonised curriculum (Christie, 2008). The school managers have to partake in a process to reconfigure or restructure and revise the curriculum, pedagogy and to reflect the values and principles of South Africa as a democratic society. It is important to note that a decolonised curriculum demands epistemological access to curricula, where teaching and assessments are designed to impart in learners the knowledge that will contribute to their academic success (Heleta, 2016). The current school system in South Africa draws its curricular content from Western knowledge traditions and does not take into account the specific Afrocentric knowledge that has its origins in Africa or other non-hegemonic traditions (Heleta, 2016).

Literature review

According to Moloi (2007), the South African curriculum has been a site of political and ideological struggle dictated by the former apartheid laws. The discriminatory education laws and practices were overshadowed by the new dispensation and new education systems following the demise of the apartheid political dispensation in 1994 and this shows how flawed the system has been, especially when one looks at the elements that undermine the inclusion of Afrocentric ideas in the curriculum (Osman, 2016). Many of the current educational content and systems of knowledge in primary schools are replete with Western-driven cultural beliefs, knowledge and theories, a feature that promotes what Kenyan writers, Nandwa and Bukenya (1993), describe as cultural imperialism. Such cultural imperialistic tendencies have culminated in the absolute submission of African communities into a form of humiliation of their knowledge systems (Nandwa & Bukenya, 1993). As a consequence, most of the African communities were trapped in a complex of inferiority over their traditional forms of knowledge. This gave Eurocentrism in the primary school curriculum an unfair supremacy over Afrocentrism (Osman, 2016). Following from this view, the Western domination of knowledge has existed in the school curriculum with the marginalisation of African systems of knowledge continuing to be relegated to the periphery (Osman, 2016; Thobejane, 2016; Le Grange, 2016).

Theoretical framework

The theoretical framework adopted for the research is the critical theory arising from the Frankfurt school in Germany with ideas of the likes of Habermas, Adorno, Marcuse and Horkheimer who noted that critique is constructive (Maclaren, 2006). It is important to begin an overview of the critical theory by examining Lebeloane's (2017) use of Mignolo (2011) as a reference point he adopts to define decolonisation as being contrary to coloniality or a state of decoloniality which he views as synonymous with the concept of decolonisation. Quijano (2007) and Vallega (2015) begin their critique of colonised curricula as those that do not exude the logic of critical thinking and analysis by the natives of original citizens of particular education systems. According to these authours therefore a colonised school curriculum is one whose socio-political practices reflect Eurocentric or Western civilisations in their nature and character. Shrestha, Costello and Saville (2017) concur that curriculum decolonisation implies a process of ensuring that fairness prevails in virtually all school practices because the Eurocentric, socio-political, cultural, economic and social inequalities that favour the former colonial masters have been eradicated and replaced with the Afrocentric characteristics and attributes. Le Grange (2015) and Motshekga (2017) add that curriculum decolonisation is a process of bringing about Afrocentrism in the educational changes without having to destroy Western knowledge. Le Grange (2015) further argues that a decolonised curriculum must include a combination from Descartes *cognito*, "I think therefore I am" and incorporates the world-view principles and African philosophy of "Ubuntu", which embodies and

captures the essence of what it means to be human. Further to the above, Zuma (2017) is of the view that decolonising education is not just about altering the content in the curriculum, but it is about a change in the mind-set and a new way of thinking in a people.

The views of social theorists such as Bourdieu and Bernstein consider conflict as a necessary evil because it is not always dysfunctional, but can be a good source of harmony in a society where tensions and class struggles exist (Mutekwe, 2017). The apartheid era in South Africa thus demonstrated the struggles between the capitalists and the working class, which specifically brought to the fore an apartheid school curriculum (Jansen, 2017). After 1994, the Department of Education (DOE) introduced a wave of changes to the school curriculum. Such changes were seen as progressive, but lacked the ideological unity and fusion of educational theory and practice, and did not fully spell out the demands of equality and democracy as it was stratified and bureaucratic in nature and character, to use the ideas of Bowles and Gintis (1976). Education and curriculum implementation by curriculum managers was not progressive and did not cater for the needs of the child; although it was deemed uniform and accessible to all, it lacked an equitable focus on the cultural elements of the Europeans and Africanism.

Drawing from Fataar's (2018) view that a decolonised education should include "all knowledge forms bequeathed to humanity including African, indigenous, Arab-Islamic, Chinese, Hindu, Indo-American, Asiatic and Western knowledge forms", one might also look at it as a process that incorporates the adoption of inter-cultural educational practices and a promotion of openness to the social construction of knowledge by all human beings regardless of race, cultural background or place of origin. It should also entail an elimination of the knowledge supremacy or the idea that one's own knowledge system is superior while denigrating that of others (Motshekga, 2019). Motshekga (2019) thus reaffirms Fataar's view when she says that South Africa needs a decolonised education system that is diversified. The call in this research study is thus for primary schools to cultivate respect for the different racial groups of people and their cultural and knowledge systems. The aforementioned implies that given the various views on curriculum decolonisation, there is an urgent call for a comprehensive analysis, evaluation, re-evaluation and planning of primary school curriculum policies to ensure a clear-cut recognition and implementation of a decolonised school curriculum (Motshekga, 2019). The argument is therefore that primary schools need to adopt an Afrocentric curriculum entrenched in decolonial education and focusing on the institutional and societal rights for the African people (Progler, 1999:1). The legacy of the apartheid education systemic design of the period prior to 1994 thus succeeded in producing the educational and economic imbalances essential for the growth and domination of European capitalism and cultural imperialism which continues to haunt both educators and learners to this day as Osman (2016) observes.

School leadership in decolonising the curriculum

As school leaders, principals need to be familiar with the merits of Afrocentric knowledge and cultural practices so that they shepherd and transfer that knowledge to new educators and learners in their respective schools (Heleta, 2016). Primary school principals as curriculum leaders thus have a duty towards transforming the school curriculum towards Afrocentrism so as to make teaching and learning appeal to all learners regardless of their racial differences (McGregor, Sanford & Hopper, 2016; Heleta, 2016). In pursuit of this view, Govender (2017), for example, contends that restructuring the history curriculum with a shift from European to an inclusion of more South African history is instead one way a decolonised curriculum can be implemented in the primary schools in South Africa. Within the context of decolonising the history curriculum, primary school managers or principals can conduct field trips to local community historical sites and inquire on the merits of an Afrocentric education system versus a Eurocentric one and the ideas emanating from such endeavours might go a long way towards boosting the decolonisation agenda for their schools (E-Forum, 2011).

Pertinent to school managers is learner achievement and successful schools and this agenda needs the implementation of bilingual or multilingual teaching and learning programmes to enable learners to develop a love for both or all forms of knowledge whether Afrocentric or Eurocentric focused (E-Forum, 2011). This would also have an effect on enhancing improved learner attainment in their schools. Through bilingual or multilingual teaching and learning programmes, school managers or principals can promote respect for diversity and intercultural dialogues or conversations among learners (E-Forum, 2011). Subban (2017) also contends that reading materials in the various languages can be implemented in the lower grades for both the foundation and Intermediate phase as a way of embracing diversity by all learners regardless of their racial or cultural differences.

It follows from the above that primary schools certainly need to implement a decolonised curriculum so as to expose learners to a multicultural dispensation, history, heritage and to promote cultural integration of all societies (National Development Plan, 2018). These aspects (history, heritage and culture) are important for developing a learner understanding of the past, analysing the present and planning for the future. It also fosters social facilitation and an understanding and social solidarity or cohesion, which is important for the country's socio-economic stability and growth (National Development Plan, 2018).

In Mosaka's (2017) view, it is important to note that in the arts and culture subject areas, for example, the construction of the African hut reflects indigenous knowledge systems in its specifics such as direction and its circular forms and therefore the implementation of such forms of indigenous knowledge in the sciences in a practical manner teaches learners to be tolerant of the different forms of knowledge held by different races of people. It is crucial for primary school leaders or principals to understand that indigenous knowledge forms reflect the dynamic way in which the different racial groups have come to understand themselves in relationship to their environment and how they organise their knowledge of flora and fauna, cultural beliefs, and history to enhance their lives, and incorporating all this in the primary school curriculum has the potential to go a long way towards curriculum decolonisation (Semali & Kincheloe cited in Le Grange, 2004).

Emeagwali (2003) asserts that for school managers or principals, the inclusion of African Indigenous Knowledge Systems (AIKS) will eradicate psychological, intellectual and economic feelings of inferiority, which are intertwined in the historical process, as well as the structures of intellectual hegemony and dependence associated with colonial and postcolonial hierarchies of the power elites (Gramsci, 2003). For the school mangers, this could mean working within the constraints of new policy developments that include pathways towards democratising forms of knowledge production. Haleta (2016) affirms this view by reiterating that South African school managers need to have a decolonised frame of mind that releases the posture of apartheid and white-dominated curricula into discourses of African indigenous cultures. They thus need to liberate and transform their organisational or institutional cultures by decolonising their own curriculum and democratising the learning space they operate in (Emeagwali, 2003). Curriculum leaders also need to help ensure the social reconstruction of knowledge by reclaiming the power of African indigenous cultures with an integration of critical pedagogies and dialogues so as to enable their learners to be conscientised (Emeagwali, 2003; Freira, 1975). Such a view is also apparent in the works of Sanford, McGregor and Hopper (2016) whose contention is that school managers should help adopt a culturally combined approach to curriculum reform.

Decolonisation and the Fourth Industrial Revoloution (4IR)

In line with curriculum decolonisation Ramaphosa (2019) has made a public announcement that in South Africa education needs to be overhauled in preparation for the Fourth Industrial Revolution (4IR) and a digital age by including six new subjects in the school curriculum and providing digital workbooks and text books on a tablet to virtually all learners. Ramaphosa (2019) views the use of digital gadgets

as an essential tool in equipping learners for success in education, in work and in life in general. He proposes that new educators need to be adequately qualified on the use of these technologies and that amendments to the curriculum will be made to cater for the 4IR. Together with the introduction of technology subjects, Ramaphosa (2019) makes reference to the promotion of indigenous language programmes and the implementation of a technology-based decolonial curriculum for all schools and the promotion of the study of history through technology.

In keeping with the 4IR, Motshekga (2019), in an interview with Businesstech, confirmed that coding and robotics should be included in the decolonised school curriculum from 2020 for grades R to 9 and that educators ought to be trained on the use and teaching of these technologies. Coding will enhance learners' ability to be problem solvers; think critically and work collaboratively and creatively while robotics will lay the foundations for engineering and programming through codes. Motshekga's (2019) view confirms Ramaphosa's assertion in that Kiswahili, an indigenous African language, should also be included as an option in the choice of African indigenous languages. Butler-Adam (2018) proposes that instead of the inclusion of robotics in the decolonised school curriculum as a 4IR initiative, learners need to succeed in society through numeracy, literacy and to develop an understanding of how the world operates. He thus calls this a different kind of decolonisation of curricula. For him, the study of humanities and social sciences and liberal arts should be underpinned by technology in language, and that the development of skills to implement, manage and work with human beings will enhance the new technology for the 4IR.

Research aim and objectives

The study seeks to explore the role of primary school managers in the process of decolonising the curriculum. Pursuant to this aim, the following objectives were set: to identify aspects that promote curriculum decolonisation in South African primary schools, establish conditions necessary for school managers to decolonise the primary school curriculum and to proffer strategies that can be used to enhance curriculum decolonisation in South African primary schools.

Research questions

The study is guided by the following main research question and sub-questions:

- The main research question is: What are the roles of school managers in decolonising the primary school curriculum?
- The following are that sub-questions:
  - What roles do South African primary school managers play in curriculum decolonisation?
  - Which aspects help promote curriculum decolonisation in South African primary schools?
  - What conditions are necessary for the decolonisation of the primary school curriculum?
  - What strategies can school managers adopt towards the decolonisation of the primary school curriculum?

Significance of the study

The findings of this study will be among the first to address the issue of the decolonisation of the primary school curriculum and will shed more light on what is meant by a decolonised school curriculum (Crow, Day & Moler, 2017). The results of this study will enable school management teams to be proactive in implementing core aspects of indigenous knowledge and Afrocentric elements and enable school managers to encompass the attitudes, values and content knowledge to be learnt. This study may contribute towards the development of a new management style for SMT given that it requires core knowledge of Africanism, and the use of technology in curriculum implementation.

On a theoretical level, the results of this study may add to the body of knowledge on curriculum decolonisation with the inclusion of indigenous Africanism as an option for primary schools. This study may also develop new theoretical perspectives by transforming the primary school curriculum for social transformation and cohesion (Le Grange, 2016).

Research design and methodology

This study adopts a pragmatic paradigm which is outcome-orientated and gives meaning and focus to the product of the research (Shannon- Baker, 2016). This paradigm communicates and creates practical solutions to the research question as it focuses on the research question itself (Tashakkori & Teddlie, 2003). The use of a pragmatic paradigm allows for the generation of data that has both objective and subjective reality because it implies combining the post-positivist and interpretivist paradigms in a bid to overcome the paradigmatic wars (Nieuwenhuis, 2016). Further to the above, it is also important to note that adopting such a paradigm can be equated to the philosophical reinforcement that pivots upon what is considered as the truth in relation to the research questions explored (Tashakkori & Teddlie, 2009:713). Adopting this paradigm also leads to what Patton (2015:257) calls a paradigm used to validate selected alternatives about research procedures to ensure the overall objectives are met.

Methodology

This study followed a mixed methods research approach and utilised as its strategy of inquiry an exploratory sequential mixed method type of design. This means that qualitative research data is generated and analysed first before the quantitative data is collected, analysed and used to supply the missing link in the qualitative data section of the study (Clark & Creswell, 2014).

Population and sampling

The target population for this study were primary school managers or principals from selected schools in the Gauteng province. It was from this population that a sample size of 60 participants were purposefully and systematically selected. Out of a total population of 180 school managers across all three districts, 60 were female and 120 were male, implying that for every one female manager in a district there were 2 male school managers. The sample of study thus comprised of six principals, 12 deputy principals, 24 heads of department and 18 senior or master teachers drawn from six schools in three districts in Gauteng. The schools represented a cross-section of semi-rural and urban social classes. Since only 60 participants are sampled, 180/60= 3, we performed a 1-in-3 systematic sample. Or, we sampled every third school manager. Since the names of the school managers were ordered alphabetically, the sampling technique became easier to select the samples. This made the sampling techniques purposive and systematic (Mutekwe & Modiba, 2013).

Data collection methods

Creswell (2012) maintains that a qualitative research approach aims to understand the perceptions, opinions and attitudes of participants in their natural settings such as schools. The study used structured and unstructured questionnaires to collect the data on the perceptions of the school managers' role in curriculum decolonisation. The data were gathered from school managers using closed- and open-ended questions respectively and this allowed a clear-cut generation of the qualitative and quantitative data sets (Bertram & Christiansen, 2014). The aforementioned implies that for the qualitative approach, the data were collected using unstructured questionnaires with open-ended questions while for the quantitative data, a structured questionnaire containing closed-ended questions was used.

Data management and analysis

In terms of data analysis, it is important to point out that given the dictates of the exploratory sequential mixed methods research, the first step involved a thematic analysis of the qualitative data. This entailed ensuring that the themes emerging from the unstructured questionnaire responses were first clustered into code families or what Nieuwenhuis (2016) calls super ordinate themes. It was the super ordinate themes coupled with the use of verbatim statements that then formed the basis of the discussion of the findings as reported in the qualitative research section of this study.

As for the quantitative research section, it is also crucial to state that the analysis followed a descriptive and inferential statistical form (Bertram & Christiansen, 2014). This implies that in this section the data analysis and presentation process was conducted in accordance with the themes as they emerged from the statistical packages for the social scientist (SPSS) version 24.1 which was used to give the analysis statistical rigour on the role of school managers in the decolonisation of the primary school curriculum.

Results and discussion of the qualitative data

First, permission was sought to conduct this study from the Research Directorate at the Department of Education, then from each school principal of the schools in which the study was conducted. Ethical clearance was sought from the Department of Education at head office and from North West University. This, according to Bertram and Christiansen (2014), is the advanced protocols needed before research is done. Participants were made aware of all recording devices used in their presence.

We sought and obtained informed consent from the participants before taking part in the study. To do this we informed the participants of the purpose of the study prior to conducting the focus group interviews with them. Participants were informed of their right to voluntary participation, confidentiality, privacy, informed consent and their right to withdraw from the study at any time (Maxfield & Babbie, 2008). They were also informed that no harm will be brought to them and were assured that all data gathered would be treated with strict confidentiality. The following section focuses on the analysis and discussion of the qualitative data section of the study. As alluded to earlier on, the following themes were the basis of the discussions of the findings: The definition of decolonisation; challenges in curriculum decolonisation; and conditions necessary for a decolonised curriculum.

Participants' understanding of decolonisation

The views gained in this study assert Lebeloane's (2017) definition of decolonisation as being contrary to colonisation and having equity with a process that ensured equal access and achievement to all learners from the different race groups, ethnic groups, class and genders. Participants also vindicated decolonisation as being a process (Motshekga, 2017; Saunders, 2017) which led to the end of colonisation. In presenting their definition of curriculum decolonisation, participants referred to the many changes that the South African school curriculum went through. Ten participants agreed that curriculum change linked directly to the change in politics in South Africa and therefore a decolonised curriculum would mean that there will be a change in politics, which directly links to what Le Grange (2017) regards as a process of change without necessarily having to destroy Western knowledge. The participants inferred that curriculum decolonisation is the inclusion of Afrocentric elements within the curriculum.

Forty-five out of 60 participants (75%) agreed that the current curriculum is very Eurocentric; however the inclusion of Afrocentric elements in the curriculum would make it biased because it would reflect the writers' perspective on education and not on teaching and learning itself. Participants provided examples of history where the authors' perspective played an important role when writing the content.

Thulane: *It is decolonising South Africa from colonisation. Meaning that making history compulsory. It's taking away the old system and replacing it with a system with whoever is in charge of teaching them. New powers changing the curriculum to suit the new system.*

Amanda: *Removal of Western influences. Removal of Eurocentric and replacing it with African elements. Knowledge of the skills must be included in the belief.*

Sindisiwe: *OBE — the idea was good but the problem is we had to consider the history of our country compared to other countries. So OBE was implemented there and it worked for them. But South Africa is very different. Our kids are different, our teachers are different. It's different. Maybe some parts of CAPS could work. Implement a little bit of everything. Don't throw out everything; incorporate different parts.*

How Participants Understand Eurocentric and Afrocentric curricula

Although many participants in the focus group agreed that our current curriculum is very Eurocentric, they held strong beliefs and ideologies about there being a centrality in the curriculum without it having to slant towards either Eurocentric or Afrocentric. Participants very profoundly declared that, with South Africa being a rainbow nation, having only Afrocentric elements in the curriculum would make it very biased. They expressed concerns of alienating elements of other cultures or that a cultural alienation in curriculum would occur. Furthermore, having only an Afrocentric curriculum would confine the South Africa learner to learning within the South African context only and not expose them to a curriculum that could be recognised worldwide or internationally. Participants propounded that the CAPS curriculum and OBE failed because the writers themselves were biased. Authors of CAPS and OBE text books wrote the content from their experiences and context during the pre- and post-apartheid eras. Thus this perspective was also reflected in the teaching of the curriculum. Most participants agreed that white teachers projected South African history from a European perspective and the same would go for African teachers. They taught the elements of history through the lens of an African person.

Sipho: *Our curriculum is Eurocentric. It's not South African. But we have a danger of making things Afrocentric. We learners and people in general who want to go out there and if we confine everything to Afrocentrism, we are confining people to having a one track mind.*

Amanda: *CAPS — they are trying to bring in Afrocentric elements more but there's a huge danger about it. Because when you make things Afrocentric, who's writing the content? And which perspectives are the students getting? Same also for Eurocentric, who's writing it? How do we make things balanced? Material in history — someone who owns slaves will write a piece will not make slavery look bad then might get a slave who has written and makes it look bad.*

Ted: *The danger of making things Afrocentric or Eurocentric is making people biased. People are biased. Where do we find that balance in education? Internationally, the government has used education to infiltrate. That's how they brainwashed people and the masses. They used education and resources. That's my concern with the shift in the curriculum. What is the mission and what is the point of this change?*

They indicated that African philosophy is Westernised from one perspective. If you are learning about apartheid, it was seen from one point of view. Managers emphasised that elements of African philosophy are heard about from the previous generations such as grandparents. Participants verified that there was no exposure to multiple understandings of African philosophy.

Tshepo: *We are not taught African philosophy. It's whether we engage or don't engage in it. It's not necessary about education if you tell me that you don't look black people in the eye. It will look ignorant, but, but … it's not, we don't know.*

Challenges in decolonising the curiculum

Although the decolonisation of the curriculum was mostly accepted by the participants, they reflected that the curriculum would present many challenges. Some of these challenges included presentation of it with a bias; it will be fully loaded with information that teachers from the old school of education have no knowledge of; it could be taught and used as a political tool; skewed in terms of deliverance; education would be unequal because of poverty; and not all learners would have the correct understanding of the decolonised curriculum because of the bias. The participants emphasised that having a decolonised curriculum with mostly African elements would limit our learners to a South African perspective of education only and that teaching would be done only to achieve assessments and not for knowledge that could be used outside South Africa.

Michael: *Writers writing from their perspective. Challenges for new national systems is needed in school. Education in the wrong hand is very dangerous. Education is linked with politics. We want to open our doors to the outside world but teaching is done to assess. There is no engaging with the learners. Education is a political tool. Politics in education hampers the growth of the learners.*

Rani: *The policy documents talk about critical thinkers. We don't have and we are not producing critical thinking, because we are basically pouring water in the jug. Filling the head with knowledge. We are teaching to assess. We are not enjoying our teaching because we are not engaging with our children. If I don't take 5 minutes of how my kids are, then I won't know what's happening in their life.*

Peter: *Stopping kids from coming to a school where there is good quality education is a problem for me. It's about attending a school where there is confinement to an area. You know what good education is all about. If you live in a rural area, then you are exposed to rural education. If you live in an urban area that is a kind of colonisation. Half way through the year you get a student from another school. How are we going to correct the injustices of the past if we don't know how?*

The above views highlight some of the challenges that managers would experience should the curriculum be decolonised. These challenges represent the true reality of what is happening at schools and is in direct contrast to Haleta's (2016) affirmations that managers need to have a decolonised frame of mind to release the posture of apartheid and white dominated curriculum into discourses of African indigenous culture. It is evident in the views above that school managers need to liberate and transform the institutional cultures by decolonising their own curriculum and democratising the learning space they operate in. In keeping with Emeagwali (2003) and Haleta (2016) curriculum leaders need to reconstruct knowledge by reclaiming African indigenous culture into and with pedagogies. It is clearly evident that managers will struggle to deliver a curriculum that is culturally combined and reformed (Sanford, McGregor & Hopper, 2016).

Conditions necessary for decolonised curriculum and technology

Fifty out of the 60 participants (83%) argued that schools and teachers need to be more equipped with the correct teaching tools, resources and teacher training programmes to implement the new curriculum. Many of these participants declared that they have a lack of knowledge of what Afrocentric means and have no knowledge of African philosophy; however if they are trained and provided with the technology they can deliver the curriculum effectively. Twelve of the 60 managers (20%) felt that the Department of Education should remove the excess paperwork involved in teaching and focus on the real work that will help prepare learners for the 4ID. Ninety per cent of the managers declared that they do not have the technology the Department of Education promised them, in order to teach the new decolonised curriculum. These participants emphasised a decolonised curriculum could be possible in the application of process or methodologies used when they teach.

Peter: *Rural schools do not have the necessities for technology. I come from a school in KwaZulu-Natal for instance. We do not have electricity for most of the time. The teachers who taught me are I would say in their late forties and they have no clue of how to switch on a computer. We need to provide our learners the best. We need to remove the parameters that are in place for admissions.*

Martha: *We have the technology but not the decolonisation knowledge. In our school the Deputy has ensured that we are techno savvy but how does one go away from the European education system to something that we do not know about?*

Dave: *Change is not easy, a minister will come with this system and do limited training and five years later another minister would come and change everything.*

Raj: *We need clarity on what decolonisation is then use the technology in our processes and methodology. In terms of mathematics and the section on money and story sums it needs to be contextualised, but the different methods in calculations or example is confusing the child.*

Arguments such as these indicate that there exists a controversy on the acceptance of a decolonised curriculum; however the necessary tools must be made available in order to implement the curriculum as one manager declares below.

Anna: *Also the department didn't do intense training. We had to figure it out on our own with OBE and CAPS and now probably with this new decolonised curriculum. We haven't perfected the previous one yet and there's a new one already. The teachers need intensive training.*

The following views demonstrate that teachers need to be trained on the different teaching apps available and that apps used should be contextualised to the South African decolonised curriculum.

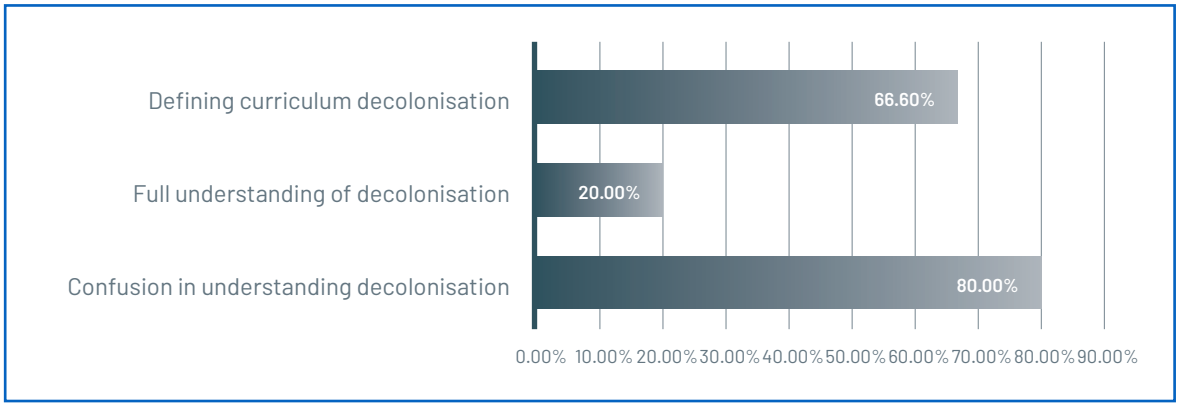
Amanda: *If we have the technology, they will be able to see the how. With robotics and coding being introduced it will be even better for our little ones who have the energy to do things on their own like building things ...*

Leslie: *We have been trained in IXL and Komodo Maths for example. It teaches the children basic calculation skills. But I see there are other apps like for social sciences for example but the context is different. So if the curriculum is decolonised we have to have apps related to South African history. The context must change.*

Results and discussion of the quantitative data

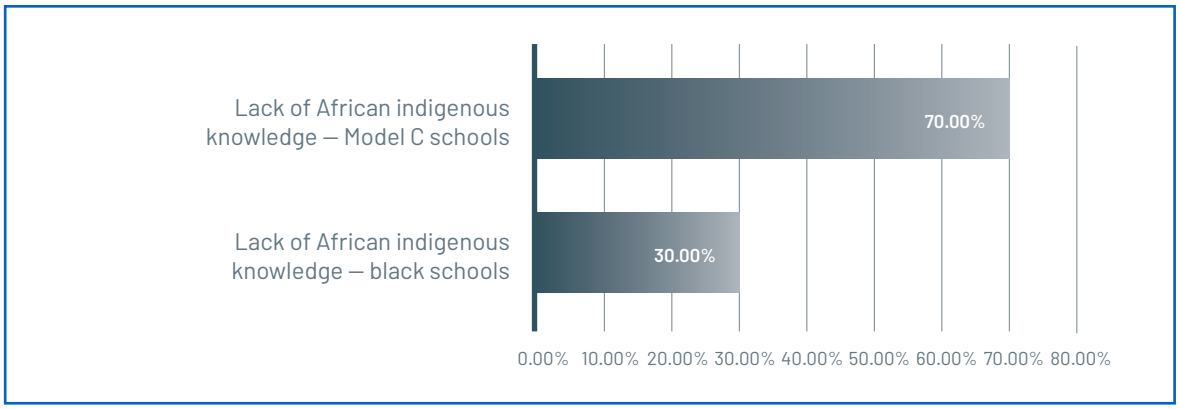
Quantitative data discussed here shows that 40 respondents out of 60, representing 66.6%, understood curriculum decolonisation as implying replacing all the Eurocentric aspects in the school curriculum with Afrocentric ones. In other words, for 66.6%, curriculum decolonisation meant Africanising the primary school curriculum. Twenty of the 60 respondents (33.3%) were of the view that decolonising the curriculum must involve a thorough examination of those Eurocentric ideas that are offensive in terms of white supremacy or racial supremacy and other offensive connotations in the curriculum. Forty-eight respondents (80%) out of the 60, showed confusion and lacked understanding of decolonisation. This meant that only 20% of the respondents had some idea what decolonisation means. These statistics can be seen in Figure 1 below.

Figure 1: Participants' understanding of curriculum decolonisation



When responding to the question on the perceived challenges in decolonising the curriculum, 42 respondents out of the 60 (70%) showed the conditions at Model C schools are not conducive to curriculum decolonisation since the school managers are white. This meant that 70% of the school managers lacked knowledge of African indigenous knowledge because their schools are still following the colonialist system of teaching. While 30% of the school managers were from black schools and therefore the conditions were conducive to curriculum decolonisation as shown in figure 2 below.

Figure 2: Challenges in decolonising the curriculum



In response to what conditions may be necessary to decolonise the curriculum, 44 of the 60 respondents (73%) declared that they need training on key aspects such as technology (85%), and knowledge of African philosophy and indigenous systems. Figure 3 below demonstrates training as the highest score when compared to Figure 1 and 2. This is in line with Ramaphosa's announcement that South Africa needs to be overhauled in preparation for the 4IR. Teacher training in technology would enhance teachers' digital skills so that they can equip learners for the 4IR.

Figure 3: Conditions necessary for curriculum decolonisation

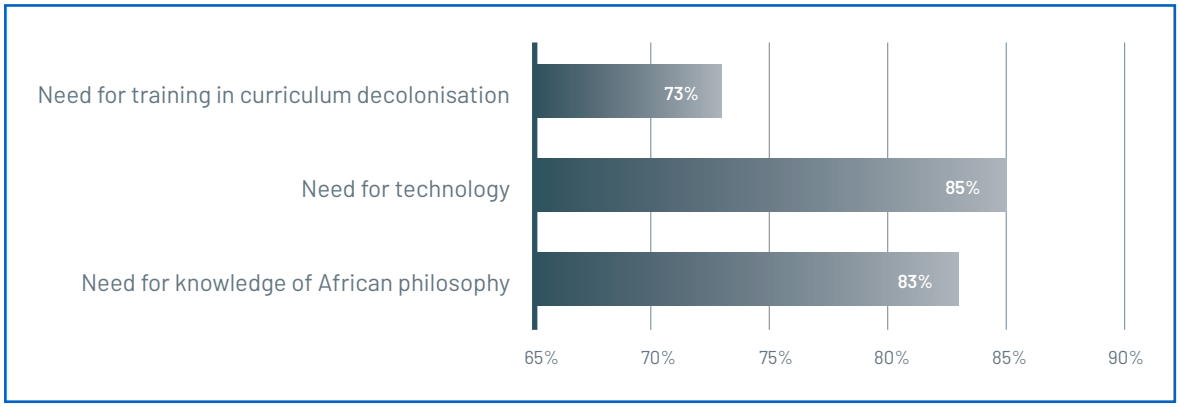


Figure 3 above shows that among the conditions necessary for curriculum decolonisation are the following: knowledge of African history, which was given by a total of 83% of the sample of study, the need for technology which also was accounted for by 85% of the sample. The need for particular training in strategies for curriculum decolonisation was also accounted for by a total of 73%.

Conclusion

The evidence presented in this paper highlights the role of school managers in decolonising the school curriculum. Among the conclusions arrived at in this study are views such as that, as a controversial topic, the subject of decolonisation has many meanings and interpretations as argued by the different authours and participants and is the cornerstone for education to recognise the racial supremacy struggles in schools. Therefore, a decolonised school curriculum or education can be mobilised on the basis of the demand for equitable educational opportunities for all the learners in the different schools and educators across these schools. There is an urgent need for transformation in the knowledge domain, particularly in the school curricula especially in light of what participants described as exposure to not only Afrocentric nor Eurocentric, racist and sexist knowledge. The main conclusion that the primary school managers advanced was that such a school curricular or knowledge transformation is at the heart of their teaching and learning experiences and a failure by the powers that be to ensure an efficient and effective curriculum decolonisation is a recipe for their alienation in the social construction of knowledge.

Recommendations

Among the recommendations of this study were the following: The primary school mangers recommended a complete overhaul of the primary school curriculum on the basis of decolonising education, inclusion of technology and new pedagogies. They also recommended that to do away with the issues of racial and/or cultural supremacy, it is important to introduce multi-cultural educational approaches in the schools, adopt a variety of Afrocentric and Eurocentric teaching and knowledge approaches as opposed to emphasising one at the expense of the other. A variety of strategies were also suggested to enhance cultural integration by all learners regardless of their racial differences in the schools.

References

Betram, C. & Christiansen, J. (2014). Understanding Research: An Introduction. Pretoria: Van Schaik

Bowles, S. and Gintis, H. (1976). Schooling in capitalist America (Vol. 57). New York: Basic Books.

Butler- Adam, J. (2018). The Fourth Industrial Revolution and education. *South African Journal of Science*, 11(4): 5—16.

Christie, P. (2008). Changing regimes: Governmentality and education policy in post-apartheid South Africa. *International Journal of Educational Development*, 26(4):373—381.

Clark, V.L. & Creswell, J.W. (2014). Designing and Conducting Mixed Methods Research. Los Angeles: SAGE Publishers.

Chukwuere, Joshua. (2017). From decolonisation to digitalisation of education in South Africa. *PONTE International Scientific Research Journal*, 73:232—241.

Chukwuere, J.E., Mavetera, N. & Mnkandla, E. (2016). An Empirical Study on the Success Factors to Consider in Developing e-Learning Systems: A Learner-Oriented System. *Asian Journal of Information Technology*, 15(16): 3087—3102.

Creswell, J.W. (2012). Educational Research: Planning, Conducting and Evaluating Research. New York: MacGraw-Hill

Crow, H., Day, C. & Moler, J. (2017). Emotional coherence in primary school headship. *Educational Management, Administration and Leadership*, 35:521—534.

Department of Education, (1996). South African Schools Act, 1996, (No. 84 of 1996),Pretoria: Government Gazette.

Emeagwali, G. (2003). African Indigenous Knowledge Systems (AIK): Implications for the Curriculum. In Toyin Falola (ed), *Ghana in Africa and the World: Essays in Honour of Adu Boahen.*

English, F. W. (2012). Bourdieu's misrecognition: Why educational leadership standards will not reform schools or leadership. *Journal of Educational Administration and History*, 44, 155—170.

Fataar, A. (2018). Decolonising Education in South Africa: Perspectives and Debates. *Journal of Educational Research for Social Change*, 7: 6—9.

Freira, P. (1975). Pedagogy of the oppressed. London: Longman.

Goodwin, R. (2010), Global Democracy: In the Beginning, *International Theory*,2(2): 175—209.

Govender, P. (2017). Baby steps to decolonise schools. *Mail & Guardian*. Available at: https://mg.co.za/article/2017-03-24-00-baby-steps-to-decolonise-schools.

Haleta, S. (2016). Decolonisation of higher education: Dismantling epistemic violence and Eurocentrism in South Africa. *South African Journal of Higher Education*, 23 (2):76—84.

Jansen J. (2017).The lost scholarship of changing curricula. *South African Journal of Sciences*, 11:35—36).

Higgs, P. (2012). African Philosophy and the Decolonisation of Education in Africa: Some critical reflections. *Educational Philosophy and Theory*, 44(S2).

Jansen, J. (2017). It's time for a new government to tackle inequality. *Education Management and Policy Studies*, 21(2): 1—8.

Lebeloane, L. (2017). Decolonising the school curriculum for equity and social justice in South Africa. KOERS. *Bulletin for Christian Scholarship*, 82(3).

Le Grange, L. (2016). Decolonising the university curriculum. *South African Journal of Higher Education*, 30 (2).

Le Grange. L. (2018). Currere's active force and the Africanisation of the university curriculum.[online] Journals.co.za. Available from: https://journals.co.za/content/high/28/4/EJC159186 [Accessed 13 Jul. 2018].

Le Grange, L. (2015). Currere's active force and the concept of Ubuntu. Keynote address at the triennial conference of the International Association for the Advancement of Curriculum Studies (IAACS). University of Ottawa. 26—30 May.

Le Grange, (2015). Ubuntu/Botho as Ecophilosophy and Ecosophy. *Journal of Human Ecology*, 49(3):301—308.

Lumby, J. & English, F. (2009). From simplicism to complexity in leadership identity and preparation: Exploring the lineage and dark secrets. *International Journal of Leadership in Education*, 12:95—114.

Maxfield, M.G. & Babbie E. (2008). *Research Methods: Quantitative and Qualitative Approaches*. Boston: Allyn and Bacon.

Mayibongwe, M. (2017). Motshekga: No definition for 'decolonisation' of education. Radio station interview with Minister of Education on 16 May.

Mestry, R., Hendricks, I. & Bosschoff, T. (2009). Perceptions of teachers on the benefits of teacher development programmes in one province of South Arica. *South African Journal of Education*, 29(4):32—42.

Mignolo, W. (2007). Delinking: the rhetoric of modernity, the logic of coloniality, and the grammar of decoloniality. *Cultural Studies*, 21(2): 449—514.

Moloi, K. (2007). An overview of education management in South Africa. *South African Journal of Education*, *27*(3):463—476.

Motsheka, A. (2019). Minister wants to decolonise education in South Arica. Interview held with Businesstech on 29 January.

Motsheka, A. (2019). South African schools will soon get 3 new subjects. Interview held with Businesstech on 13 March.

Mutekwe, E. (2018). Structure, Agency and Curricular Influences on Girls' Occupational Aspirations: The Zimbabwean Experiences. *Journal of Research in Gender Studies*, 8 (2): 32—43.

Mutekwe E. (2017). Unmasking the ramifications of the fees-must-fall-conundrum in higher education institutions in South Africa: A critical perspective. *Perspectives in Education*, 35 (2).

Mutekwe, E. & Modiba, M. (2014). Hegemonic masculinity as a pedagogical challenge in the school curriculum: The Zimbabwean example. Conference proceedings of the 58th ICET World Assembly held at the Ontario Institute of Education 9—11 July.

Musitha, M. & Mafukata, M. (2018). Crisis of decolonising education: Curriculum implementation in Limpopo Province of South Africa. *Africa's Public Service Delivery & Performance Review*, 6(1):12—25.

Nandwa, J. and Bukenya, A. (1993). African oral literature for schools. Nairobi: Longman.

Nieuwenhuis, J. 2016. Analysing qualitative data. In K Maree (ed). *First Steps in Research*. Pretoria: Van Schaik.

Osman, A. (2015). Indigenous Knowledge in Africa: Challenges and Opportunities. An Inaugural Lecture, Centre for Africa Studies: University of Pretoria.

Progler, J. (1999). Mapping the musical commons: Digitization, simulation, speculation. *First Monday*, 4(9):210—221.

Quijano, A. (2000). Coloniality of Power, Eurocentrism, and Latin America. Nepantla: *Views from South*, 1(3): 533—580.

Quijano, A 2007. Coloniality and Modernity/Rationality. *Cultural Studies*, 21(2—3): 168—178.

Ramaphosa, C. (2019). 6 New subjects you can expect to be introduced at South African Schools. Interview held with Businesstech 12 February.

Sanford, K. Williams, L. Hopper, T. McGregor, C. (2016). *Indigenous Principles: Teacher Education: What we have learned*. Oshawa: University of Victoria.

Shannon-Baker, P. (2016). Making Paradigms Meaningful in Mixed Methods Research. *Journal of Mixed Methods Research*, 10(4): 319—334.

Subban, A. (2017). Department of Education irons out plans to decolonise English curriculum. Interview held by radio station on 23 June.

South African Government. (2015). The National Development Plan. Pretoria: Government Printers.

Teddlie, C. and Tashakkori, A. (2012). Common "Core" Characteristics of Mixed Methods Research. *American Behavioral Scientist*, 56(6):774—788.

Thobejane, D.T. 2013. History of Apartheid Education and the Problems of Reconstruction in South Africa. Conference proceedings of a paper presented at the Sociology conference in Cape Town 25—27 August

Wooi, T. 2017. Strategic Management in Education. Paper presented at Jitra conference at Kedah in Malaysia, 12—15 October.

ROLES OF PRIMARY SCHOOL ADMINISTRATORS IN THE DEVELOPMENT OF CURRICULUM ON CLIMATE CHANGE IN ABAKALIKI EDUCATION ZONE OF EBONYI STATE, NIGERIA

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Abstract: This study was carried out based on the roles of primary school administrators in the development of curriculum on climate change in Abakaliki education zone of Ebonyi State. It was a descriptive survey design. A population of two hundred and seventy eight (278) primary school head teachers in public primary schools in Abakaliki education zone was used as the respondents. A self-developed rating scale instrument titled "Managerial Roles of Primary School Administrators towards Curriculum Development on Climate Change Scale (MRPSATCCCS)" was used for the collection of data. Three research questions and three hypotheses were posed and formulated respectively. This study is divided into two sections. Section "A" is on respondents' personal information while section "B" has a 15 items rating scale which sorts information on the role of primary school administrators in the development of curriculum on climate change in Abakaliki education zone. The rating scale has three clusters; each of the clusters addresses the research questions. The scale consists of a four-point response scale rated as: Strongly agree [SA] 4 points; Agree [A] 3 points; Disagree [D] 2 points; Strongly disagree [SD] 1 point. The face validity of the instrument employed for this study was done in respect of the items. The researcher made use of two well-trained research assistants to administer the instruments using a direct delivery method. The instrument were validated by experts and tested for reliability. They yielded acceptable reliability coefficient values of 0.87 using Cronbach Alpha Statistics. Data collected were answered using mean statistics for research questions while the hypotheses were tested using the z-test and One Way ANOVA statistics. It was found among others that the head teachers are expected as part of their role to work with teachers in planning and developing curriculum guide lesson diaries and pamphlets needed instructional areas as well as planning for workshops and seminars for teachers upon introduction of curriculum for climate change. Based on these findings, the study recommended among others that the head teachers should always ensure that they work with teachers in planning curriculum guides, lesson diaries and pamphlets needed in instructional areas for climate change and should always instruct pupils to attend school with cardigans.

Key Words: climate, climate change, curriculum, curriculum planning

Background to the study

One of the greatest challenges of humanity in the 21st century is climate change, thus, it has become a topical global issue. This is basically because of its chain reaction on every facet of human endeavour. Climate according to Encyclopedia Britannica is the condition of the atmosphere of a particular location over a long period of time. The condition of the atmosphere of a place over a short period of time is known as weather. In other words the weather condition of a particular place over a long period of time sums up the climate condition of the place.

Climate is controlled by the sun through its electromagnetic radiations which reach the earth by radiation, conduction and convection processes. This electromagnetic radiation creates atmospheric elements such as temperature, precipitation, humidity, wind, air pressure, cloudiness and visibility which sum up

the climatic parameters of a place. These elements control our physical environments thus shaping the soils, vegetation, animals and the operation. Climate refers to the long –term average pattern of weather in a place. For example, we describe the weather of a place in its content at a particular time. So, it could be described as warm, moist or sunny; but climate is a combination of the aforementioned over a particular period of time. Ekpo (2002) in his contribution defined climate as a composite of the day to day weather conditions and atmospheric elements of a place for a long period of time. At present, the issue of climate change is broadening as it is being influenced by climatic elements of solar energy, temperature increases and decreases as the case may be, precipitation, humidity, wind, sun shine, rainfall, cloudiness and pressure.

The United Nations Framework Convention (2000) defined climate change as: a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere in addition to natural climate variability observed over a comparable time period. Consequently, climate change in Abakaliki education zone of Ebonyi State is influenced by global warming indicating that climate change is a product of global warming. Global warming is an observable atmospheric phenomenon that is caused primarily by the excess release of carbon dioxide from the burning of fossil fuels like coal, oil and gas in power plants, cars, factories, etc., into the atmosphere (Nwaoku, 2005). This global warming became alarming with the understanding that greenhouse gas emissions have almost rendered the ozone protective layer of the earth invaluable due to excess release of carbon dioxide (Co2) and deforestation that should have rendered the usurpation of the generated excess Co2 impossible (Ekpo, 2002). While the forests ought to consume Co2 for photosynthesis and release oxygen for a cleaner atmosphere, the decimation of the forests have made this impossible posing serious hazards of unimaginable dimensions to health, agriculture, environment, economy and human beings. This kind of change in climate may be natural or human induced.

School climate refers to the social, physical and academic environments of the school. It is very important that events in school encourage students to feel comfortable and able to carry out the learning process. On the other hand, educators feel respected, so they are able to perform their work effectively and efficiently. When students feel the emotional climate of a conditioning emotional climate that encourages the achievement of academic success and personal welfare students will get higher self-esteem, it will grow a sense of empathy towards teachers and the school environment.

Curriculum in any society has always been seen as a structural series of interacting forces through which educational institutions seek to translate the hopes, aspirations, needs and visions of society into reality. In essence, curriculum has always been and will remain an instrument reflecting society's felt needs, beliefs and what they do. It keeps changing as society grows and its needs changes to reflect its new status. When such a situation arises, there is a need to review the curriculum and update it to meet with the current imperatives and therefore serve the people well. Note that the National Curriculum Conference (1969) gave birth to the National Policy on Education (1977) with the design of a curriculum for the needs of Nigerians.

From all indications, curriculum planning precedes curriculum development but both are essentially inseparable. According to Hess and Kelly (2007:5) curriculum planning is the process of gathering, sorting, selecting, balancing and synthesizing relevant information in order to design those experiences that will assist the learners in attaining the goals of the curriculum. In line with the above, Esu, Enukoha and Umoren (2006) maintain that curriculum planning is needful to guide teaching activities and it should be flexible, open and incomplete in the sense that as long as changes occur, it must be revised, extended, redesigned or restructured to clinch new ideas, knowledge, norms, aspirations and values. Thus, for effective planning and development of the curriculum, the following groups are involved:

curriculum experts, teachers, patents, subject specialists, ministries of education and government agencies, learners and other interest groups. Curriculum development involves the whole process of designing and re-designing curriculum materials, trying them out, collating and synthesising data emanating from the trial test, utilising human and material resources to ensure that the objectives of the planned curriculum are achieved.

The school curriculum is evaluated in terms of its response to the social issues of the day. Social reconstruction in education stresses the needs of society over the needs of the individual. This orientation envisages great change in society and demands that curriculum provides the necessary tools for the individual to survive in what appears to be an unstable and ever-changing world. To the proponents of this orientation, survival implies developing a curriculum that would enable the individual to cope with and function meaningfully in a rapidly changing world. So, as a matter of fact, there is a challenge of climate change which calls for the entrenchment of climate change issues into academic curriculum for reasonable environmental education and literacy at the primary level. UNESCO (2009) explains that at all levels, forms of existing educational teaching and learning programmes are to be reviewed and re-oriented to address the causes and consequences of climate change.

School as a formal organisation according to Okeke (1997) is an assemblage of individuals whose activities are consciously interrelated and coordinated in order that one or more task or objectives can be accomplished. It is an official organisation set out to perform specific functions. Assigned status, hierarchy and work responsibilities are present in such a formal organisation. These tasks or objectives of a school as a formal organisation ought to be managed. In the words of Nwaoku (2005) management is concerned with the organisation of people, resources and policies for the achievement of a set goal. The ability to delegate authority and still get the job effectively done is the acid test of managerial talent. Furthermore, to achieve this, school systems require firm knowledge and implementation of the broad organisational policy. Okunamiri (2005) explain that policy could be seen as a specific type of statement of decision which highlights the intention of a given organisation as to what should be done for the fulfillment of the goal for which the organisation is set up. The school authorities in this context are the management teams that are lawfully considered as the chief facilitators and managers of the schools. In line with their responsibilities, they are expected to work at a macro planning level at school (Mampuru 2001:3).

In Abakaliki education zone, school management authorities at the primary level start from the Ministry of Education to State Universal Basic Education Board (SUBEB) to the Local Government Education Authority (LGEA), down to head teachers at individual schools and classroom teachers.

According to Babalola (2006), studies have shown that no country can reach a recognised height in development without effective revision of the curriculum at all levels of education. The school curriculum is used as a means to achieve the educational objectives of the policy-makers in education.

It is important that the education industry should have access to reliable information about climate change so that they will be in a position to entrench the climate change issues into an integrated academic curriculum. It is against this background that the researcher estimated it necessary to examine the roles of primary school administrators in the development of curriculum on climate change in Abakaliki education zone of Ebonyi State.

Statement of the problem

The primary education system is known to be the foundation of all other systems of education. Primary school heads occupy important management positions and as such are bound to be influenced by

change within and outside the education system. Oredein (2009) opined that change drivers create the forces that engender institutional leaders to alter their ways of operations in schools. Thus, there is a need to incorporate climate change issues in school curricula at all levels, particularly in primary school where children and adolescence are bound, and are likely to be most vulnerable to climate change risk. This calls for awareness and empowerment of primary school heads on effective management of climate change in order to achieve the millennium development goal (MDG) in Nigeria. So, knowing full well that changes in climate have natural implications and effects, social and environmental implications, political, scientific, educational, medical and economic implications on us, it is important that the education industry should have access to reliable information about climate change. Education stakeholders and other education sectors should therefore be positioned to entrench the climate change issues into an integrated academic curriculum. Hence the need to investigate the roles of primary school administrators in the development of curriculum on climate change in Abakaliki education zone of Ebonyi State.

Scope of the study

The roles of primary school administrators in the development of curriculum on climate change in Abakaliki education zone of Ebonyi State is the focus of this study. It delves to evaluate the roles of head teachers, state ministry of education and State Universal Basic Education Board (SUBEB) policy makers towards curriculum development on climate change.

Purpose of the study

The main purpose of this study is to examine the roles of primary school administrators in the development of curriculum on climate change in Abakaliki education zone of Ebonyi State. Specifically, the study is out to:

1. Determine the role of head teachers towards curriculum development on climate change at primary level;
2. Ascertain the role of State Ministry of Education towards curriculum development on climate change at primary level; and
3. Find out the role of State Universal Basic Education Board (SUBEB) policymakers towards curriculum development for climate change at primary school level.

Significance of the study

This study will be of benefit to students, teachers, head teachers, management of primary schools, government and future researchers.

The findings of this study if published will enlighten students on the impact of climate change and their duties to keep themselves safe from such impact through teachers' instruction.

This research work, no doubt, will help teachers and all stakeholders in education to be enlightened and review the school curriculum in order to tackle some problems encountered through climate change in Abakaliki education zone.

Teachers and head teachers, from this research finding, will be encouraged to update their knowledge on this issue of climate change and impart the same to their learners to be aware of what is going on in the world around them.

The result of this research work will help the government of Ebonyi State and school management integrate pupil centred skill curriculum where these pupils will be taught on how to find a lasting solution to the negative effects of climate change or minimising its effects on all components of life.

Lastly, the study will serve as a reference point to subsequent researchers as it will serve as resource material to others who want to carry out research in emerging areas on the managerial roles of primary school authorities towards curriculum on climate change.

Research questions

The following research questions were posed to guide the study

1. What are the roles of head teachers towards curriculum development on climate change at primary school level?
2. What are the roles of State Ministry of Education towards curriculum development on climate change at primary school level?
3. What are the roles of SUBEB policymakers towards curriculum development for climate change at primary school level?

Hypotheses

The following hypotheses are formulated and were tested at 0.05 level of significance.

Ho1: There is no significant difference in the mean response scores of male head teachers and female head teachers on the roles of head teachers towards curriculum on climate change at primary school level.

Ho2: There is no significant difference in the mean response scores of male and female head teachers on the roles of State Ministry of Education in the development of curriculum on climate change at primary school level.

Ho3: There is no significant difference between the roles of head teachers, SME and SUBEB policymakers towards curriculum for climate change.

Review of related literature

Conceptual framework

Concept of school management

According to Nwaoku (2005) management is concerned with the organisation of people, resources and policies for the achievement of a set goal. According to Njang (2002) "the extent to which the school succeeds will depend greatly upon the quality and caliber of school management engaged in the system and also upon the effectiveness with which they discharge individual and group responsibilities". School management represents the school's management structure which is responsible for the day-to-day running of the school and for putting the school's policies into operation.

The school management is also responsible for working out how the school can be categorised best to bring about the vision of the school community (DOE 2000:8). Mgbodile (2003) agrees with Nkang that school management rests on the understanding that the end result of the educational process will be determined by the effectiveness of the school staff. Abba (2008) asserted that school management is the art and science of planning, organising, implementing and evaluating personnel and material resources in the organisation to ensure optimum utilisation of its resources for the achievement of its objectives, goals and targets.

Thus, the organisation, management and control of the staff in the school system are the most crucial roles of school authorities. Here, the head teachers as the school management are in the best of places to contribute to the development and implementation of appropriate policies for the staff, because

they liaise between the State Ministry of Education, primary school management board, and Local Government Education Authority (LGEA), school organisations which are the policy implementers.

Ogbiji (2004) maintains that school management must make sound contributions to the development and implementation of appropriate personnel policies. He also declares that school management should be involved in facilitating teaching and learning through provision of conducive classrooms and all the materials required for effective teaching and learning. From the above definitions, it is evident that a school as an organisation is made up of people; hence the duty of school managers is to effectively utilise people at work for optimum productivity.

Concept of curriculum

Curriculum is a reflection of a society's needs, aspirations and challenges in terms of education as a strategy for both human and societal development. It determines the focus and dynamism of any education system. The school curriculum is used as a means to achieve the educational objectives or the objectives of the policymakers in education (Azikiwe, 2018). It reflects the culture, real life experience, interests, needs and aspirations of the society. Nations use their curriculum content to produce various kinds of manpower needed in all fields of endeavour in the nation.

The term curriculum originated from a Latin word "currus" which means to run a race. It is courses offered in educational institutions. This means that curriculum is a race course, which implies that the moment a child starts school, the race begins and stops at the end of the child's educational career (Offorma, 2005). It is a course of study which students pursue in order to get a degree, a certificate, a diploma or any other forms of academic awards. Curriculum is a structured series of learning experiences intended for the education of the learners. It is a course of studies offered in the school for the education of the learners. Curriculum is a set of courses constituting an area of specialisation.

Curriculum is a programme. This includes a programme of studies, programme of activities and a programme of guidance. One cannot talk about curriculum without referring to the programme of studies which is seen in the form of subjects, contents, subject matters and bodies of knowledge. The programme of activities is made up of all the learning experiences presented to the learners. These experiences can be overt or covert; mental or physical. They are also learner-oriented and goal-oriented. Learners learn through activities and so the programme of activities facilitates the learning of the programme of studies.

Kanno (2002) defines curriculum in three ways:

a. A systematic group of course or subjects required for graduation or certification in a major field of study, for example, social studies curriculum, physical education curriculum.
b. A general overall plan of the content or specific materials of instruction that the school offers the learner qualifying him/her for graduation or certification or for entrance into a professional or vocational field.
c. A group of courses and planned experiences which a learner has under the guidance of the school.

Concept of climate change

The issue of climate change became topical in the 1980s when fears were raised by the Scientific Commission on the Increase in Emission of Greenhouse Gases (GHGS). This alarms which came out of a general consensus at the commission, among other issues, had it that the emission of (GHGS) were using global warming and that if left unchecked, the warming would adversely affect mankind and his environment in years to come.

Climate change has posed a lot of problems in Nigeria and Ebonyi State such as (a) change in rainfall patterns, (b) a rise in the incidence of pests and diseases of crops and livestock, (c) reduction in crop yield, and (d) destruction of lives and property caused by floods and droughts (Kunateh, 2013). All these have a negative effect on income generation activities. Some of the human activities that contribute to the climate problems in Ebonyi State and Abakaliki Education zone are deforestation caused by bush burning and the use of wood as fuel and charcoal making (GhanaCentric, 2010).

According to United Nations (2007) climate change refers to alternation in prevailing climate condition which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed, over a comparably long time. The United Kingdom Environmental Change Network (UKECN, 2010) asserts that climate change is not a fallacy but a reality and goes on to show evidence of climate change. Evidence adduced by the Network to buttress this assertion includes:

- Rising global temperatures by 0.6 degrees Celsius in the last 130 years.
- Accumulation of carbon dioxide in the atmosphere at an alarming rate occasioned by the burning of fossil fuel due to growing industrialisation pollutions.
- Increased human activities on the environment such as the decimation of forests reducing carbon dioxide utilising plants and increasing methane content in the atmosphere.
- Rising carbon dioxide accumulation result in the depletion of the ozone layer of the atmosphere that shades the earth from the direct scotch of the sun.

Ayoado (2010) describes climate change as a dynamic phenomenon that involves the indices of weather deviating from the mean over a considerable period of time. It could be natural or human-induced. Climate change refers to significant and persistent changes in national, regional and global climate over a considerable period of time including increases in average air and ocean temperatures and widespread melting of ice, leading to rising global sea level (Ujah, Ebo, Nzeh & Chukwu 2010).

Recent developments in climate change as identified by Simmonds and Eliot (2009) are summarised as:

- Rise in sea level
- Increase in global temperature
- Decrease in global precipitation
- Change in sea ice cover
- Melting of the arctic oceans
- Diminishing process of arctic animal species
- Changes in salinity/acidity of main environments
- Increased ocean areolation
- Increased storminess and climate pattern
- Expansion of subtropical deserts

Causes of climate change

Climate change is a global phenomenon that cuts across every strata of the global village. Vordzorgbe (2007) asserted that continued rates of high population growth, increasing reliance on fossil fuel, driven growth technologies and land use effects particularly urbanisation agriculture and deforestation can cause global climate change. According to him, other causes include high concentration of GHGS and aerosols.

Adinna (2007) says that climate change can be caused by a number of factors, grouped as human (anthropogenic) and, which includes:

- Changes in the composition of natural gases in the atmosphere.
- Changes in the volume of moisture in the atmosphere.
- Changes in the surface features of land and sea caused by human activities such as urbanisation, agricultural practices and irrigation.
- Human activities that increase the volume of Co2, CFC and GHGS in the atmosphere, including: the burning of fossil fuels (coal, petroleum and natural gas), industrialisation and mining.

The major causes of climate change are the accumulation of carbon dioxide (mainly from the burning of fossil oils), CFC gases, methane and other dense gases, moisture, particulates from desert dust, exhaust pipes, factories, bush burning, gas flaring and clouds (collectively regarded as pollutants) in the atmosphere and their interaction with meteorological elements on sustained oasis over a considerable power of time.

Effects of climate change on primary school management

Climate change being an emergent curriculum in our Nigerian primary school have some adverse effects on school management. So, one of the adverse effects it will have on the school management is the ability to adapt according to IPCC (2001). Thus, adaptation should be implemented in the context of national and global sustainable development efforts. It is therefore pertinent that the international, state and local communities identify resources, tools and approaches to support adaptation to climate change.

Primary school management will encounter difficulties in identifying and providing appropriate materials according to the context and location due to lack of interaction between material developers topers and users. It will lead to difficulty on how to address uncertainty because of lack of pedagogical materials and information on climate change.

School management will be faced with an ever-growing variety of subject matter contents, skills, techniques, machinery and equipment, etc. for which they are ill-prepared. Strategies are yet to be developed to help teachers cope effectively with emerging issues in the curriculum. The interdisciplinary nature of climate change education is likely to create a problem of integration into the curriculum; interdisciplinary curriculum framework reinforces the links between science, the environment and other important areas such as economy, culture ethics and justices, gender equity and peace, all of which require a network of expertise to tackle.

The need for climate change education

Although natural phenomena such as ocean currents, emissions from volcanoes, or normal climate variability can influence climate change to a great extent, it is also influenced by some of these activities of humans: deforestation, intensive farming, and intensive use of fossil fuels (Sharma, 2012). The anthropogenic nature of global climate change has support in the literature (Semper, 2010; Sharma, 2012; Stanford University, 2011). There is, therefore, the need for something more than technology to address it. Sharma argued that if it were the consequences of individual actions, as shared by Pettenger, cited by Feirabend and Eilks (2010), then the logical thing to do to address global climate change was to educate individuals to behave in environmentally responsive ways. As a social solution, Sharma suggested that the preparation of students in schools should equip them with a better understanding of climate change to enable them to act in ways that will sustain the environment.

According to CarboSchools Consortium (2010), Sharma (2012), Stanford University (2011), and United Nations Educational, Scientific and Cultural Organisation [UNESCO] (2009), education is an indispensable component of any programme to combat climate change and its effects.

For example, if one considers "adaptation" and "mitigation," which are the two current approaches in responding to climate change (Ofei-Nkansah, 2013), not much can be done to combat climate change and its effects without education. The need for education is clarified by Dyster (2013):

> Education is the most powerful tool and can engage young people in the debate, prepare them for working with the green economy, and give the definitive science and facts about the biggest issue facing young people. To quote H.G. Wells: "Human history becomes more and more a race between education and catastrophe." (p. 3)

Research shows that pupils are empowered to do something about climate change and feel positive and less worried about it when they are given accurate information about it (Bryan, 2011). Examples abound in the literature where education has been helpful in addressing issues with respect to climate change such as: (a) when a 15-year-old student opposed the removal of climate change from the geography curriculum of the United Kingdom by writing eloquently about the dangers of its removal. Thirty thousand signatures supported her petition in a matter of weeks (Dyster, 2013); (b) pupils made a great impact in their communities regarding the reduction of global warming gas emission with resultant great monetary savings through school carbon reduction initiatives (Cherry, 2011); and (c) The League of Conservation Voters Education Fund found in a study that it was information from educational materials that their children brought home from school that even environmentally minded citizens received most of their "green" information. Moreover, it was pressure from their children that caused them to act in a responsible way toward their environment (Cherry, 2011). Although children are vulnerable,

they are agents of change in climate change issues (Anderson, 2010; UNICEF, 2012). Thus, if children are empowered by providing them with the necessary education on disasters and climate change in a conducive environment, their vulnerability is reduced, and, at the same time, they contribute to sustaining the environment. Such knowledge and empowerment given to children through the school curriculum results in reduced vulnerability to risk, and, at the same time, it promotes the achievement of children's environmental rights as is contained in the numerous articles of the Convention on the Rights of the Child (UNICEF, 2012).

Different definitions have been given to climate change education, but they mainly stress on knowledge, attitudinal, and behavioural change. One such definition is: Climate change education is about helping learners understand and address the impacts of global warming today, while at the same time encouraging the change in attitudes and behavior needed to put our world on a more sustainable path in the future (Matsuura quoted by UNESCO, 2009:3).

Therefore, some of the characteristics of a climate literate person are that the person is: (a) knowledgeable enough about climate change to take informed decisions that will help mitigate climate change, and (b) has desirable attitude and behaviour toward climate adaptation and mitigation (Anderson, 2010; Semper, 2010). A successful climate change education should therefore move from awareness, to understanding, and finally taking action (Carboschools Consortium, 2010).

Need for Curriculum Development and Management towards Climate Change in Primary School

The education sector has a vital role to play as a facilitator of climate change education in the country. Climate change education is a new and complex subject area, and so its complexities and serious challenge to school's management in the development of school curriculum. Therefore for school management to design curricula documents and in the process opportunities for the inclusion of new content related to climate change.

According to Bartlett (2008), children are more vulnerable to the many challenges associated with climate change particularly health issues which could have a negative effect on their ability to learn. It is therefore important that they understand climate change and how it can affect their health and those of their families and society at large.

The aim of teaching children about climate change is to inspire them to make changes their day-to-day behaviour in order to reduce carbon emission. It will also help them to think of their own energy consumption and what they can do to reduce carbon emission. Schools have a special role to play in helping pupils understand the causes and impacts of our changing environment and also how their actions can contribute to climate change. For example, children can be taught about simple things they can do at home to reduce emissions. Such as:

- Turn off lights, TVs, videos and computers when not in use.
- Unplug their phone charges when they finish charging.
- Fill electric kettles with only as much water as they need.
- Close fridge and freezer doors as soon as they take out things out.
- Use fans instead of too much use of air conditioners.
- Use compact fluorescent bulbs (they use less power).
- Plant trees.

Learning and applying these principles in their everyday activities at home would help them to know how they can contribute in reducing greenhouse gas emission there by reducing implications of climate change on them.

Sheridon (2008) in his writing listed some likely implications of climate change on children. Such as:

- Children have greatest vulnerability to heat stress, respiratory diseases and malnutrition.
- Higher risk of death, illness such as malaria, reduced option or play and social interaction.
- Children with higher risk of malnutrition with long term implication for development.
- Highest rates of death from Stalinization of water supplies, long term developmental implications.

So, it is important that schools strengthen children's knowledge, skills, attitude and abilities to adapt to a changing physical environment. Children should therefore be given the chance to understand climate change as soon as possible. This will help them to deal with the immediate and future challenges of climate change facing us as a nation.

Theoretical framework

Integral theory of adaptation

Integral theory of adaptation is Wilber's idea in 1996 where he stated the frameworks that capture different dimensions of reality, which together provide a more comprehensive and inclusive understanding of both problems and solutions.

Integral theory discloses four domains of reality that are important to acknowledge and include in any adaptation intervention. These irreducible domains of reality or perspectives, described as four quadrants, draw from different methodologies, each with their own particular validity claims. The four perspectives (subjective, inter-subjective, objective, and inter-objective) recognise that phenomena can be seen in different way: from an inside or an outside perspective, and from a singular or plural perspective (Wilber, 2006; Esbjorn-Hargens, 2009). Integral theory points to the need to include all four perspectives in both theoretical and practical approaches to adaptation, and to consider different levels of consciousness or awareness and worldviews among those undertaking adaptations. The framework captures different dimensions of reality, which together provide a more comprehensive and inclusive understanding of both problems and solutions. Integral theory recognises both interiors and exteriors, with interiors referring to the subjectivity and intentionality of individuals and exteriors referring to behaviours and physiological characteristics in the singular, and to cultural (interior) and systems (exterior) phenomena in the plural. It also recognizes different states and stages of consciousness as well as the role of psychological shadow elements (e.g., projection and denial) (Wilber, 2006).

Importantly, integral theory recognises that no reality can be assessed based on only one set of validity claims. For example, changes in adaptive capacity cannot be measured only by interior validity claims (e.g., asking how one feels), or only by exterior validity claims (e.g., measuring what one does), but rather is best assessed by including diverse sets of indicators and measurement methods. An integral approach draws on multiple validity claims from all quadrants; since each quadrant derives evidence from different data using different methods, it can provide a more complete understanding of adaptation. This represents a more comprehensive way to promote and develop successful responses to climate change.

The integral model provides a way to include all quadrants all four domains of reality, their methodologies and validity claims in any adaptation strategy. While there are numerous calls for interdisciplinary research and actions, the lack of a framework remains a barrier to bringing disciplines together into meaningful dialogue.

Integral theory integrates disciplines by including and transcending them. That is, it "hovers" above conventional disciplines, providing a map for understanding how they relate to and influence each other. The integral framework is perhaps better described as a trans-disciplinary framework that serves to integrate each discipline or approach into a larger picture, rather than as a multi- or interdisciplinary framework that brings different disciplines together, without necessarily accounting for the synergies between perspectives and domains of reality.

Integral theory offers an innovative framework that can contribute to the process of adaptation. Integral theory's rigor, inclusivity, breadth, and depth offer a promising way forward to addressing complex issues (Wilber, 2006). An integral approach has been applied to many complex challenges, such as forest conservation in the Peruvian Amazon (Hochachka, 2009); leadership development for sustainability in sub-Saharan Africa (One Sky, 2009); leadership development and community capacity enhancement in relation to HIV/AIDS in 40 countries; organisational development (McLaren & Kelleher, 2005); and community development in El Salvador (Hochachka, 2008).

An integral approach to adaptation recognises that adaptation cannot be solely conceptualised or engaged as behavioural and systemic changes. It must also include interior changes, both personally and culturally. Adaptation involves a changed sense of self, not as a passive subject to shifts in the climate system that are outside of one's control, but as an active player in the future of the community and world — all of which relate to worldviews, values, beliefs, and self-definitions. This includes individuals' personal capacities to be creative and innovative by thinking outside the box, to be reflective yet action-oriented as leaders, and to be internally resilient in the face of disruptive change. Invoking multiple scales, an integral approach also includes the cultural dimension of adaptation, such as the capacity of groups to peacefully negotiate responses in turbulent times (e.g., through periods of unpredictable weather events and financial instability), to undertake collaborative action in spite of conflicting values and beliefs, and to take into consideration the ethics of greenhouse gas emissions reductions (e.g., cultures with the smallest carbon-emission footprints are often the most vulnerable to the impacts of climate change).

Review of empirical studies

Uchendu's (2012) study was designed to ascertain the relationship between funding, training programmes and management of climate change in secondary schools in Cross River State, Nigeria. To achieve the purpose, two hypotheses were formulated. A survey research design of the study consisted of 200 principals randomly sampled from a population of 233 principals. A research instrument designed with 24 items of a Likert scale type questionnaire was used to obtain data from the principals. The resulting data were analysed using Pearson product moment correlation analysis at 0.05 level of significance. There was a significant relationship between funding and training programmes and management of climate change in secondary schools in Cross River State.

Nwaka and Ezeoba (2016) examined the possible strategies of managing climate change in order to ensure effective curriculum implementation in primary schools in Anambra State. The study was guided by three research questions. The population comprised 105 head teachers hence there was no sampling. The descriptive research design was used. Data was collected through 25-item researchers developed questionnaire titled Strategies for Managing Climate Change (SMCC). Mean and standard deviation were used to answer the research questions. Findings indicated that implementing climate change policies from the Federal Ministry of Education and Environment, installation of fans in the classroom, organising enlightenment programmes among others are the possible strategies to effectively manage climate change.

Research design and procedure

Research design

This study adopted descriptive survey design. According to Nwankwo (2013) a descriptive survey design is a research design in which data are collected from a population with a view of finding out the relative opinion, belief, attitude, and status of that population about a phenomenon. Again, Uzoagulu (2011) noted that a descriptive survey design is a design in which data are collected, organised, analysed and then described as they exist (natural setting) without interfering with them. This design is deemed appropriate for this study because the researchers will collect data from the respondents through a few representatives and analyse them in order to determine and to analyse the roles of primary school administrators in the development of curriculum on climate change in Abakaliki education zone.

Area of the study

The research was carried out in public primary schools in Abakaliki Education Zone of Ebonyi State. The area is characterised by urban, semi-urban and rural areas.

The inhabitants are mainly farmers. The citizens of the state are predominantly educated and enlightened since their chief industry is education.

Population of the study

The population of this study comprised of primary schools with head teachers in Abakaliki education zone (EBSUBEB, 2018).

Sample and sampling techniques

All the population of the study was utilised for the study since their number is handy. Therefore, a census study was adopted.

Instrument for data collection

A rating scale called "Managerial Roles of Primary School Authorities towards Curriculum Development on Climate Change Scale (MRPSATCCCS)" developed by Egwuogu (2014) was adopted and used for the collection of data. This rating scale was distributed to the sample schools (head teachers) through personal visits. It is divided into two sections. Section "A" is on respondents' personal information while "B" has a 15-item rating scale which sort information on the role of primary school administrators in the development of curriculum on climate change in Abakaliki education zone. The rating scale has three clusters; each of the clusters will be addressing the research questions. The scale consists of a four-point response scale rated as: Strongly agree [SA] 4 points; Agree [A] 3 points; Disagree [D] 2 points; Strongly disagree [SD] 1 point.

Validation of the Instrument

The face validity of the instrument employed for this study was done in respect of the items. All 15 questions were presented to experts in education measurement and evaluation and one in educational management for corrections.

The corrections made by the experts were affected by the researcher and that attested for the validity of the instrument in which most of the items in the instrument were modified but without dropping any item.

Reliability of the instrument

In establishing the reliability of the instrument, it was pilot-tested using 20 head teachers from Onueke education zone which is different from the zone under study. These head teachers thus filled the copies

of the questionnaire items. Their responses were tallied and the scores were calculated using the Cronbach Alpha reliability method. The Cronbach alpha yielded a coefficient of 0.87 for the items. The coefficient was considered high and positive which was an indication that the instrument was reliable. The choice of Cronbach Alpha is in line with Howith and Cranner (2011) who recommended Cronbach Alpha as a very useful statistical tool for determining the internal consistency of a homogenous instrument.

Method of data collection

The researcher administered the instrument using the Direct Delivery Technique (DDT) with the help of two well-trained research assistants from the Education Zone under study. The direct method of questionnaire administration was adopted in the distribution of the instrument. Here the researcher and the assistants visited the respondents in their schools and administered the instrument. This method was adopted in the data collection to minimize the loss of the instrument. The research assistants were instructed on how to distribute and collect copies of the instrument from the respondents and thereafter hand them over to the researcher for analysis.

Method of data analysis

In line with the instrument for data collection, the responses of the head teachers (male and female) were assigned numerical values thus: strongly agree (4 points), agree (3 points), disagree (2 points) and strongly disagree (I point). The total score for each item was calculated and the mean score was computed. The responses to the research questions were analysed using mean scores. A score of 2.5 was taken as a cut off point for accepting an item as agreed while scores less than 2.5 was taken to mean disagree. Z-test was used to test hypotheses 1 and 2 while hypothesis 3 was tested using One Way ANOVA with SPSS ver.20 @ 5% error level.

Data analysis and results

Research question one

What are the roles of head teachers towards curriculum on climate change at primary school level?

Table 1 Mean score analysis of male and female head teachers on their roles towards curriculum on climate change at primary school level.

		Male Head Teachers'			Female Head Teachers'		
	Item Statement	N	X	Decision	N	X	Decision
1	Working with teachers in planning and developing curriculum guides, lesson diaries, and pamphlets needed in instructional areas	153	3.86	Agreed	125	3.86	Agreed
2	Planning for workshops and seminar for teachers upon introduction of curriculum for climate change	153	3.68	Agreed	125	3.65	Agreed
3	Instructing pupils to attend school with cardigans	153	3.48	Agreed	125	3.58	Agreed '
4	Instructing teachers to space seat arrangement and to open classroom windows very well	153	3.52	Agreed	125	3.69	Agreed
5	Instructing teachers and prefects that waste should be disposed of effectively and not burnt	153	3.82	Agreed	125	3.48	Agreed
	Grand Mean		**3.67**			**3.65**	

The result in table 1 shows that the five items 1-5 are the roles of head teachers towards curriculum on climate change at primary school level because their mean scores are greater than 2.50 which is the point for accepting the notion in the questionnaire items. Item 1 was jointly agreed with a mean of 3.86 respectively. It also indicated that both male and female head teachers agreed to the items with high mean scores, the grand mean of 3.67 and 3.65 for male and female head teachers respectively are above the cut off mean of 2.50 which implies that the items were agreed upon by the respondents.

Research question two

What are the roles of State Ministry of Education towards curriculum development on climate change at primary school level?

Table 2 Mean score analysis of male and female head teachers on the roles of State Ministry of Education towards development of curriculum on climate change at primary school level

S/N	Item Statement	Male Head Teachers'			Female Head Teachers'		
		N	X	Decision	N	X	Decision
6	Develop a comprehensive and coordinated climate education and outreach programme for schools teachers	153	3.65	Agreed	125	3.62	Agreed
7	Raising awareness on climate change	153	3.78	Agreed	125	3,77	Agreed
8	Establish appropriate funding mechanisms for raising teachers' awareness on climate change	153	3.67	Agreed	125	3.57	Agreed
9	Develop teaching and learning materials in the field of climate change for educational institutions	153	3.42	Agreed	125	3.48	Agreed
10	Develop official website to provide information on climate change	153	3.26	Agreed	125	3.32	Agreed
	Grand Mean		**3.56**			**3.55**	

Analysis in table 2 reveals that the mean scores for items 6, 7, 8, 9 and 10 are above 2.50, which suggests that the respondents agreed to the items as the roles of State Ministry of Education towards curriculum on climate change at primary school level. From the table one could see that item 17 recorded the highest score with a mean of 3.78 for the male head teachers and 3.77 for the female head teachers. The grand mean of 3.56 and 3.55 for male and female head teachers respectively are above the cut off mean of 2.50 which means that the items were agreed upon by the respondents.

Research question three

What are the roles of SUBEB policy makers towards development of curriculum on climate change at primary school level?

Table 3 Mean score analysis of male and female head teachers on the roles of SUBEB policy makers towards curriculum for climate change at primary school level

S/N	Item Statement	Male Head Teachers'			Female Head Teachers'		
		N	X	Decision	N	X	Decision
1	Formulating and implementing climate change policies from Federal Ministry of Education and Environment	153	3.36	Agreed	125	2,96	Agreed
2	Making policies on the need for planting of new ornamental trees in the school compound	153	3.15	Agreed	125	3.07	Agreed
3	Organizing enlightenment programmes for pupils, teachers and parents on climate change	153	3.20	Agreed	125	3.31	Agreed
4	Formulating and Ensuring policies that any warning information on climate change is disseminated immediately to the teachers, parents and pupils	153	3.39	Agreed	125	3.31	Agreed
5	Making policies to create landfills in the school compound for waste disposal	153	3.54	Agreed	125	3.53	Agreed
	Grand Mean		**3.33**			**3.24**	

Table 3 revealed the opinion of male and female head teachers on the roles of SUBEB policy makers towards curriculum for climate change at primary school level. The mean scores of the items revealed that both male and female head teachers agreed to the items as the roles of SUBEB policy makers towards the development of curriculum for climate change at primary school level. The respondents held strong assertions to the items since their mean scores were above the cut off mean of 2.50. The grand mean of 3.33 and 3.24 for male and female head teachers respectively are above the cut off mean of 2.50 which shows that the items were agreed upon by the respondents.

Testing of hypotheses

Ho1: There is no significant difference in the mean response scores of male teachers and female teachers on the roles of head teachers towards curriculum on climate change at primary school level.

Table 4 Summary of Z-test Analysis of the significant difference in the mean response scores of male teachers on the roles of head teachers towards curriculum development on climate change at primary school level.

Respondents	N	X	S.D	Df	Zeal	ZCrti.	Decision
Male Head Teachers	153	3.67	0.171	276	0.20	1.96	Accept Ho
Female Head Teachers	125	3.65	0.141				

Result of table 4 shows that the calculated value of 0.20 is less than the critical.

Z value of 1.96, at 0.05 level of significance with 276 degree of freedom. The acceptance of null hypothesis implies that there is no significant difference in the mean response scores of male teachers and female teachers on the roles of head teachers in towards curriculum on climate change at primary school level.

Ho2: There is no significant difference in the mean response scores of male teachers and female teachers on the roles of State Ministry of Education towards curriculum development on climate change at primary school level.

Table 5 Summary of One Way ANOVA Analysis of the significant difference between the roles of head teachers, SME and SUBEB policy makers towards curriculum for climate change

Summary of the One way ANOVA Table
Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Intercewpt Error	350.750 .666	1 13	350.750 .061	5796.972	.000
F_{tab} - F (1, 13, 0.05) = 4.67					

Table 5 above shows a summary of sum of squares, mean squares and f-test of difference of the mean scores of the significant difference between the roles of head teachers, and SUBEB policy makers towards development of curriculum for climate change. The calculated ratio value used in testing the hypotheses, stood at 5796.972, using a total degree of freedom of 14, at 0.05 level of significance, the calculated value of f, 5796.972 is far greater than the critical f value of 4.67, hence, there is no significant difference between the roles of head teachers, State Ministry of Education and SUBEB policy makers towards curriculum for climate change.

Summary of findings

From the analyses above, the following findings were made:

1. The head teachers are expected as part of their role to work with teachers in developing, planning and managing curriculum guides, lesson diaries, and pamphlets needed in instructional areas as well as planning for workshops and seminars for teachers upon introduction of curriculum for climate change.
2. As part of the role of the State Ministry of Education in managing curriculum on climate change at primary level, they are expected to develop a comprehensive and coordinated climate education and outreach programme for schools teachers.
3. The roles of SUBEB policy makers towards the management of curriculum for climate change at primary school level include among others making policies on the need for planting of new ornamental trees in the school compound as well as formulating and ensuring policies that any warning information on climate change is disseminated immediately to the teachers, parents and pupils.
4. There is no significant difference in the mean response scores of male teachers and female teachers on the roles of head teacher towards curriculum on climate change at primary school level.
5. There is no significant difference in the mean response scores of male teachers and female teachers on the roles of State Ministry of Education towards curriculum on climate change at primary school level.
6. There is no significant difference between the roles of head teachers, SME and SUBEB policy makers towards curriculum for climate change.

Discussion of findings

The findings of research question one revealed that the head teachers are expected as part of their role to work with teachers in planning and developing curriculum guides, lesson diaries, and pamphlets needed in instructional areas as well as planning for workshops and seminars for teachers upon introduction of a curriculum for climate change. This finding is supported by Olibie (2013) whose consequent study indicated that there is insufficient curriculum planning among the principals. The perceived challenges faced by principals in school curriculum planning include: inadequate allocation of resources and funds for school curricula and co-curricula activities, incompetence and poor understanding of curriculum change visions, inadequate training on curriculum innovations, and poor ability to use statistical data to make inferences for curriculum improvement. This therefore calls for the need for head teachers in helping to improve the climate change condition in primary school curriculum.

The study further revealed that the roles of the State Ministry of Education in developing curriculum on climate change at primary level includes among others, that they are expected to develop a comprehensive and coordinated climate education and outreach programmes for school teachers. In line with this finding, Ekpoh and Ekpoh (2011) who examined the level of climate change awareness among secondary school teachers in Calabar Municipality found that the level of climate change awareness was generally low among teachers and the awareness varied with sex. Also, teachers' access to sources of information on climate change was low.

The study also revealed that the roles of SUBEB policy makers towards the development of curriculum for climate change at primary school level include among others, making policies on the need for planting of new ornamental trees in the school compound as well as formulating and ensuring policies that any warning information on climate change is disseminated immediately to the teachers, parents and pupils. In support of this, Nwaka and Ezeoba (2012) examined the possible strategies of managing climate change in order to ensure effective curriculum implementation in primary schools in Ebonyi State. The study indicated that implementing climate change policies from the Federal Ministry of Education and Environment, installation of fans in the classroom, organising enlightenment programmes among others are the possible strategies to effectively manage the climate change.

Recommendations

Based on the findings of the study, the researcher made the following recommendations:

1. The SUBEB policy makers should make appropriate policies on the need for planting of new ornamental trees in the school compound as these will aid check climate change effects.
2. They should also make sure that they organise enlightenment programmes for pupils, teachers and parents on issues concerning climate change.

3. The head teachers should ensure that the teachers are functionally involved in the planning of Curriculum guide, lesson diaries and instructional areas for climate change.
4. Teachers and students should be giving proper orientation on the most appropriate ways of waste disposal instead of burning them.
5. Establishment of appropriate and adequate funding mechanisms for raising teachers awareness on climate change.

Educational implication

The educational implication of this study cuts across every facet of education beginning from primary to tertiary education. The teaching of science has been relatively stable with occasional modifications and innovations but with climate change, major modifications will emerge. In the natural sciences, curriculum will alter to suit emerging knowledge, in technological construction procedures will now alter from what is previously known and assumed. Curricula will also vary with emerging knowledge while in general education studies, teaching methods will also vary with emerging facts and levels of teaching, Hence the school management role is crucial in this changing curriculum. The primary school managers: head teachers, State Ministry of Education and SUBEB policy makers are therefore charged with the responsibilities of improving and ensuring adequate implementation of curriculum on climate change in our primary schools in Ebonyi State.

References

Abba, U.E. (2008). Modern public administration: Theories and Practice. Onitsha: Abbot Books Ltd.

Adinna, E.N. (2007). Climate Change and Food Security in Nigeria. Paper Presented at the National Conference on Climate Change and Sustainable Development, held at Awka from 12—14 June 2007.

Adinna, E.N., Ekopo, O.B. & Attah, G.I. (2003). Environmental pollution and management in the tropics. Enugu: Snaap Press.

Anderson, A. (2010). Combating climate change through quality education. Retrieved from http://www.brookings.edu/~/media/research/files/papers/2010/9/climate%20education%20anderson/09_climate_education.pdf.

Ayoade, J.O. (2010). Climate change: Causes, effects and solutions in impact of climate change on food security in Subsaharan African. Proceedings of the 14th Annual Symposium of the International Association of Research Scholar and Fellows. 25th Feb. 2010. 11 (A) Ibadan Nigeria.

Babalola, J.B. (2006:1). Overview of educational management, in Babalola, J.B.

Bartlett, J. (2008). Teachers Guide to High Quality Educational Materials on Climate Change and Global Warning Retrieved from hdge.cum.edu/teachers guide/teachers guide.htm.

Bredeson, P.V. (2004). Creating spaces for the development of democratic school leaders: A case of program redesign in the United State. Journal of Educational Administration. 42(6): 708—723.

CarboSchools Consortium. (2010). Global change: From research to the classroom. Retrieved from http://www.carboeurope.org/ education/3rd-booklet-single-reduced.pdf.

CarboSchools Consortium. (2010). Global change: From research to the classroom. Retrieved from http://www.carboeurope.org/ education/3rd-booklet-single-reduced.pdf.

Cherry, L. (2011). Young voices on climate change: The Paul F-Brandwein 2010 NSTA Lecture. Journal of Science Education and Technology, 20, 208—213.

Campbell, R.F. (1971). *Introduction to educational administration*. London: Allyn and Bacon, Inc.

Dyster, A. (2013). In recent months, climate change education has hit the headlines. Retrieved from http://www.leftfootforward.org/2013/07/education-is-the-key-to-addressing-climatechange/Doe, E.G. (2000:8). Total Facilities Management U.K: Blackwell Publishing.

Doe, E.G. (2001:3). A New Perspectives in African Education. London: Macmillan Education Ltd.

Ekpoh, I.J. (2002). Environmental Changes and Management. Catlabar: St. Paul's Publishing and Printing Company.

Ekpoh, U.I. & Ekpoh, I.J. (2011). Assessing the level of climate change awareness among secondary school teachers in Calabar municipality, Nigeria: implication for management effectiveness. International Journal of Humanities and Social Science, 1(3), 106—110.

Esbjorn-Hargens, S. (2009). An overview of integral theory: An all-inclusive framework for the 21stcentury (Resource Paper No. 1). Boulder, CO: Integral Institute.

Fadare, G.M. & Olojede, K. (2004). Curriculum Development and Processes (2). Roytel Communication Ltd Lagos, Nigeria pp.12—14.

Federal Republic of Nigeria (2004:14). National Policy on Education, Lagos: Federal Government Press. 4th Edition.

Fullan, M. (2005). Leadership and sustainability: systems thinkers in action. California: Corwen Press and Ontario Principals' Council.

Gollick, D.M. (2008). Foundations of American Education (14th Edition) Allyn and Bacon: Boston, MA.

Hess, F. and Kelly, A. (2007). Learning to lead: What gets taught in principal-preparation programmes. Teachers College Record, 109(1), 274.

Hochachka, G. (2008). Case studies in integral approaches in international development: An integral research project. Journal of Integral Theory and Practice, 3(2), 58—108.

Hochachka, G. (2009). Integral approach to capacity building for Amazon rainforest conservation. Paper presented at the Global Environmental Change & Human Security (GECHS) Conference, Oslo, Norway (June 22).

Ileuma, S. and Isah, E.A. (2010). Educational Management, Environmental Literacy and Climate Change. Ibadan: His Lineage Publishing House Mokola.

1PCC, (2007). A Scoping Study on Knowledge and Gaps. March .2008. Prepared for the U.K. Department for Int'l. Development by Alyson Broadly of Development Studies (IDS) UK.

1PCC, (2010). Climate Change: The Physical Science Basis. Jeiyol, E. (2010). The Role of Women in Climate Change Adaptation Process in Nigeria. Conference Proceeding on Climate Change and the Nigeria Environments: Enugu. Jamoe Publishers.

Isom, (2000). *Adaptation to Climate Change: A Vulnerability Assessment for Sudan*. London: Gatekeeper Series.

Kanno, H. (2002). *Curriculum Development: Theory and Practice*. New York: Harcourt Brace.

Khatun, W.B. (2001). *An Introduction to Global Environment Issues*. Routledge, London, 390.

Kirkland, K. & Sutch, D. (2009). Overcoming the barriers to educational innovation, A literature review. Bristol: Futurelab.

Mampuru, (2001:3). The Concept of Environment Education. *Journal of Environmental Education*, (1): 30-31 Retrieved from www.ask.com.

McLaren, K., & Kelleher, D. (2005). New horizons in organisational development. Au Courant: A publication of the Canadian Council for International Cooperation, 13, 6—9.

Mgbodile, T.O. (2003). Fundamentals in Educational Administration and Planning. Enugu: Magnet Business Enterprises.

NEST, (2004). Nigerian Vulnerability and Adaptation to Climate Change. Ibadan: University of Ibadan Press.

Nkang, I.E. (2002). Fundamentals of Educational Administration, Planning and Supervision. Uyo: Afahaide and Bros Printing and Publishing Co.

Nwaka, N.G. & Ezeoba, K.O. (2012). Effective management of climate change for a successful curriculum implementation in primary schools. Journal of Research and Development, 4(1): 212—221.

Nwaoku, N.A. (2005). Educational Management in Nigeria. Theory and Practice. Aba:Assemblies of God Press.

Obanya. P. (2004). Education for the Knowledge Economy, Ibadan: Mosuro Publishers.

Odey, (2010). Nigeria and the Effects of Climate Change: http://www, punchontheweb.com Retrieved 15 October 2010.

Ofoha, D., Uchegbu, C.N., Anyikwa, B., Nkemdirim, M. & Ekwueme, L. (2009). A Critical appraisal of the mode of implementation of Nigerian secondary school curriculum: Towards socio-economic empowerment of youth. Education Research Network for West and Central Africa (ERNWACA), Research Grants Programme.

Ogbiji, J.E. (2004). Educational Administration: An Introduction. Enugu: Masters Press and Co.

Okeke, B.S. & Uwazuruike C.N. (1997). Introduction to Educational Administration, Owerri. Khet Keir Publisher Ltd.

Okoronkwo, C. (1998). Basic Issues in History of Education Owerri: Grace of God Press.

Okunamiri, P.O. (2005). The Politics of Education, The Nigerian Experience. Owerri: Fasmen Communication.

Oiibie, E.I. (2013). Curriculum Planning in Secondary Schools: Principals' Practices and Challenges in an Era of Knowledge and Learning Management. International Journal of Academic Research in Progressive Education and Development, 2(1): 443—453.

One Sky. (2009). One Sky: Canadian Institute for Sustainable Living. Retrieved October 21, 2009, from http://www.onesky.ca/pro1ects/detail/leading from_within/.

Oredein, L.M. (2009). *School Organisation*. Onitsha: Loma Printers.

Ozor, N. and Madukwe, M.C. (2012). Influencing curriculum development and knowledge of climate change issues in universities: The case of university of Nigeria Nsukka. Journal of Agricultural Extension, 16(1): 103—118.

RAVTICH, DIANE (2001J. Left Back: A Century of Failed Education Reform. New York Simon and Schuster.

Sharma, A. (2012). Global climate change: What has science education got to do with it? Science & Education, 21, 33-53.

Sheridan, B. (2008). Climate Change and Impacts on Urban Children: Implication's for Adaption Retrieved on July 12, 2010 from Siterere Sources. World Bank org/inturbanddevelopment/ Bartlett.pdf.

Semper, R. (2010). Promoting climate literacy through informal science learning environments. Retrieved from http://www.project2061.org/events/meetings/climate2010/includes/media/presentations/SemperAAASClimateChange.pdf.

Uchendu, C.C. (2012). Climate Change Management in Secondary Schools in Cross River State: Funding and Training Perspective. Annals of Modern Education, 4(1): 1–8.

Ujah, O.C., edo, E.C., Nzeh, C.E. & Chukwu, A. (2010). Economic Implication of Climate Change Adaptation in Agriculture. Paper Presented at International Conference on Enhancing Agricultural Adaptation to Climate Change in Southern Nigeria, Held at Enugu on 27 July, 2010.

UKECN, (2010). The Impacts and Effects of Climate Change. http://www.United Kingdom Environmental, Retrieved on 21 August, 2010.

UNESCO. (2009). Education for Sustainable Development and Climate Change. http://Unesdoc.Unesco.org/images.

United Nation Framework Convention and Change. (2010). Retrieved 16th October 2010 from http://www.chevron.com/issues/environemnt.

United Nations. (2007). Framework Convention on Climate Change: Washington: Department of Public Information.

United Nations Children's Fund. (2012). Climate change and environmental education. Retrieved from http://www.unicef.org/ education/bege_61668.html.

United Nations Educational, Scientific and Cultural Organization. (2009). learning to mitigate and adapt to climate change: UNESCO and climate change education. Retrieved from http:// unesdoc.unesco.org/images/0018/001863/186310e.pdf.

Vordzorgbe, S.D. (2007). Climate Change and Risk Management in Africa: Major Issues, World Economic Forum on Africa Cape-town.

Wilber, K. (1996). A brief history of everything in Integral Theory of Adaptation (2nd Ed.). Boston, MA: Shambhala.

Wilber, K. (2006). Integral spirituality: A startling new role for religion in the modern and postmodern world. Boston, MA: Integral Books.

Wright, P., Kroll, M.J. & Parnell, J. (1996). Strategic management concepts and cases. New Jersey: Prentice Hall

DEVELOPING STUDENTS' PROFESSIONAL LEARNING FOR AN INTEGRATED CURRICULUM BY IMPLEMENTING AN INNOVATIVE INITIAL PROFESSIONAL EDUCATION OF TECHNOLOGY TEACHERS (IPETT) PROGRAMME

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Abstract: The decreasing numbers of students who have met the entrance requirements for the four-year undergraduate degree in technology education as part of the IPETT programme was a serious concern. However, in an attempt to reverse this trend so that we could build some required capacity for the Fourth Industrial Revolution by developing technology students' professional learning for an integrated curriculum, we have implemented an innovative programme. The participants were enrolled first cohort students for the programme. The research questions were: What innovative curriculum options and entrance requirements could be implemented? What innovative changes could be made to lecturers' pedagogy to meet the needs and challenges of students who enrolled under more flexible curriculum options? How do the expectations, experiences and performances of the students in their first year who did have engineering graphics and design (EGD) as a subject in grade 12 compare to those who did not have EGD as a subject in grade 12? How do the initial expectations, experiences and performances of the students in their first year who did or did not have EGD as a subject in grade 12 compare with those when they were in their second year? A mixed-method methodology was utilised including various open and semi-structured questionnaires and students' academic performance at the end of each semester. The findings revealed that implementing more flexible curriculum options and utilising innovative pedagogical practices could be ways to address the concerns. The findings contribute toward the body of knowledge in the sense that EGD at secondary level should not necessarily be a prerequisite for admitting prospective technology teachers to an IPETT programme. Therefore, by reconceptualising the IPETT programme we could develop teacher capacity with relevant skills while promoting and sustaining knowledge democracy by allowing students with related grade 12 subjects to enrol for this programme.

Keywords: flexible curriculum options, innovative pedagogical practices.

The Department of Education launched a Technical High Schools Turnaround Strategy in 2013. The objectives of this strategy was to expand the opportunities available for technical education, to increase the enrolment of technical students, to increase the human resource capacity for the offering of technical subjects and to involve higher education institutions and Further Education and Training (FET) colleges to support technical schools in achieving these outcomes. In South Africa the last three school years of technology education is referred to as technical education.

This university plays an important part in the education of technology teachers but despite technology-related subjects being regarded as scarce subjects, extremely low numbers of students have opted for these subjects over the past few years. The rigid entrance requirements for the four-year undergraduate degree in technology education as part of the IPETT programme could be one of the impediments. We had to find innovative and imaginative ways to turn this trend of low enrolment numbers around so that we could build some required capacity for the Fourth Industrial Revolution by developing technology students' professional learning for an integrated curriculum.

The purpose of this research was to explore some of the innovative and imaginative ways to address these concerns so that we can build human capacity for the Fourth Industrial Revolution. The research questions were:

1. What innovative curriculum options and entrance requirements could be implemented?
2. What innovative changes could be made to lecturers' pedagogy to meet the needs and challenges of students who enrolled under the more flexible curriculum options?
3. How do the expectations, experiences and performances of the students in their first year who did have engineering graphics and design (EGD) as a subject in grade 12 compare to those who did not have EGD as a subject in Grade 12?
4. How do the initial expectations, experiences and performances of the students in their first year who did or did not have EGD as a subject in grade 12 compare with those when they are in their second year?

Context of the study

Curriculum options and entrance requirements

One of the qualifications for initial teacher education at this South African university is a BEd degree in Technology (Senior Phase and FET) with specialisation in engineering graphics and technology education (EGTE) up to third-year level, and civil technology up to second-year level.

Having done EGD at grade 12 level was a prerequisite for students to enrol for the programme in 2013, 2014 and 2015. However, student enrolment dropped from 17 to eight to zero respectively, therefore, we had to put the intake of new first-year technology students on hold for 2015. After intensive consultation with stakeholders, more flexible curriculum options for the 2016 intake were set whereby EGD as an entrance requirement was dropped, and EGD on second-year level could be combined with physical sciences or geography or mathematics at third-year level. Students only had to comply with the entrance requirements for their specific majors in the Faculty of Science. This decision was supported by the fact that the academic discipline on which technology is based is manifested in more than one of the mentioned disciplines (Ankiewicz, 2015). According to Ankiewicz (2015) technology can be seen as a multi-discipline or a poly-discipline, of which components are spread over more than one discipline. The expectation was that the more flexible curriculum options would support the agenda to build some required capacity for the Fourth Industrial Revolution while promoting and sustaining knowledge democracy.

Pedagogical practices

During 2016 the first-year students had one double period class per week which was facilitated by a lecturer and the focus was on the development of conceptual knowledge (*knowing that*). Due to the more flexible curriculum options and entrance requirements, the lecturers realised that they had to provide more intensive support to the students without EGD at secondary level. These students needed sessions focused on practical apprenticeship providing an interaction between an expert and a novice (Jakovljevic & Ankiewicz, 2015) to develop the novices' procedural knowledge (*knowing how*). A double period per week was set aside for practical apprenticeship (tutorial) which was facilitated by an expert. The expert guidance was given in a peer-based collaborative learning environment (Jakovljevic & Ankiewicz, 2015). The appointed expert, a qualified draughtsman with related work experience, is a practicing technology teacher at a nearby secondary school. An additional expert, a student in technology education on an honours level, was appointed at the beginning of 2017 as a tutor assistant to provide individual attention during the tutorials and consultation times so that the second-year students could better cope with the learning content.

Research design

A mixed method approach was utilised whereby quantitative and qualitative data were collected (Creswell, 2003; Creswell, 2005). The participants were students who enrolled for engineering graphics and technology education (EGTE) in 2016. A number was allocated to each student to ensure anonymity. The only person who could identify the specific participant was the researcher who was not involved in teaching the students. Ethical clearance for this study was granted as it adhered to all the required conditions set by the research ethics committee.

Biographical data related to the students' grade 12 subjects were collected. Open and semi-structured questionnaires were completed at the beginning and the end of each semester. The focus of these questionnaires was on students' expectations and experiences of the various semester modules of EGD and the pedagogical practices. The challenges that students might experience would then lead to innovative changes to the lecturers' pedagogy and support systems (refer to research questions 2, 3 and 4). The students' academic performance at the end of each semester was captured and the overall final mark for the year was calculated. The first phase of a longitudinal study which forms the basis for this report was done over a period of two consecutive years.

Results

Biographical data and academic performances at tertiary level

The biographical data related to the students' required grade 12 subjects and their overall final mark for EGTE, as indication of their academic performance, are indicated in tables 1 and 2. The learning content for EGTE 1 included basic drawing techniques, and geometrical and orthographic concepts, while mechanical and civil drawings formed part of EGTE 2.

Table 1 Quantitative data

		School subjects					EGTE 1	EGTE 2
Number of student	Gender	EGD	Maths	Maths Literacy	Physical Sciences	Geography	2016 Final Mark (%)	2017 Final Mark (%)
1	Female		Yes		Yes	Yes	59	57
2	Male	Yes	Yes		Yes		62	67
3	Female		Yes		Yes	Yes	57	54
4	Female		Yes		Yes	Yes	53	62
5	Male			Yes			63	70
6	Male			Yes		Yes	75	77
7	Female	Yes	Yes			Yes	79	73
8	Male		Yes		Yes		51	46
9	Male		Yes		Yes	Yes	60	58
10	Male	Yes	Yes		Yes		68	58
11	Male	Yes	Yes		Yes		84	78
12	Male	Yes	Yes			Yes	78	60
13	Male	Yes		Yes			69	65

Comparison between the performances in EGTE 1 in 2016 of students with or without EGD at secondary level

The data from the two groups were subjected to the Kolmogorov-Smirnov (D) test to see if the distribution differs significantly from the normal distribution. The values were as follows: EGDYes (6) = 0.193; p = 0.200; EGDNo (7) = 0.190; p = 0.200. Therefore, the test is non-significant (p > 0.05) which suggests that the distribution of the population was not significantly different from a normal distribution. Hence, the data can be subjected to an independent means t-test as the two groups either took EGD at secondary level or they did not take it as a subject indicating an unpaired situation (Cohen, 1988). Table 2 represents the group statistics related to the performances of the students.

Table 2 Group statistics related to the performances in EGTE 1 in 2016

EGD in grade 12	Number of students	Mean score for EGTE 1	Standard deviation	Standard error mean
Yes	6	73.33	8.29	3.38
No	7	59.71	7.89	2.98

An independent means t-test was conducted to compare the mean scores for the two groups. The significance level for Levene's test was 0.53 meaning the assumption of equal variances was not violated. There was a statistically significant difference in the mean score for students with EGD (M = 73.33, SD = 8.29) and students without EGD, M = 59.71, SD = 7.89; t (11) = 3.03, p = 0.01 (two-tailed). Therefore, the students who did have EGD as a subject in grade 12 scored statistically significantly higher than the students who did not have EGD (73.33% and 59.71% respectively, see Table 2).

In addition, the calculated effect size indicated an Eta squared value of 0.455 (Pallant, 2007) which can be valued as a large effect (Cohen, 1988) and Cohen's d (1.68) with r = 0.64 (medium to large effect) and hence the effect of having done EGD as a subject in grade 12 is important. A website calculator (https://www.uccs.edu/~ibecker/) was used to calculate Cohen's d and the related effect size.

Comparison between the performances in EGTE 2 in 2017 of students with or without EGD at secondary level

Seeing that the measures are numeric, the data has a normal distribution, the whole population was included in the study and the two groups are independent, the data can be subjected to an independent means t-test. Table 3 represents the group statistics related to the performances of the students.

Table 3 Group statistics related to the performances in EGTE 2 in 2017

EGD in grade 12	Number of students	Mean score for EGTE 2	Standard deviation	Standard error mean
Yes	6	66.83	7.63	3.11
No	7	60.43	10.36	3.92

The significance level for Levene's test was 0.48 meaning that the assumption of equal variances was not violated. There was no statistically significant difference in the mean score for students with EGD (M = 66.83, SD = 7.63) and students without EGD, M = 60.43, SD = 10.36; t (11) = 1.25, p = 0.24 (two-tailed). Therefore, by the end of their second year it seems that the performances of students who did have EGD in grade 12 and those without EGD in grade 12 are similar.

Five of the six students who did have EGD at secondary level had a final mark for EGTE 1 of 67% or more in 2016 whereas not one of the students without EGD but with mathematics and physical sciences at secondary level could achieve 67% or more. Three of the six students who did have EGD at secondary level had a final mark for EGTE 2 of 67% or more in 2017 whereas not one of the students without EGD but with mathematics and physical sciences at secondary level could achieve 67% or more.

The qualitative data were collected by means of various questionnaires over a time span of two consecutive years. The quotes are representative of the dominant feedback by the students. The data from the students who had EGD and those who did not have EGD in grade 12 are indicated separately in Table 4 so that the feedback by the various groups on the open-ended questionnaire could be compared.

Table 4 Examples of students' feedback during their first year of atudy

	Variable	Students with EGD in grade 12	Students without EGD in grade 12
Beginning of the first semester EGTE 1A	Initial expectations of EGTE as a major Feelings about taking EGTE as a major	"I am expecting to be the best student and **to excel** in this module." "I actually **feel great** with EGTE because I loved EGD in grade 10 to grade 12."	"I expect to **see myself succeeding** in this module no matter how tough it might be." "I **feel very good about it** and I am looking forward to it."
End of the first semester EGTE 1A	Experiences of EGTE 1A	"One of the topics that **drained my energy** was geometrical construction, so I had to work very hard when the exam was around the corner."	"Truly speaking and from the bottom of my heart first semester module, EGTE 1A was hell of a module. The **thought of quitting** was always on my mind."
End of the second semester EGTE 1B	Satisfaction of expectations	"Yes, I wanted to be able to analyse and draw neat and clear drawings using equipment and to be able to draw clear freehand drawings. **My skills improved**."	"Yes, I expected to learn more about how technology satisfy or make people's lives easier of which I learnt in 2016 and now I know how technology contributes to the world. I also expected to learn how to draw and **I have learnt more about drawings. I learnt how to design**."

Students from both groups, those with EGD and those without EGD, experienced the first semester module as challenging but by the end of the second semester students indicated the module satisfied their expectations (see Table 4).

The data for Table 5 were collected by means of an open-ended questionnaire and the feedback by the students with or without EGD in grade 12 are indicated separately for comparison purposes.

Table 5 Examples of students' feedback at the beginning of the first semester of their second year of study

Variable	Students with EGD in grade 12	Students without EGD in grade 12
Expectations of EGTE 2A	"My overall expectation/s for my experience in the course is that of an enjoyable and educational outcomes that will assist me in my overall understanding of this module and the various aspects linked to it."	"I also expect this module to equip me with the necessary skills I will need for my future practice as a teacher. This means that I will be also accountable for my schoolwork."
	"I also expect that we should be given as many activities for practice."	"In EGTE 2A I expect to know more about mechanical drawings. How mechanical objects operate. And I also expect to know how we relate those drawings to the careers of our future learners as student educators."

It follows from Table 5 that both groups had a positive attitude towards EGTE 2A and they indicated their expectations regarding pedagogical principles.

At the end of the first semester of their second year students received a semi-structured questionnaire. Questions regarding their own personal experiences and their experiences of the teaching in the module were included. Students from both groups gave similar feedback (refer to Table 6).

Table 6 Examples of students' feedback at the end of the first semester of their second year of study

Variable	Students with EGD in grade 12	Students without EGD in grade 12
	"With every new challenge or concept my **fears grow greater** as the level of complexity keeps on increasing."	"**Time for completing some tasks** such as semester tests is very limited leading to incomplete or wrong answers due to stress and **anxiety**."
	"I like this module, I **feel inspired** every day I attend it with an encouragement at the back of my mind I know that I will make it ..."	"The **experience** with the tutors, assistant, peers and the lecturer has been **good** because I learn a lot from each one of them."
	"... since there is less time for completing the tests and exams which are sometime really challenging. Time allocation for the tests is **so little** ..."	"Time for completing some tasks such as semester tests is **very limited** ..."
	"I am **still trying to find my way** around it."	"... some of us never did EGD in high school, we **become really confused** when we encounter something new in the exam, something we never seen before. You find that you are thinking but nothing is adding up because you do not have that drawing knowledge."
	"Had it not been for the weekly assignments **chances are that I would not make it**." "The assignments is where we supposed to get marks from, but I feel as if you **too strictly in marking**."	"... the portfolio for the practical has unnecessary fields that are required that **cannot help us with anything but to take our time** (e.g. the case of the whatever we are going to make, the disadvantages and the advantages before we do the project and others)."

	"The lecturer has taught the content at a **reasonable pace** and has always offered his **assistance** when required and has also used and explained concepts in such a way that it promotes understanding."	"The lecturer has made my learning experience fruitful by **explaining to us** the requirements of what needs to be done, and also offers **assistance** with regards to what has been covered in the classroom."
	"I appreciate his concern when content is not clearly understood and he then makes a concerted **effort to assist** us in understanding and retaining this information."	"The tutor has been good in terms of simplifying concepts and **offering assistance** with any problems we may encounter in the tutorials. The experience with the tutor has been excellent."
	"The assistant tutor **does help** but I feel like she expect a lot from us when she sees others doing well. I feel like her presence **makes the classroom a bit tense**."	"Offers great help and assistance at all times. The assistant also makes sure that she makes times for consultations and also **helps in clarifying concepts** which are challenging."
	"Those who do well in class put me under **pressure** as it is depressing to see them getting good marks while some of us are struggling to qualify. But we do **get along well**."	"My peers offer great assistance and support with regards to the content covered in class and in tutorials. We often prepare for assessments together and **helping each other** in academic related issues."

From Table 6 it follows that students from both groups, students with EGD and those without EGD in grade 12, experienced some sort of anxiety, have positive feelings, are concerned about the time allocation, found it hard to deal with something new, and indicated that the demands are challenging. Students from both groups indicated that they appreciated the assistance from the lecturer, tutor, tutor assistant and peers. However, students who had EGD in grade 12 indicated that the tutor assistant "makes the classroom a bit tense" and that they experience "pressure" among their peers.

The next open-ended questionnaire, administered at the beginning of the second semester of the second year of study, dealt with the expectations for the second semester module and the researchers wanted to know what would assist them to better cope with the expected challenges (refer to Table 7).

Table 7 Examples of students' feedback at the beginning of the second semester of their second year of study

Variable	Students with EGD in Grade 12	Students without EGD in Grade 12
Expectations of EGTE 2B	"Lastly, is to ensure that I **complete this module with flying colours** or ace the module by being given all the aids of assistance."	"I want this semester to be interesting and enclosed with **hard work and perseverance** from both the students and the lecturer."
	"As far as the course is concerned, I do not anticipate any challenges at present, with the pace of the course as I am aware that the lecturers see to it that there is a **reasonable pace** from one concept to another." "I am hoping **more time** will be given to longer topics to enable us to fully understand what civil drawings are and how to go about interpreting them." "However, a challenge that I always face with civil drawings is time-coverage ..."	"As long as **we work together** as the class together with the lecturer, we will defeat failure and confusion."
What would assist you to better cope with the expected challenges?	"I think it would be better if the tutor and a tutor assistant have their own **consultation time** besides the tutorials on Wednesday, so that if an individual does not understand a certain topic can consult."	"I would like the lecturer and the tutors to be patient with us and give us **enough time** to understand what is expected from us."

It follows from Table 7 that students from both groups — students with EGD and those without EGD in grade 12 — seemed to have a positive attitude and some of them referred to the pedagogical practices of following a reasonable pace and cooperation in the classes. Regarding what would assist them to better cope with the expected challenges some students also mentioned that they would like to get possible questions that will appear in tests and exams; they regard weekly assignments of the utmost importance; and that they would like to receive homework for extra practice.

During the last class of the year the students had to complete a questionnaire which included open and semi-structured questions. The variables of the semi-structured questions are indicated in the aspect column (see Table 8).

Table 8 Examples of students' feedback at the end of the second semester of their second year of study

Variable	Students with EGD in grade 12	Students without EGD in grade 12
Experiences of EGTE 2 compared to EGTE 1:		
Subject/ content knowledge and skills	"As expected, the content in the second year course had been or has been **more challenging** than those in first year ..."	"When compared to my first year modules, my second year modules were **more demanding** and they required consistency."
	"The second year modules were **more abstract** than the first year modules ..."	"The second year content is far different and **much harder** compared to the first year. I think it is because in the first year the subject was new to me but now even though it is hard I am able to follow much easier."
	"... they had been challenging in the sense of **time management** ..."	
Teaching and learning:		
Lectures	"I could not understand some of the topics especially in civil drawings, other than that I think the lecturers (and the tutors) were able to explain and teach everything in detail for us as students to understand."	"The lectures (and tutorials) were of a great use because they make sure we understand the content."
Tutorials	"I could not understand some of the topics especially in civil drawings, other than that I think (the lecturers) and the tutors were able to explain and teach everything in detail for us as students to understand."	"Even on tutorials the addition of the tutor assistant was of a great use because they are now able to engage with one of us individually."
Personal learning experiences	"During the course of the first-year modules my personal experiences vary from those in second year. The main occurrence for this had been the content, personally the content taught in first year had been manageable and less challenging in that sense ..."	"Teaching and learning was very productive in lectures and in tutorials."
Challenges	"... in the second year the expectations had increased in terms of what had to be done."	"The main challenge for me both the first- and the second-year modules was the time allocated for semester tests. This led to a few semester test to be submitted while incomplete."

Variable	Students with EGD in grade 12	Students without EGD in grade 12
Resources		
Lecturers	"... in both second year and first year the lecturers (and tutors) had and have been of great support in terms of content understanding throughout these two years."	"The lecturer (tutors and classmates) provided enough support to advance my knowledge base."
Tutor	"... in both second year and first year the lecturers (and tutors) had and have been of great support in terms of content understanding throughout these two years."	"... the activities they give us every week help us practice and to possibly improve our marks EGTE 2B seemed to be a lot of work but with the help of ... and my tutors I managed to improve."
Tutor assistant	"... in both second-year and first-year the lecturers (and tutors) had and have been of great support in terms of content understanding throughout these two years."	"... both the tutor (and the tutor assistant) would give us assessments and it was a great strategy."
Drawing equipment	"I now can say that I am finally exposed to a lot of drawing tools and equipment that we need to draw with. Comparing this with my high school EGD in KZN, I never knew a flexi curve nor use both set squares together when I had to draw without a T-square e.g. non-isometric lines."	"In terms resources, I was adequately covered and there were no major problems experienced."

Although the students were asked to make *sug*gestions that will help them to meet the challenges they had experienced in the programme over the past two years, the majority of them wrote about the overall challenges they had experienced without providing any suggestions (refer Table 8). However, a few of them did suggest that more time should be allocated to them to be able to finish their assignments during tests and the exam. One student wrote: "The issue of teaching theory in class should be eliminated and students should spent more time drawing since this is what they will be doing in the exam."

Conclusion

By introducing more flexible curriculum options and dropping EGD as an entrance requirement (refer to the first research question), 19 students could enrol for the programme in 2016, of which 13 completed their second year successfully. Therefore, moving away from the rigid entrance requirements, inter alia, having done EGD at secondary level, to allow students with grade 12 subjects from related disciplines (Ankiewicz, 2015) to follow a more flexible curriculum, develop teacher capacity with relevant skills while promoting a "democracy of choice" by allowing students with related grade 12 subjects to enrol for this programme should be implemented.

The implementation of tutorial sessions, the appointment of an expert in the field as a tutor, and appointing the tutor assistant testify to the innovative changes made to the lecturers' pedagogy (refer to the second research question). The collaborative learning environment (Jakovljevic & Ankiewicz, 2015) was invaluable for the students and much appreciated as mentioned in the feedback on various questionnaires. This is in line with Butler-Adams's (2018) second implication for institutions of education which requires people to have the skills to implement, manage and work with the new technology, and with one another.

Although the students who had done EGD in grade 12 achieved statistically significant higher marks at the end of their first year than those who did not have EGD in grade 12, the last group also completed their year successfully (refer to the third research question). Furthermore, the performance of students with and those without EGD in grade 12 equalise by the end of their second year of study (refer to fourth research question). This might be a consequence of the innovative and imaginative pedagogical practices which were introduced in the learning environment contributing towards capacity development.

The qualitative data from the various questionnaires do not show important differences between the various groups of students (refer to the third and fourth research questions). The overall findings indicate that all students experienced challenges from time to time, had a positive attitude towards the modules, and appreciated the support they received from the lecturers, the tutor, the tutor assistant as well as their peers. The biggest concern seemed to be the need for more time allocated to be able to finish their assignments in the tests and during the exam.

Finally, having done EGD as a subject in grade 12 had a large effect on the final marks for EGTE 1 of students. However, having done EGD at secondary level is not essential to pass at tertiary level as long as ample support is provided to meet the students' needs and challenges. Therefore, by reconceptualising the IPETT programme we could develop teacher capacity with relevant skills while promoting and sustaining knowledge democracy by allowing students with related grade 12 subjects to enrol for this programme.

References

Ankiewicz, P.J. (2015). The implications of the philosophy of technology for the academic majors of technology student teachers. In M. Chatoney (Ed.), *Plurality and complementarity of approaches in design and technology education.* Proceedings of the PATT 29 conference (pp.13—25). Marseille, France.

Butler-Adams, J. (2018). The Fourth Industrial Revolution and education. *South African Journal of Science*, 114, 5—6. Available at: http://dx.doi.org/10.17159/sajs.2018/a0271

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences* (2nd ed.). Hillsdalen, New Jersey: Erlbaum.

Creswell, J.W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Thousand Oaks, California: Sage.

Creswell, J.W. (2005) *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (2nd ed.). New Jersey: Pearson Prentice Hall.

Department of Basic Education (DoBE). (2011). *Curriculum and assessment policy statement (CAPS): Engineering and graphics design Grades 10—12*. Pretoria: Department of Basic Education.

Jakovljevic, M. & Ankiewicz, P.J. (2015). Project-based pedagogy for the facilitation of webpage design. *International Journal of Technology and Design Education*. DOI 10.1007/s10798-015-9312-5.

Pallant, J. (2007). *SPSS Survival manual: A step by step guide to data analysis using SPSS for Windows* (3rd ed.). New York: Open University Press.

LEARNING MATHEMATICS — A THEORETICAL PERSPECTIVE

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Abstract: This paper discusses theoretical frameworks directed at TVET (Technical Vocational & Education Training College) students and the misconceptions that permeate to errors in differential calculus (application in optimisation). A theoretical framework is beneficial in describing misconceptions that result in errors students display in differential calculus. The framework is underpinned by the radical constructivism model and its supporting theories.

The first radical constructivism supporting theory under scrutiny is Tall's idea of a procept. The procept construct holds the view that basic mathematics begins with "perceptions of" and "actions on" objects in the external world. These objects are seen as visuo-spatial gestalts but as they are examined and their properties discovered, they are verbally pronounced, leading to different classifications. Such classifications may be misconceptions if students fail to map the examined procepts correctly.

The second radical constructivism supporting framework discussed is the APOS (Action-Process-Object-Schema) which proposes the phases that students go through when they interiorise external mathematical concepts. During the interiorisation phase, students may develop misconceptions if some of the phases during mathematics learning are not sufficiently and properly learned.

The third radical constructivism supporting theory explained is Sfard's idea of perceiving mathematical notions as entities with static structure that is integrative without going into details. Operational knowledge is stored informally in sequential cognitive schemas. This suggests that pure operational understanding may create misconceptions during problem-solving in that processing has to take place segmentally, which results in a particular degree of cognitive challenges.

The point is that many students develop misconceptions based on different philosophies they hold on their current knowledge of mathematics. The inability of learners to understand mathematical symbols results in their failure in their inability to comprehend important mathematical concepts; and lack of understanding these mathematical notation results in syntax errors and misconceptions.

Keywords: theoretical framework, errors, misconceptions, differential calculus

Introduction

Critical studies are foregrounded by a reliable well developed theoretical framework. This is because research cannot exist in space, and the theoretical framework suffuses the concepts that affect the research. The word "theory" is derived from the Greek word "*theorein*", which translates to "gaze upon" or "to behold" (Popper, 1963). The term "theory" is defined as an organised and systematic set of interrelated statements that specify the nature of relationships between two or more variables with the aim of understanding the problem or the nature of things (Fain, 2004). Meanwhile, the theoretical framework is defined as a model based on the existing theory in a particular field of study that reflects the hypothesis of the study (Adom, Agyem & Hussein, 2018); it informs the research methodology, design and data analysis. Grant and Osanloo (2014) define theoretical framework as a guide for research. Although Anfara and Mertz (2006) acknowledge that the term does not have a clear and consistent definition, they define theoretical framework as "any empirical or quasi-empirical theory of social and/or psychological processes, at a variety of levels (e.g. grand, mid-range, and explanatory) that can

be applied to the understanding of phenomena" (p xxxvii). This definition of a theoretical framework rules out what Guba and Lincoln (1994) have called "paradigms" of social research like post positivists, constructivists, and critical constructivists, etc. This model is often "borrowed" by researchers to build their research inquiries. Eisenhart (1991:205) defined a theoretical framework as "a structure that guides research by relying on a formal theory constructed by using an established, coherent explanation of certain phenomena and relationships, e.g. Piaget's theory of conservation, Vygotsky's theory of socio-historical constructivism and Simon's theory of human problem-solving."

In any research, it is important that the theoretical framework is coherent, understandable and relates to the topic. Moreover, it must be useful in promoting a clear understanding of the phenomenon under investigation. This suggests that the theoretical framework must support the research problem and questions, because it is chosen to support them after they have been identified. The theoretical framework describes the researcher's presumptions about how the main concepts supporting the research may be understood (Anfara & Mertz, 2006). The main argument of this paper is students' errors as a result of misconceptions in mathematics, with specific reference to differential calculus. The researcher further discusses how and why students comprehend mathematics in ways that result in misconceptions that are evident in errors they make by discussing the components of the theoretical framework — the cognitive constructivism learning theories and the likely misconceptions that result in errors in differential calculus. Furthermore, the researcher justifies the importance of studying aspects of students' errors and misconceptions in calculus.

In discussing the theoretical framework of the study, the researcher presents the purpose of the study and the research question.

Aims of the Study

With regard to TVET college students' errors and misconceptions in differential calculus, the aims of the study were to:

1. Identify common errors and misconceptions made by learners' in answering differential calculus questions;
2. Identify and provide reasons why learners hold the misconceptions.

Research questions

What are the common errors displayed by NC(V) level 4 students at TVET colleges in differential calculus?

This question is divided into the following sub-questions:

1. What are the common errors displayed by TVET college students in differential calculus?
2. How can the students' errors be addressed in order to enhance learning outcomes?

With regard to students' errors as a result of misconceptions, the researcher assumed that the cognitive constructivism theory (Piaget, 1968) and its resultant notions of concept image, concept definitions (Tall & Vinner, 1981) and the duality of mathematical concepts (Sfard, 1991) assist in explaining learners' thinking and how they comprehend mathematics concepts. The researcher also focused on the APOS (action, process, object and schema) theory (Dubinsky & McDonald, 2008), which is underpinned by constructivism. The APOS theory argues that learning is a constructive process that involves different phases for external concepts to be interiorised by students (Luneta & Makonye, 2013). At the centre of Sfards (1991) theory of reification lies the conception that mathematical notions can be acquired in two basic different ways, that is, structurally as objects and operationally as processes. She argued that the two approaches despite their differences are complementary and that successful mathematics learning and problem-solving requires students to be flexible in traversing between the two.

Gaining the overall understanding on how mathematics learning takes place and how students hold misconceptions that result in errors is one powerful task in mathematics education research. The researcher discusses one by one the outlined theoretical underpinnings as they relate to the study's main concepts. The researcher further discuss how the theories are related and their implications on students' errors and misconceptions.

Theories of learning

The researcher assumes that the constructivist theory of learning (Piaget, 1968; Von Glassersfeld, 1990; Siegler, 1995; Hatano, 1996) is a useful framework that can be used to describe and assume how students acquire knowledge of mathematical concepts and their misconceptions. Learning mathematics begins with understanding basic concepts, rules and acquiring procedural knowledge. This process takes place in students' minds, so it is imperative for the researcher to "borrow" theoretical underpinnings in terms of cognitive factors. Then, the researcher argues that errors and misconceptions arise in the cognitive domain as students think and learn.

The constructivist framework for learning posits that learning occurs in students' mind (Piaget, 1968; Smith et al., 1993; Siegler, 1995). This argument contradicts the behaviourism theory of learning (Skinner, Pavlov, & Thorndike, cited in Luneta & Makonye, 2013), situated theories of learning (Lave & Wenger, 1991) and socio-cultural learning theories (Vygotsky, 1978; 1986). Constructivist theory of learning argues that students build mathematical knowledge through a cognising mind guided by self-regulation (Hatano, 1996). As students encounter learning situations that are contradictory towards their current understanding, they develop cognitive conflict, which is a state of mental disequilibrium, causing students to explore problems in relation to their prior-knowledge. The revisiting prior knowledge causes students to think systematically in trying to reconcile and settle the disequilibrium, resulting in learning.

Even though Piaget is seen as the first proponent of the constructivist framework, it is researchers like Von Glassersfeld who discovered radical constructivist theories of learning, which argues that mathematical knowledge is actively constructed by individuals and that coming to know is an adaptive process (Luneta & Makonye, 2013).

Several studies on radical constructivism have been conducted over the past decades. At the core of these studies were discussions on the duality of mathematical concepts as being both the "processes" and "objects" (Dubinsky, 1991; Harel & Kaput, 1991; Sfard, 1987; Dubinsky & Harel, 1992; Tall & Vinner, 1981). Although proponents of mathematical thinking present differing views on their approaches, their theoretical perspectives are similar. In the following section, the researcher provides an account of the work done by Tall and Vinner.

Tall and Vinner concept image and concept definition

Borrowing from the assumption that a constructivism framework describes how students construct their mathematical knowledge including misconceptions, the researchers assumed that Tall and Vinner's ideas of concept image and concept definition further clarifies students, errors and misconceptions in differential calculus. By concept image, Tall and Vinner explained a mental image of cognitive knowledge that students form regarding specific mathematical concepts. This is the cognitive knowledge that students develop based on previous personal experiences with specific mathematical concepts. According to Tall and Vinner (1981), concept image is made up of mental pictures, sets of properties and definitions that are linked to an individual's mind based on a specific concept.

Luneta and Makonye (2013) likened the concept image to Piaget's schema. They argued that the concept image is a picture of a concept built by learners to make reference to identified concepts. Concept

images might be correct, partially correct or erroneous, and they are a function of maturity and experience with a concept (Luneta & Makonye, 2013). This suggests that concept images are constantly changing as students continually think and refine their concepts. Tall and Vinner (1981) revealed that individuals tend to construct different ideas about a specific concept, as a result, a concept image may have contradictory and competing ideas. Additionally, Tall and Vinner (1981:77) mentioned that "it is not always pure logic which gives us insight, nor chance that causes us to make mistakes." This suggests that concept images constructed by students might be different from formal mathematical knowledge known by the wider mathematical community. The difference results in misconceptions that hamper students' successful problem-solving in mathematics.

The prevalence of misconceptions in concept images present learning difficulties in the construction of new mathematical knowledge, in a way that students may build new knowledge on inadequate previous knowledge. The resulting consequence is a pattern of misconceptions that are bound to hamper the cognitive equilibrium (Piaget, 1968). Additionally, Luneta and Makonye (2013) argues that concept images may be non-existent in some students when they have never encountered the concepts previously. Tall and Vinner (1981) revealed that in some instances, the brain might contradict itself, thereby activating a certain part of the concept image called "*evoked concept image*". Different stimulated concept images might happen simultaneously, resulting in students having unexplained confusion as they feel that something is amiss. In such instances, students might have feelings of uncertainty — this happens when evoked concept images do not match. In such instance students may have partial understanding of concepts.

Concept definitions are words that define or identify concepts as defined by mathematics experts (Tall & Vinner, 1981). Concept definition might be acquired instrumentally or relationally (Tall & Gray, 1992). According to Luneta and Makonye (2013), students' "personal" concept definition may differ from formal concept definition. The authors defined concept definition as the outer reality of learners. They argue that some educators teach insufficient concept definitions and students encounter challenges in that they construct incoherent and partial concept images. Educators need to present same concepts using varying representations (imagery, wording, anecdotes, cases in point and formal principles) or models so that students develop complete mental pictures of the mathematical concepts (Özerem, 2012). Thus, to a learner, a concept definition is the external reality that the educator wants a learner to comprehend, whereas the concept image is the inner model of the same reality, which can sometimes be a misconception of the external reality. For instance, Luneta and Makonye (2013) argued that a student might hold a concept image that calculus is extended algebra, because he/she notes that calculus is communicated using algebraic terms. Such a student's concept image is simplistic and is different from the concept definition that calculus is an analytic method for investigating rates of change in phenomena.

Tall and Vinner (1981) argue that concept images or concept definitions are likely to conflict other concept images or definitions. These may result in cognitive conflict factors in students. Luneta and Makonye (2013) argued that cognitive conflict factors occur when probable conflict factors arise simultaneously, yet are considered to be separate. They are perceived as apparent and feasible, never seen as conflicting. Probable conflict factors describe varying misconceptions that students hold of the same concept. It is necessary that the researcher brings to the fore potential conflict factors in calculus so that they can be resolved to improve calculus learning.

Cognitive conflict factors are subconsciously triggered so that the conflict presents itself in inexpressible confusion (Tall & Vinner, 1981). If two concept images are no different between themselves but are different with regard to concept definition, students may not experience cognitive conflict and the two may exist side by side. This result in what Luneta and Makonye (2013) termed a situation of stability. Where students do not feel the need to learn new information. This results in barriers to

learning of formal theory, since such students are comfortable with their interpretations. These notions are noted in calculus concepts where various concept images that students have are not in conflict. In such instances, students might have learned algebra and considered calculus as not important and not necessary. Educators need to be aware of the potential conflict factors in differential calculus, that is, stable misconceptions. What is required is to create conflict between these or conflict with concept definitions such that students see the need to acquire equilibrium.

As mentioned, students hold misconceptions based on variations between concept images and concept definitions. If students become aware of the concepts but have not constructed the meaning to the concept, they will only acquire operational understanding of the concept. Jaworski (1994) termed that process weak constructions. Hence in abstract problems, where these concepts are implicit and are required during problem-solving, students are likely to be confused. The researcher assumed that mathematical errors and misconceptions happen when students are unable to acquire conceptual knowledge into their concept images. This may lead to limited concept images held by students where the existing concept images are not in agreement with formal experts, concept definitions. Acquisition of mathematical knowledge should be the transformation of the knowledge from the forms in which it exists, that is, from contextual, textual and educators' minds into ways that students can understand and apply.

Dubinsky's APOS theory

APOS (Action-Process-Object-Schema) is a framework for research and curriculum development which advocates for the development of ways that abstract mathematics can be assimilated and learned (Brijlall & Ndlovu, 2013). The framework is underpinned by the constructivism model, which is based on the notion that mathematical knowledge is made up of individuals' tendencies to view mathematical problem situations through construction of mental actions, processes and objects; and organising them into schemas to make sense of the situations and to solve problems (Dubinsky & McDonald, 2008). Research by Dubinsky & McDonald (2001) proposed that for a given concept, the likely mental structures need to be identified, then appropriate learning activities should be developed to aid the construction of these mental structures in students' mind. APOS framework is further anchored in Piaget's (1967) theory of cognitive development. Central to Dubinsky's theory is Piaget's perception of reflective abstraction (Bowie, 1998). According to Bowie, reflective abstraction is divided into two parts, namely, projection of existing knowledge onto a higher plane of thought and reorganisation of existing knowledge structures (Dubinsky, 1991). Dubinsky (1991) argued that reflective abstraction is therefore a process of knowledge construction and explained five types of construction as:

a. Interiorisation
   This is parallel to Sfard's and Piaget's notion (Bowie, 1998). According to Bowie (1998) actions on objects are interiorised into a system of operations.
b. Coordination
   When two or more processes are coordinated to develop a new process, for instance the chain rule for differentiation needs coordination of composition of functions with derivatives (Bowie, 1998).
c. Encapsulation
   Encapsulation is similar to Sfard's concept of reification. It is a leap to viewing as an object what has previously been seen as a process (Bowie, 1998).
d. Generalisation
   When the existing schema is applied in a variety of contexts, for instance, when students have abilities to view functions as a map not only to numbers but also to vectors (Bowie, 1998).
e. Reversal
   When the interiorised process can be reversed, for instance, the ability of students to find antiderivatives (Bowie, 1998).

According to Weller, Arnon and Dubinsky (2009), an action is defined as a transformation when it is a reaction to stimuli which an individual sees as external. It needs specific teaching and the need to perform each step of the transformation explicitly. For instance, a student who requires an explicit expression to think about a limit of a function, $\lim x \to a\ f(x)$, and can do little more than substitute values of x close to a for the variable in the expression $f(x)$ and manipulate it, is seen to have an action understanding of a limit of a function.

Weller, Arnon and Dubinsky (cited in Aydin & Mutlu, 2013) define a process as a phase where an individual repeats and reflects on an action, it may be interiorised into a mental process, that is, a process takes place when a mental structure that undertakes the same operation as the action, but wholly in the mind of an individual. To be specific, individuals can imagine performing the transformation without having to execute each step explicitly. For instance, a student with the process understanding of a limit of a function ; $\lim x \to a\ f(x)$; will construct a mental process for values of x close to a and think in terms of inputs, possibly unspecified, and transformations of those inputs to produce outputs.

If one becomes aware of the process as a totality and realises that transformations can act on that totality and can actually construct such transformations (explicitly or in one's imagination), then Weller, Arnon and Dubinsky (cited in Aydin & Mutlu, 2013) argue that an individual has encapsulated the process into a cognitive project. For instance, the limit of a function concept an individual may situations that require him/her to apply different actions and/or processes. These may include the thought about an operation that takes two functions and produces a new function, such as in $\lim x \to 2+ \frac{/x-2/}{x-2}$. In order to operate on the one-sided limit of this new function, the process must be encapsulated and converted into an object.

Weller, Arnon and Dubinsky (cited in Aydin & Mutlu, 2013) made an example of a schema as a certain mathematics topic that often involves many actions, processes and objects that need to be organised and linked into a coherent framework, called a schema. It is coherent in that it provides an individual with means of deciding, when presented with a particular mathematical situation, whether the schema applies. For instance, the coherence might lie in an understanding that to determine the extant of a limit of a function; $\lim \to a\ f(x)$; these must be taken into consideration: input values to the left and right of a, the corresponding output values, and a means of transforming elements of the inputs to elements of the outputs.

Sfard's model of learning mathematics

Lin and Fong (2007) suggested that mathematical concepts can be developed in two ways, structurally as objects and operationally as processes (Sfard, 1991). The structural concept postulates seeing mathematical notions as entities with a static structure that is integrative, and recognisable "at glance" without going into details (Sfard, 1991). She argues that this visual outlook to abstract notions makes them more tangible and to be manipulated like real objects. While operational thinking on mathematical notions is centralised on sequential and dynamic processes on performing algorithms and actions, rather than about objects. The figure below describes structural and operational representations of mathematical notions.

Sfard (1991) argued that during the process of concept formation, operational concepts preceded structural conceptions. She mentioned that exceptions may include figures from geometry where static objects seemed simpler than the algorithms or constructions required to create them. This is in line with Piaget's (1952) observation that when young children learn to count, they respond to the question 'how many are there?' by recounting, not repeating the last number name they used. Other researchers (Carpenter, Corbit, Kepner, Linquist, & Reys, 1980) reported that about half of the 13 year-old

students were unable to provide a symbolic representation of a division problem like 7 divided by 4 in a fraction format. It took a while for mathematicians to treat $\sqrt{-1}$ as acceptable, although the operation of finding the roots was well accepted (Sfard, 1991); suggesting that it takes time for a process on an object to become reified into a new object in and of itself. This shift from computational operations to abstract objects is acquired in three phases, namely, interiorisation, condensation and reification.

During the interiorisation phase, a learner gets familiar with the processes which leads to the new concept for instance, counting leads to natural numbers, subtraction which results in negatives or algebraic manipulations which yields functions (Sfard, 1991). These processes are operations that are performed on lower level mathematics objects. The learner gradually progresses and becomes skilled in performing these processes. The interiorisation process works similarly to what Piaget (1970:14) mentioned when he said that a process has been interiorised if it 'can be carried out through [mental] representations', and in order to be taken into consideration, analysed and compared to the point that it needs no longer to be actually performed. In a case of a negative number, it is a phase where individuals become skilful in performing subtractions; in a case of complex numbers, it is when learners gain proficiency of using square roots; in a case of functions, it is when the concept of a variable and the ability of applying a formula to determine values of the "dependent" variable is gained (Sfard, 1991).

	Structural	Operational
Function	Set of ordered pairs (Bourbaki, 1934)	Computational process or Well defined method of getting from one system to another (Skemp, 1971)
Symmetry	Property of a geometrical shape	Transformation of a geometrical shape
Natural number	Property of a set or The class of all sets of the same finite cardinality	0 or any number obtained from another natural number by adding one ([the result of] counting)
Rational number	Pair of integers (a member of a special defined set of pairs)	[the results of] division of integers
Circle	The locus of all points equidistant from a given point	[a curve obtained by] rotating a compass around a fixed point

Figure 2: Examples of structural and operational descriptions of mathematical notions. Adapted from Sfard (1991).

For instance, if one takes a closer look at any mathematical concept from Figure 2 above, more often than not, one recognises that it can be defined, thus conceived, both as a structural and operational concept. The ability to see a function or a number as a process and an object is essential for comprehending mathematical notions (Sfard, 1991). She argued that the dual nature of mathematical constructs can be recognised not only through verbal descriptions, but also through other various symbolic representations. For example, different approaches to the function concept can be seen in three different ways in which the mapping $y = 3x^4$ is been presented in Figure 3 below:

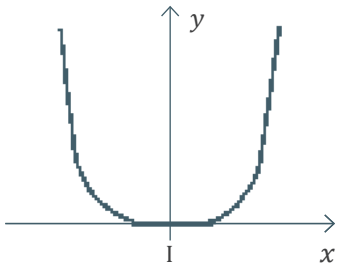
Graph	Algebraic expression	Computer program
	$y = 3x^4$	10 Input X 20 Y = 1 30 For I = 1 to 4 40 Y = Y * X 50 Next I 60 Y = 3 * Y

Figure 3: Differing representations of a function. Adapted from Sfard (1991)

From Figure 3 above, the computer program appears to correspond to an operational notion as opposed to a structural one, because it represents a function as a computational process; not as a unified entity. While the graphic representation shows infinite many components of the function represented by a smooth line, they can be grasped simultaneously as integrated; the graph. The graph therefore endorses a structural approach (Sfard, 1991). The algebraic representation can be interpreted either operationally as a short description of some computation, or structurally as a static relation between two magnitudes (Berg et al., 1976; Kaput, 1979; Kieran, 1981).

Structural and operational conceptions present themselves in special representations by which individuals avail themselves when they process knowledge mentally (Sfard, 1991). This special representation is termed internal encoding (Paivio, 1971; Clement, 1981; Bishop, 1988; Eisenberg & Dreyfus, 1990). Mathematical concepts are sometimes visualised with the aid of "mental pictures", while on other ocassions, the same concepts are handled mainly through verbal representations. According to Sfard (1991) mental images, because of their compactness and integrative nature, seem to support structural conception. Hadamard's self-contained observations on the role of visualisation underpinned this postulation "I need [an image] in order to have a simultaneous view of all elements ... to hold them together, to make a whole of them ...; to achieve synthesis ... and give the concept its physiognomy" (Hadamard, 1949, p.77). Thus, visualisation enables abstract concepts to appear tangible, and endorse treatment of such as if they are real objects.

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The condensation phase occurs when a learner is able to squeeze lengthy sequences of operations into more manageable chunks (Sfard, 1991). She makes examples in a case of a negative number, condensation may be assesed through students' proficiency in combining the underlying processes with other computational operations; or in other words, in his or her ability to perform such arithmetic manipulations as adding or multiplying negative and positive numbers. In a case of complex numbers, condensation is what helps the learner to realise that reversing the operation of squaring may be useful as part of lengthy calculations even if it would not, by itself, yield a legitimate mathematical object. The student may still treat such symbol as $5 + 2i$ as nothing but shorthand for a certain procedure, but at this stage it would not prevent him from skill fully using it as part of a complex algorithm. When function is considered, the more capable the person becomes of playing with mapping as a whole, without actually looking into its specific values, the more advanced in the process of condensation he or she should be regarded. Eventually, the learner can investigate functions, draw their graphs, combine a couple of functions (by composition), even to find the inverse of a given function (Sfard, 1991:19).

Condensation enables reification, that is when a concept is seen as a fully fledged object (Sfard, 1991). Sfard describes it as an ontological shift — the ability to see something familiar in a totally new light. She made the examples as 'in a case of negative numbers, it is the learner's ability to treat them as a subset of the ring of integers (without necenssarily being aware of the formal definition of a ring) which can be viewed as a sign of reification. Complex number may be regarded as reified when the symbol $5 + 2i$ is interpreted as a name of a legitimate object — as an element in a well defined set — and not only as a prescription for certain manipulations. In a case of function, reification may be evidenced by proficiency in solving equations in which "unknowns" are functions (differential and functional equations, equations with parameters), by the ability to talk about general properties of different processes performed on functions (such as composition or inversion), and by ultimate recognition that compatibility is not a necessary characteristic of the sets of ordered pairs which are to be regarded as functions (Sfard,1991:20). She suggests that mathematical conceptions become fully formed when they are acquired fully operationally and structurally by saying "the structural approach invites contemplation; the operational approach invites action; the structural approach generates insight; the operational approach generates result " (Sfard, 1991:28). This suggests that as more processes become reified into objects, students' cognitive capabilities to engage in calculus expands. She also cautions about the likely misconceptions if one or the other is acquired by arguing that at one point a solely operational approach seemed necessary and perhaps sufficient. However, the co-dependence of operational and structural conceptions and the learning challeges of reification explain why many students struggle with learning differential calculus even at highest levels. Sfard (1991:34) argues that many students become discouraged when reification is slow to happen and the challenge to mathematics educators is to find ways to "unravel" the harmful tangle and to stimulate reification'.

There is a general consensus among mathematics education researchers that activities and processes precede the development of mathematical concepts (Dubinsky et al., 1997). Gray and Tall (1994) are the proponents of the concept of a "precept" as the blend of the process and the concept represented by a single symbol, while Sfard (1991) proposed the concept of developing mathematical concepts as both the objects and processes. Although the APOS loop is not linear, it is important during mathematics

learning. Any learning difficulties that may arise in this loop do not bode well for mathematics learning. Such difficulties may result in misconceptions that are evident as errors. For instance, determining a gradient of a tangent to the curve is a process as well as an object. The process of determining the limit and the derivative can be separated, although one originates from the other.

Stein et al. (1993) argued that in engaging mathematics tasks that involve conceptualisation of mathematical ideas, they must first be taught in specific contexts before procedures can be learned. This assists students to develop conceptual knowledge prior to the learning of procedures. Contexts are seen as the motivators of engaging formal mathematics from the informal (Freudenthal, 1991; Gravemeijer, 1994). Engaging in contextual mathematical tasks enables students to develop physical and mental objects from which mathematical meaning and cncepts can be derived. This suggests that once mathematical concepts have been abstracted from real life contexts through actions and processes, students are able to internalise them as generic mental objects which they can use in other practical situations different from the concrete contexts that derived them. Objects become part of their schema.

Cognitive constructivism and misconceptions

Research (Smith et al., 1993; Nesher, 1987) revealed a strong correlation between cognitive constructivism and students' mathematical misconceptions. According to Ernest (1991:2) "Constructivism accounts for the individual idiosyncratic construction of meaning, for systematic errors, misconceptions and alternative conceptions in the learning of mathematics". This view is supported by Confrey (1990, p.201) who argued that "Misconceptions are taken as the strongest pieces of evidence for the constructive nature of knowledge acquisition, because it is highly unlikely that learners acquired them by being taught". These views suggest that teachers do not teach students misconceptions they hold, but, students hold the misconceptions themselves. Cognitive constructivism argues that errors and misconccceptions occurs because of the ways in which learners construct and make sense of mathematics concepts, not because they are careless (Osei, 2000).

Makonye (2013) emphasised that educators should embrace and acknowledge students' misconceptions. In doing so, educators should help students relook and redefine their conceptions, because once students recognise their concept limitations, they are likely to manage the misconceptions in order to resolve them. However, this might not always be the case because at times, students never resolve their misconceptions due to new knowledge.

Conclusion

This paper discussed the radical constructivist theories of learning underpinned by the constructivism framework on students' errors and the associated misconceptions. The learning theories argued that in supporting learning, mathematics educators need to support students to explore differential calculus concepts in order to identify some potential misconceptions around concepts. Such support assists in developing students' broader and strong concept formations. These misconceptions need to be pointed out to students so that they are used as cognitive aids of what is valid and what is not. The researcher suggests that analysing errors through the constructivism model assists in understanding the nature of students' errors and misconceptions in differential calculus.

References

Adom, D., Agyem, A.J. & Hussein, E.K. (2018). Theoretical and conceptual framework: Mandatory ingredients of a quality research. *International Journal of Scientific Research*, 7(1), 438—441.

Anfara, V.J. & Mertz, N.T. (Eds.) (2006). Theoretical Frameworks in qualitative research, SAGE Publications: Thousand Oaks, London.

Aydin, S. & Mutlu, C. (2013). Students' understanding of the concept of limit of a function in vocational high school mathematics. *The Online Journal of Science and Technology*, 3 (1), 145—152.

Bishop, A.J. (1988). Mathematics Education in its cultural context. *Educational Studies in Mathematics*, 19(2), 179—191.

Carpenter, T.P., Corbitt, M.K., Kepner, H.S., Jr, Lindquist, M.M. & Reys, R. E. (1980). National Assessment: A perspective of students' mastery of basic mathematics skills. In M.M. Lindquist (Ed.). *Selected Issues in Mathematics Educatio*n, 215-227, Chicago: National Society for the study of Education, Reston, VA: National Council of Teachers of Mathematics.

Clement, J. (1992). Algebra word problem solutions: Thought processes underlying a common misconception. *Journal for Research in Mathematics Education*, 13, 16—30.

Dreyfus, T. & Eisenberg, T. (1990). On difficulties with diagrams: Theoretical Issues, *Proceedings of PME* 14, Mexico.

Eisenhart, M. (1991). Conceptual Framework for Research in Circa 1991: Idea from a cultural anthropologist: Implications for Mathematics Education Researchers. Paper presented at the Proceedings of the thirteenth annual meeting North American Paper of the International Group for the Psychology of Mathematics, Blacksburg, Virginia, USA. Available at: http://nepc.colorado.edu/files/Eisenhart_ConseptualFrameworkforResearch.pdf.

Freudenthal, H. (1991). *Revisiting mathematics education*. Dordrecht: Kluwer Academic Press.

Gravemeijer, K.P.E. (1994). *Developing realistic mathematics education*. Utrecht:CD-βPress/ Freudenthal Institute, Utrecht University.

Gray, E.M. & Tall, D.O. (1994). Duality, ambiguity, and flexibility: A 'proceptual' view of simple arithmetic. *Journal for Research in Mathematics Education*, 25, 116—140.

Hadamard, J.S. (1949). *The Psychology of Invention in the Mathematics Field*. Princeton University Press, NJ.

Hatano, G. (1996). A conception of knowledge acquisition and its implications for mathematics education. In P. Steffe, P. Nesher, P. Cobb, G. Goldin & B. Greer (Eds.). *Theories of mathematical learning*, 197— 217, New Jersey: Lawrence Erlbaum.

Jaworski, B. (1994). Investigating mathematics teaching: *A constructivist enquiry*. Washington, DC.: The Falmer Press.

Kaput, J.J. (1979). Mathematics and learning: Roots of epistemological status. In J. Clement & J. Lochhead (Eds.) *Cognitive Process Instruction*, 289—303, Philadelphia, PA: Franklin Institute Press.

Kieran, C. (1992). The learning and teaching of school algebra. In Grows, D. (Ed.). *Handbook of Research in Mathematics Teaching and Learning: A project of the National Council of Teachers of Mathematics*. New York: MacMillan.

Luneta, K. & Makonye, J. (2013). Learners' mathematical errors in introductory differentiation: A theoretical framework, *US-China Education Review*, 12(3), 914—923.

Nesher, P. (1987). Towards an instructional theory: The role of learners' misconception for the learning of mathematics. *For the Learning of Mathematics*, 7(3), 33—39.

Tall, D. & Vinner, S. (1981). Concept image and concept definition in mathematics with particular reference to limits and continuity, *Educational Studies in Mathematics*, 12, 151—169.

Osei, C.M. (2000). Student teachers' knowledge and understanding of algebraic concepts: The case of colleges of education in Eastern Cape and Southern KwaZulu-Natal, South Africa. Unpublished Ph.D. dissertation, University of Witwatersrand.

Paivio, A. (1971). *Imagery and verbal processes*. New York: Holt, Rinehart & Winston.

Piaget, J. (1952). *The origins of intelligence in children*. New York: International Universities Press.

Piaget, J. (1968). Development and learning. *Journal of Research in Science Teaching*, 40, S8 – S18

Sfard, A. (1991). On the dual nature of mathematical conceptions: Reflections on processes and objects as different sides of the same coin. *Educational Studies in Mathematics*, 22, 1-36, http//:doi.org/10.1007/BF00302715.

Stein, M.K., Smith, M.S., Henningsen, M.A & Silver, E.A. (1993). *Implementing standard-based mathematics instruction: A casebook for professional development*. Reston: NTCM.

Özerem, A. (2012). Misconceptions in geometry and suggested solutions for seventh grade students. *International Journal of New Trends in Arts, Sports & Science Education – 2012*, 1(4)4

Von Glassersfeld, E. (1990). An exposition of constructivism: Why some like it radical. *Journal for Research in Mathematics Education*, 4, 19—31.

Vygotsky, L. (1986). *Thought and Language*. Cambridge, M.A.:MIT Press.

Vygotsky, L. (1978). *Mind in society. Cambridge*, M.A.: Harvard University Press.

ENHANCING GRADE 3 TEACHERS' MATHEMATICAL PROBLEM SOLVING PROCESSES THROUGH PROFESSIONAL DEVELOPMENT INITIATIVES: A THEORETICAL PERSPECTIVE

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Abstract: In South Africa, there is a need for teachers' mathematical problem solving processes to be enhanced. This paper reports on a doctoral study, in progress, on strengthening teachers' understanding of mathematical problem solving processes so that teachers can effectively and successfully teach mathematical problem solving to learners. Mathematical problem solving involves the common ground between language instruction and mathematics instruction, culminating in mathematical word problems. To successfully teach the mathematical problem solving processes, which are necessary in dealing with word problems, teachers need a combination of pedagogical content knowledge and subject matter knowledge that is integrated with professional development. The doctoral study investigates a particular professional development programme to reconceptualise and enhance teachers' understanding of mathematical problem solving processes. The conceptual framework for the study is an integration of the CRASP I model for action research and the CRASP II model for professional development, along with the Concerns-Based Model of Teacher Development (CBMoTD). The research design of the study is participatory action research, which will involve grade 3 teachers from three different schools to be part of the research process and act as co-researchers. The ultimate aim of the study is to introduce a paradigm shift in teachers' understanding of mathematical problem solving processes in order to influence learners' performance in mathematical problem solving.

Keywords: mathematics education, problem solving, professional development, participatory action research (PAR)

Introduction

Mathematics education is a challenge for foundation phase teachers across South Africa. This leads to very poor educational achievement of learners in South African (Nel, 2012). One reason for learners' underperformance in mathematics in the foundation phase points to poor teacher education and teachers' (in)ability to transfer knowledge and skills to learners. Teachers' insight into basic mathematics processes has a direct influence on learners' performance. It is envisaged that once teachers understand mathematics problem solving processes, they will have the necessary skills to teach mathematics problem solving, and thereby influence learners. In terms of the doctoral study in progress, mathematics problem solving is an umbrella term used for mathematics word problems. By means of a doctoral study in progress, it will be investigated how teachers' mathematical problem solving processes can be enhanced through professional development initiatives. The focus of this work in progress will be on strengthening teachers' understanding of mathematical problem solving processes. Teachers' mathematical problem solving processes and skills run hand-in-hand. When teachers' mathematical problem solving processes are addressed, their mathematical problem solving skills will also be addressed (Luneta, 2018). The envisaged contribution of the study is a paradigm shift in mathematical problem solving instruction. By means to developing teachers' understanding and instruction of mathematical problem solving processes and equipping them through professional

development, they act as the agents of change, and thus introduce a transformation in learners' understanding and performance of mathematics problem solving. The study in progress is viewed through the constructivist, critical and interpretivist paradigms. The conceptual framework for the study is an integration of the CRASP I model for action research and the CRASP II model for professional development, along with the Concerns-Based Model of Teacher Development (CBMoTD). The research design is participatory action research, which will involve grade 3 teachers from three different schools to be part of the research process and act as co-researchers. The unit of analysis throughout the study will be to enhance grade 3 teachers' problem solving processes.

Problem solving processes vis-à-vis mathematics

Problem solving cannot be separated from mathematics; thus, in placing problem solving across mathematics, one can start identifying the value of mathematics problem solving in society and develop ways in which mathematics problem solving can be understood.

The value of mathematical problem solving in society

Mathematical problem solving has a significant place in society (Wilson, Fernandez, & Hadaway, 1993). Teachers and learners alike need to understand the value of well-established problem solving processes in order to employ the relevant skills and processes when the opportunity presents itself. Mathematics is integrated into everyday activities, and most problems can be solved by using mathematical thinking processes and skills. Shoenfeld (1983) explains that a [mathematical] problem can only be defined as a problem if you are not sure how to go about solving the question at hand. A "problem" needs to have a few challenges that "cannot be solved comfortably by a routine or a familiar procedure". Teaching learners about the appropriate ways to solve mathematical problems requires teachers to be the role models and lead by example.

In doing so, teachers constantly need to re-evaluate their teaching philosophy and stance towards mathematical problem solving. Ball (1988) explains that "teachers need to examine their commitment to teaching; and to bring to the surface, challenge, and extend their current ideas about teaching, learning and learning to teach [mathematical problem solving]".

Mathematics is an area of specialisation that is not isolated from other areas of development. Howe (2000:885) states that the most disappointing aspect of working with education issues is the fact that most teachers view mathematics as "a set of rules with no relation to one another or to other parts of life". Similarly, Howe (2000:885) explains that "a teacher who is blind to the coherence of mathematics cannot help students see [the beauty and meaningfulness of mathematics]".

Understanding mathematical problem solving

Mathematical problem solving is the heart of mathematics education (Kaur & Har, 2009; Halmos, 1980). The framework of the Singapore school mathematics curriculum illustrates the vital role mathematical problem solving plays in mathematical instruction. Mathematical problem solving is at the core of mathematics instruction in general, and is then surrounded by metacognition, processes, skills, concepts and attitudes, as indicated in the diagram below. It should be noted that metacognition, processes, skills, concepts and attitudes all play a role in the understanding of mathematical problem solving. However, this study is mainly concerned with teachers' (poor) understanding of mathematical problem solving processes, which needs to be enhanced through professional development initiatives, so that teachers can teach mathematical problem solving with sound understanding of the processes involved. An understanding of the processes involved will eventually lead to the successful integration of skills, attitudes, metacognition and concepts.

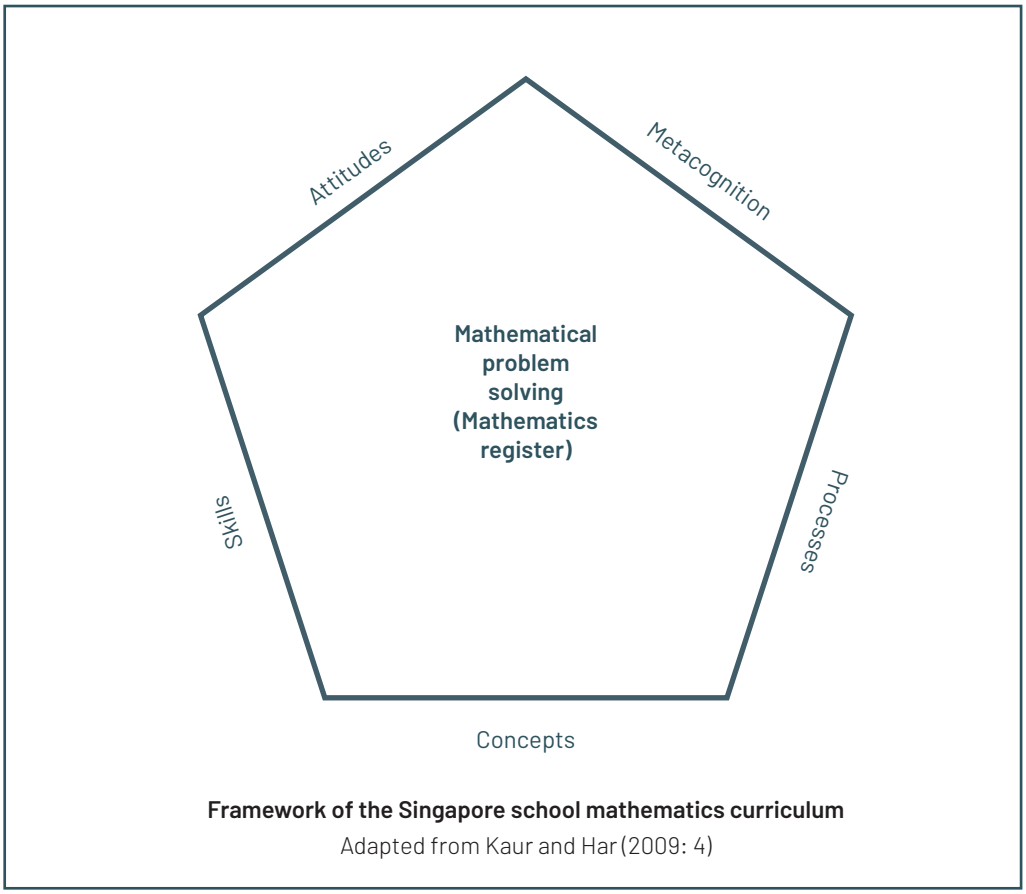


Figure 1 Framework of the Singapore school mathematics curriculum

Mathematics is a language on its own, and can be referred to as the mathematics register; it consists of subject-specific concepts and vocabulary (Usinkin, 2012; Pirie, & Schwarzenberger, 1988). Mathematical problem solving stems from the common ground formed between the overlap of language instruction and mathematics instruction as seen in the conceptual framework. In light of the mathematical register, true understanding of mathematics refers to "more than the ability to merely remember facts but rather being able to connect knowledge of the concepts to other context" (Luneta, 2016:293). Schleppegrell (2007:142) states that "learning mathematics is not just a question of manipulating symbols, but of understanding how different systems for making meaning interact". Teachers, in this case grade 3 teachers, are expected to teach problem solving processes to grade 3 learners, but time should be taken to determine if teachers themselves understand the processes of problem solving. Along with this, teachers' understanding of the mathematical register and their knowledge of problems should be determined. Only once teachers' knowledge has been evaluated can the process of professional development commence.

Professional development of mathematics teachers

The following section looks at the knowledge that teachers should have *of* and *about* problem solving, subject matter knowledge and pedagogical content knowledge that teachers should have, as well as the ability to integrate the required knowledge with professional development to ensure that teachers grow in their understanding of mathematics problem solving process.

Knowledge *of* and *about* mathematics

Teachers need to be equipped with knowledge about mathematics. Ball et al. (2001:444) define knowledge about mathematics as "teachers understanding the nature of knowledge in the discipline of mathematics, where it comes from, how it changes and how truth is established. Knowledge about mathematics also includes what it means to know and do mathematics ..." Many teachers assume that knowledge about mathematics entails "common sense and memories of their own schooling", which will be enough to enable teachers to teach mathematics to learners (Ball, 1988:8). However, Ball (1988) makes it very clear that teachers need to know about mathematics — and mathematical problem solving — and how this knowledge is understood by the teachers themselves and then organised and conveyed to assist learners in understanding the relevant concepts in mathematics (Ball, 1988).

An aspect critical to teaching mathematics — and mathematical problem solving — is the manner in which teachers organise the teaching environment and how teachers themselves think, interpret, internalise concepts. The more solid teachers' understanding is about the various concepts and processes related to mathematics — and mathematical problem solving — the easier it is to convey knowledge and understanding to learners. Professional development of mathematics teachers start with the manner in which teachers understand content in order to relay the content to learners. Teachers' mathematical problem solving processes can only be enhanced once their understanding of the relevant skills and processes are understood. This is in line with Feimann-Nemser and Buchmann's (1986) view of understanding mathematics: "understanding mathematics for teaching also means being able to think pedagogically about the subject".

Subject matter knowledge and pedagogical content knowledge

Teachers' knowledge is not merely limited to knowledge *of* and *about* mathematics. Teachers need to have thorough subject matter knowledge (SMK). Ball et al. (2001) explain that SMK or content knowledge refers to the understanding of particular topics in mathematics, procedures, skills and concepts. Teachers are responsible for helping learners learn worthwhile content, therefore, teachers must know and understand the subject they teach (Feiman-Nemser, 2001). Since SMK is not nearly enough to teach mathematics effectively, teachers also require knowledge about how to best teach mathematics. This type of knowledge is known as pedagogical content knowledge (PCK) (Feiman-Nemser & Parker, 1990). However, through closer inspection, teachers' SMK is often taken for granted, assuming that teachers have a broad understanding of concepts, skills and academic knowledge related to mathematics education. Most time is spent on strengthening teachers' PCK about the 'how' to teach mathematics — in this case mathematical problem solving processes.

Teachers need to know their subjects from a pedagogical perspective (Feiman-Nemser, 2001). Combining teachers' SMK and PCK, should give teachers a platform to interpret the mathematics curriculum. "It is not just what teachers know, but how they know it and what they are able to mobilise mathematically in the course of teaching" (Ball, 2000:243; Ball et al., 2001:451). The implication of teachers' SMK can make an average teacher an excellent teacher: "if teachers are to be effective practitioners they need to possess an in-depth knowledge of how to represent the subject matter to learners. This is predicated on teachers' subtle and detailed knowledge of the subject matter itself" (Parker, & Heywood, 2000:91). The problem of all mathematical teaching is teachers' understanding of the mathematical knowledge that is needed to teach mathematics — and mathematical problem solving — well (Ball et al., 2001:435). The figure below illustrates the intertwined relationship between SMK and PCK.

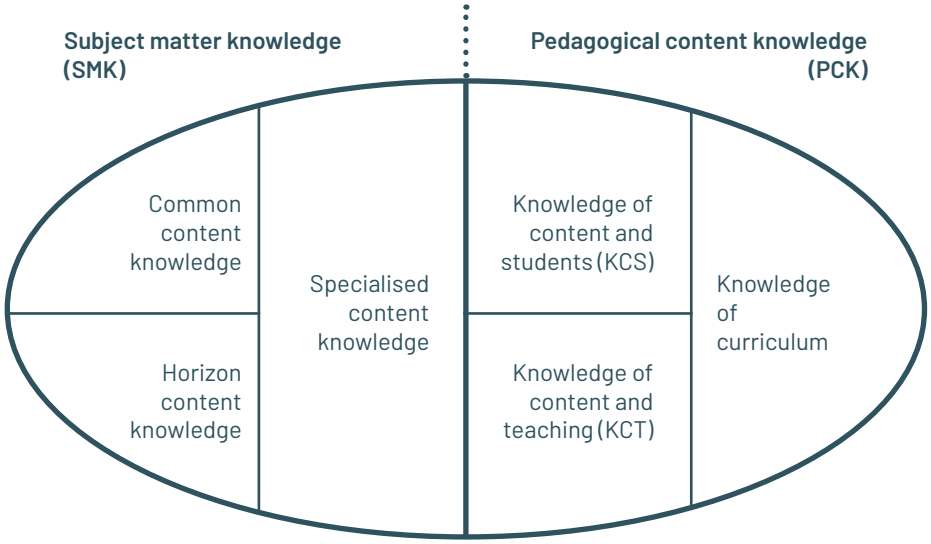
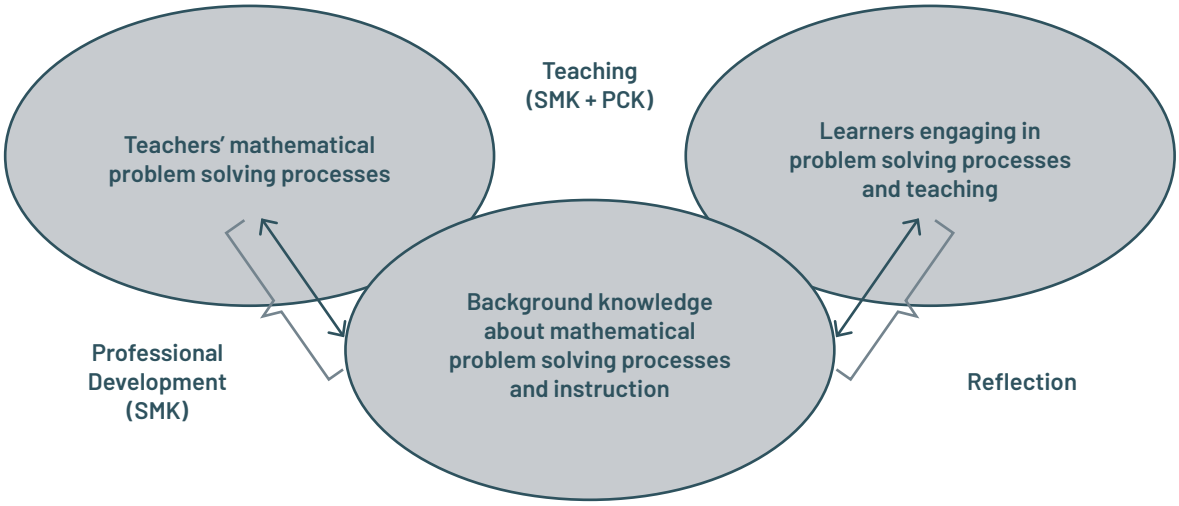


Figure 2 Dimensions of mathematical knowledge for teaching (MKT) from Hill, Ball, and Schilling (2008)

The interrelated relationship between SMK, PCK, professional development and mathematical problem solving instruction

Tambychik and Meerah (2010) initially proposed a framework that outlines the relationship between skills, processes and abilities in problem solving. However, upon closer inspection, the structure of the framework can be used to highlight the interrelated relationship between SMK, PCK, the role of professional development and mathematical problem solving instruction. There is an interrelated relationship between these aspects of problem solving instruction where the one aspect constantly influences the other.



The interrelated relationship between SMK, PCK, professional development and mathematical problem solving instruction adapted from Tambychik and Meerah (2010: 144)

The interrelated relationship between SMK, PCK, professional development and mathematical problem solving instruction illustrates the link between mathematical problem solving teaching and learning. Teachers have background knowledge about mathematical problem solving processes and instruction. The term "background knowledge about mathematical problem solving processes and instruction" does not only refer to academic knowledge and processes, it also refers to teachers' affective nature towards mathematical problem solving, teachers' resistance to mathematical problem solving and cultural and historical perspectives about mathematical problem solving. Teachers' mathematical problem solving background knowledge about processes and instruction thereof will most definitely have an impact on the manner in which they teach. Therefore, in order to assist teachers in gaining knowledge and skills to assist in the teaching of mathematical problem solving, teachers need professional development which should be aimed at reinforcing SMK based on mathematical problem solving. Teachers should be trained in using various strategies and techniques to teach mathematical problem solving. Teachers themselves should be taught ways to feel more positive about teaching mathematical problem solving. Once teachers understand the mathematics problem solving process, they will be able to teach mathematics problem solving better to learners.

A combination of SMK and PCK will be utilised when teachers transfer newly acquired knowledge and skills[1] to learners through the teaching and learning of mathematical content knowledge. Teachers should be able to act as agents of change when tapping into knowledge and skills gained during professional development opportunities. Teachers should be able to teach mathematical problem solving skills with confidence, while showcasing a variety of processes and skills, which learners can adopt and make their own. In the end, learners' affective nature towards mathematical problem solving should be more positive. Both teachers' and learners' background knowledge and skills (affective nature, cultural and historical views) toward mathematical problem solving can have an effect on the teaching and learning success and climate in the classroom. All three components to this interrelated relationship have the capacity to influence the other and make an impact whether positive or negative in the teaching and learning of mathematical problem solving.

The need for a professional development initiative

The current situation in terms of mathematics teachers' competency is that "the majority of teachers are intimidated by mathematics and are neither prepared nor comfortable to teach the subject" (Luneta, 2016:293). The teachers' perception of mathematics is carried over to learners, and eventually affects "how the mathematical cognitive structures are formed in the learners" (Luneta, 2016:293). Teachers' (lack of) knowledge of mathematics and problem solving creates a ripple effect that starts with the teachers, but eventually the problem spreads out to affect learners. Ball (1988:3) reiterates the fact that most teachers are negatively inclined towards mathematical instruction: "most elementary teachers dread [mathematics] and are worried about teaching it". There is resistance from teachers against problem solving as well. Wilson et al. (1993:10) explain that teachers are quick to make excuses why problem solving does not enjoy enough attention in schools. For every excuse, there is a counter argument.

"Teachers often provide strong rationale for not including problem solving activities in school mathematics instruction. These arguments include aspects such as problem solving being too difficult, problem solving takes too much time, the school curriculum is very full and there is no room for problem

1 Teachers' knowledge and skills about problem solving go hand in hand with their understanding of mathematical problem solving processes.

solving ... and basic facts must be mastered through drill and practice before attempting the use of problem solving" (Wilson et al.,1993:10)

Mathematical problem solving instruction, with specific reference to the processes thereof, needs to start with teachers. Change is needed to ensure learners are trained to become competent and confident problem solvers. This can only happen if teachers are also guided and assisted in the development of their own problem solving skills and understanding of the problem solving processes. Teachers are not only the agents of change who can make the transition in problem solving processes possible, but they are the ones setting the example. Therefore, the aim of this study is to enhance teachers' mathematical problem solving processes through professional development initiatives. A paradigm shift in teaching mathematical problem solving is required, and the change starts with teachers through professional development initiatives.

Teachers' understanding of teaching mathematical problem solving processes needs to be reconceptualised, and teachers need guidance and specific instruction on the relevant mathematical problem solving processes to be taught. Feinman-Nemser (2001:1013) explains that "what and how teachers teach depends on the knowledge, skills and commitments they bring to their teaching and the opportunities they have to continue learning in and from their practice". An aspect such as instruction of mathematical problem solving processes would be able to be improved, if teachers do not have a clear understanding and knowledge of this regard: "if we want schools to produce more powerful learning on the part of students, we have to offer more powerful learning opportunities to teachers" (Feiman-Nemser, 2001:1014).

Envisaged research project

This project is a doctoral study in progress that aims to collaboratively synthesise a professional development initiative with co-researchers (participants), which can assist to enhance grade 3 teachers' processes of mathematical problem solving. In addressing grade 3 teachers' problem solving processes, teachers can act as the agents of change, and hence change the way in which mathematical problem solving education is done in grade 3 classes (Luneta, 2018). Research indicates that teachers' knowledge of problem solving processes is weak and should be enhanced through appropriate intervention. The design and combination of data collection techniques will assist in analysing teachers' current knowledge on mathematical problem solving processes.

Rationale

After I started working as a lecturer in the early childhood education department at a higher education institution, I started lecturing academic mathematics as well as methodology of mathematics, both modules pertaining to the foundation phase. Referring to past work experience and having had the opportunity to teach mathematics in pre-school, foundation phase and higher education, I realised that there is a link between how teachers teach mathematics and how learners excel in mathematics. It has become clear to me that in order to change the outcome of learners' achievement in mathematics, teachers need to be guided and trained effectively to convey knowledge, skills, processes and values to foundation phase learners. One area of mathematics that I am intrigued with is the theme of problem solving. Mathematical word problem solving is the common ground which language education and mathematics education share, thus having done research on reading comprehension and currently lecturing mathematics, I would like to work in the indicated field of mathematical problem solving. Based on experience and research, learners and students alike refrain from answering word problems due to the fact that they do not understand what to do. I have also found that teachers spend very little time in the classroom explaining the correct procedures to solve a word problem. This has brought me to question why

so little time is spent on this content area in mathematics education. I started to consider whether it could be due to time constraints, a lack of interest from both teachers and learners or possibly due to teachers' inability to analyse the problem themselves before attempting to explain it to learners. Professional development will be the catalyst of change (Price & Valli, 2005) in the practice of mathematical problem solving education in grade 3 classes (Clarke, 1994; Sheridan, Edwards, Marvin, & Knoche, 2009).

Research design and methodology

This study investigates qualitatively how grade 3 teachers' mathematical problem solving processes can be enhanced through professional development initiatives. The qualitative approach is used to explore and understand the meaning individuals or groups assign to a problem they are experiencing (Creswell, 2013). Three paradigms will be used for this study, namely the interpretivist paradigm, the critical paradigm and the constructivist paradigm. The interpretivist paradigm will be used as a way to understand how grade 3 teachers understand mathematical problem solving processes (Maree, 2017). The critical paradigm will be used to explain "what is wrong with current social reality, identify actors to change it and provide both clear norms for criticism and achievable practical goals for social transformation" (Maree, 2017:63). The third paradigm is the constructivist paradigm, which will be used to explain how individuals "construct their own understanding of the world through experiencing things and reflecting on those experiences" (Adom, Yeboah, & Ankrah, 2016:2). In light of this study, co-researchers will collaboratively construct knowledge of mathematics problem solving processes. Co-researchers will have an opportunity to discover new knowledge and reflect on the knowledge.

Participatory action research (PAR), the research design, employs social sciences research methods to develop actionable local knowledge (Somerville, 2014). Jason, Keys, Suarez-Balcazar, Taylor, and Davis (2004:4) explain that PAR is an umbrella term "for a wide range of approaches to empowering community members to engage in research that increases citizen power and voice in communities". The essence of PAR is situated in the researcher's relation to the participants. Mackenzie, Tan, Hoverman, and Baldwin (2012) explain that the researcher engages with the participant as a collaborator who can inform project designs, purpose methods, facilitate some of the project activities, and importantly review and evaluate the process as a whole. Collaboration is the term given to the occasions when the researcher will interact and engage with the co-researchers (participants) during the various workshops as part of the research process.

The central goal of PAR is both participants' and researcher's acquisition of knowledge. Participants from a community engagement project in the Gauteng province in South Africa will be approached to take part in the study. Three research sites (schools) in the community where the community engagement project takes place will be approached to take part in the study. Convenience sampling will be used to select English speaking participants (practicing grade 3 teachers), with the sampling criteria being that participants are situated at the relevant research sites. I intend to approach up to five grade 3 teachers (participants) from each of the three research sites.

The conceptual framework on which the study is based consists of three separate parts. The first part is a visual representation of the origin of mathematical problem solving, which indicates that mathematical problem solving stems from being the common ground between language instruction and mathematical instruction. It further illustrates the composition of problem solving as skills, concepts, attitudes, metacognition and processes (Kaur & Har, 2009). The second part is the CBMoTD (Fuller, 1969) which focuses on self-concerns, task concerns and impact concerns (Fuller, 1969). The last part is the CRASP I model of action research and the CRASP II model for professional development (Zuber-Skerritt, 1992). All three parts to the conceptual framework work in collaboration with each other. Although they are three distinct parts, the framework is strengthened, since there is a model which represents all the facets to the study: The origin of mathematics problem solving, professional development, an

explanation of mathematics problem solving and the factors a teacher must be aware of during teacher development.

Since the study is aimed at enhancing grade 3 teachers' mathematical problem solving processes through professional development, the CBMoTD comes into place. Throughout the process of the grade 3 teacher developing an understanding of the essence of mathematical problem solving, the teacher should always be concerned about his/her own growth and development in mathematical problem solving. Without growth taking place in the "self", the teacher will not be able to successfully transfer mathematical problem solving processes to learners. There should be a definite need and want from the teacher himself/herself to grow in mathematical problem solving processes. The focus of the study is highlighted through the task-concern: once teachers understand the core of the task at hand; in the case of the study — mathematical problem solving processes — teaching thereof will be impacted and learners will benefit from the teachers' understanding about what the task concerns. Once the teacher himself/herself is equipped with the necessary understanding of mathematical problem solving knowledge and processes, the task of teaching the related content to learners will be made easier and the impact of improved learner performance should be visible. However, the emphasis still lies with teacher development: Without the teacher realising a need to be equipped with the necessary "tool" to enhance mathematical problem solving processes, the task of teaching will never be impacted, and hence the outcome of the impact of teaching will never be possible.

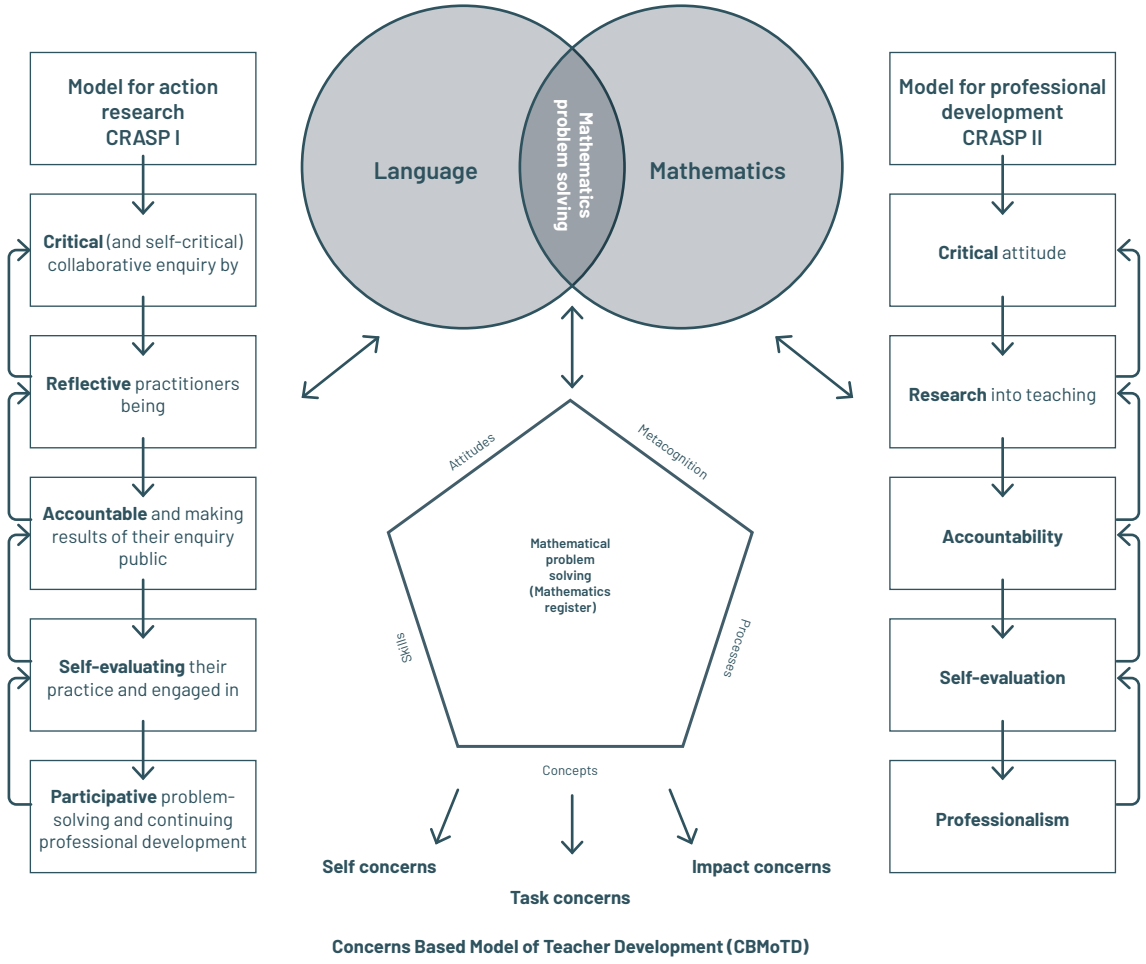


Figure 4 The conceptual framework which supports enhancing teachers' mathematical problem solving processes through professional development initiatives

Data collection and analysis

There will be a variety of data collection methods used as part of the study. During the first part of the data collection period, grade 3 teachers will be completing an activity where they are required to solve Grade 3 mathematical problems; this instrument is still in the process of development. This is to determine whether teachers understand the essence of each of the problems they are required to teach. Teachers will be observed while they are teaching mathematical problems, this is to see if teachers are able to apply their theoretical understanding of the essence of mathematical problems to the teaching and learning situation.

After information has been gathered about what teachers' understanding of mathematical problem solving entails, teachers will take part in workshops that form part of collaborative discussions as part of the PAR research design. Recordings will be made of collaborative discussion during each workshop and the interviews will be transcribed. Participants will be asked to give written feedback at the end of each workshop. These narratives will be used for data analysis. The researcher will keep a journal throughout the study, which will be used to make field notes during classroom observations and collaborative discussions. Participants will make field notes and make use of reflection diaries, which will also be analysed accordingly.

There will be five workshops that will take on the form of the action research processes. The aim of the five PAR workshops, is to work in collaboration with grade 3 teachers to firstly identify what knowledge they have about problem solving. Furthermore, based on grade 3 teachers' knowledge about problem solving skills, establish a professional development initiative aimed at enhancing teachers' mathematics problem solving processes in order to make a difference to the way in which problem solving teaching and learning are conducted in classrooms.

As part of data analysis, thematic analysis will be used to analyse the collected data. Documents used for data collection will be analysed to identify codes that become evident in the data. The codes will then be used to create themes related to the data. These generated themes will be discussed accordingly and used to answer the research questions.

Foreseen contribution

The foreseen contribution that this project aims to achieve is to positively contribute to the state of South Africa's mathematical performance. "The reality of South Africa's mathematics education is that learners are underperforming ... The [poor mathematics performance] results paint a bleak picture of the mathematical competence level of South African students (Botha, Maree, & De Witt, 2005:697).

Understanding that learners' performance in mathematics is directly influenced by a teachers' ability to transfer the required knowledge and processes to learners, change needs to start with supporting teachers in their understanding of mathematical problem solving. This change will indirectly influence learners' understanding and performance in mathematical problem solving. Once teachers are assisted by means of professional development initiatives to acquire a better understanding of the essence of mathematical problem solving processes, their ability to teach mathematical problem solving will also be addressed.

We envisage to guide and assist grade 3 teachers in their understanding of mathematics problem solving processes through collaborating with practicing grade 3 teachers. Teachers should have a change of heart about mathematics problem solving instruction and be motivated and enthusiastic to teach mathematical problem solving to their learners. We believe if teachers view the teaching of mathematical problem solving differently and are able to understand the essence of mathematical problem solving processes, teachers' renewed motivation and understanding will be transferred to

learners. This change in attitude and understanding about mathematical problem solving can potentially influence the mathematical pedagogy. In the end, the main contribution I wish to make is to introduce a paradigm shift in teachers' understanding and instruction of mathematical problem solving processes (Luneta, 2018).

References

Adom, D., Yeboah, A. & Ankrah, A.K. (2016). Constructivism philosophical paradigm: Implication for research, teaching and learning. *Global Journal of Arts, Humanities and Social Sciences, 4*(10), 1–9.

Ball, D.L. (1988). Unlearning to teach mathematics. *For the Learning of Mathematics, 8*(1), 1–19.

Ball, D.L. (2000). Bridging Practices: Intertwining content and pedagogy in teaching and learning to teach. *Journal of Teacher Education, 51*(3), 241-247.

Ball, D.L., Lubienski, S.T., & Mewborn, D.S. (2001). Research on teaching mathematics: The unsolved problem of teachers' mathematical knowledge. In V. Richardson (Ed.). *Handbook of research on teaching*. (4th ed.). (pp. 433-456). New York, NY: Macmillan.

Botha, M., Maree, J.G. & De Witt., M.W. (2005). Developing and piloting the planning for facilitating mathematical processes and strategies for pre-school learners. *Early Child Development and Care, 175*(7/8), 697–717.

Clarke, D.M. (1994). Ten key principles from research for the professional development of mathematics teachers. In D.B. Aichele & A.F. Coxford (Eds.). *Professional development for teachers of mathematics* (pp. 37-48). Reston, VA: National Council of Teachers of Mathematics.

Faulkenberry, E.E.D. (2003). *Secondary mathematics preservice teachers' conceptions of rational numbers.* (Unpublished Doctoral Dissertation). Oklahoma State University, Oklahoma.

Feiman-Nemser, S. (2001). From preparation to practice: Designing a continuum to strengthen and sustain teaching. *Teachers College Record, 103*(6), 1013–1055.

Feiman-Nemser, S. & Buchmann, M. (1986). The first year of teacher preparation: Transition to pedagogical thinking? *Journal of Curriculum Studies, 18*(3), 239–256.

Feiman-Nemser, S. & Parker, M.B. (1990). *Making subject matter part of the conversation or helping beginning teachers learn to teach.* East Lansing, MI: National Center for Research on Teacher Education.

Halmos, P.R. (1980). The heart of mathematics. *The American Mathematical Monthly, 87*(7), 519-524.

Hauk, S., Toney, A., Jackson, B., Nair, R. & Tsay, J.J. (2014). Developing a model of pedagogical content knowledge for secondary and post-secondary mathematics instruction. *Dialogic Pedagogy: An International Online Journal, 2*, A16–A40.

Hiebert, J., Carpenter, T.P., Fennema, E., Fuson, K., Human, P., Murray, H., Oliver, A. & Wearne, D. (1996). Problem-solving as a basis for reform in curriculum and instruction: The case of mathematics. *Educational Researcher, 25*(4), 12-21.

Howe, R. (2000). Book Review: Knowing and Teaching Elementary Mathematics by Liping Ma. *Humanistic Mathematics Network Journal, 1*(23), 41–48.

Ibrahim, I. (1997). Di Mana Susahnya Matematik? *Jurnal Pengurusan Pendidikan*, 7, 17–21.

Jason, L.A., Keys, C.B., Suarez-Balcazar, Y., Taylor, R.R., & Davis, M.I. (Eds.). (2004). *Participatory community research: Theories and methods in action*. Washington, DC: American Psychological Association.

Kaur, B. & Har, Y. B. (2009). Mathematical problem solving in Singapore schools. In B. Kaur, Y.B. Har, & M. Kapur (Eds.). *Mathematical problem solving: Yearbook 2009* (pp. 3-13). London: World Scientific Publishing.

Kolovou, A. (2011). *Mathematical problem solving in primary school.* (Unpublished Doctoral Dissertation), Utrecht University, Utrecht.

Luneta, K. (2016) Mathematics cognition. How learners acquire mathematical knowledge at elementary level. In B. Goba & J. Naidoo (Eds.). *Proceedings from the 22nd Annual National Congress of the Association of Mathematics Education of South Africa* (pp. 401—416). Johannesburg: AMESA.

Luneta, K. (2018). Teaching problem solving in mathematics pedagogy: Using a protocol to document instruction. In *9th Annual UNISA ISTE Conference on Mathematics, Science and Technology Education* (pp. 51—56). Pretoria: University of South Africa.

Parker, J. & Heywood, D. (2000). Exploring the relationship between subject knowledge and pedagogic content knowledge in primary teachers' learning about forces. *International Journal of Science Education, 22*(1), 89—111.

Pirie, S.E. B. & Schwarzenberger, R.L.E. (1988). Mathematical discussion and mathematical understanding. *Educational Studies in Mathematics,* 19(4), 459—470.

Polya, G. (1957). *How to solve it.* (2nd ed.). Princeton, NJ: Princeton University Press.

Polya, G. (1981). *Mathematical discovery on understanding, learning and teaching problem solving.* New York, NY: John Wiley and Sons.

Price, J.N. & Valli, L. (2005). Preservice teachers becoming agents of change: Pedagogical implications for action research. *Journal of Teacher Education, 56*(1), 57—72.

Rittle-Johnson, B. & Alibali, M.W. (1999). Conceptual and procedural knowledge of mathematics: Does one lead to the other? *Journal of Educational Psychology, 91*(1), 175—189.

Schleppegrell, M.J. (2007). The linguistic challenges of mathematics teaching and learning: A research review. *Reading and Writing Quarterly, 23*(2), 139—159.

Schoenfeld, A.H. (1983). The wild, wild, wild, wild, wild world of problem solving: A review of sorts. *For the Learning of Mathematics, 3*(3), 40—47.

Schoenfeld, A.H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense-making in mathematics. In D. Grouws (Ed.). *Handbook for Research on Mathematics Teaching and Learning* (pp. 334—370). New York, NY: MacMillan.

Sheridan, S.M., Edwards, C.P., Marvin, C.A. & Knoche, L.L. (2009). Professional development in early childhood programmes: Process issues and research needs. *Early Education and Development, 20*(3), 377—401.

Somerville, M.M. (2014). *Participatory Action Research: Improving professional practices and local situations. SAGE Research Methods Cases.* Los Angeles, CA: SAGE Publications.

Tambychik, T. & Meerah, T.S.M. (2010). Students' difficulties in mathematics problem-solving: What do they say?. *Procedia-Social and Behavioral Sciences, 8*, 142—151.

Thompson, A.G. (1984). The relationship of teachers' conceptions of mathematics and mathematics teaching to instructional practices. *Educational Studies in Mathematics, 5*(2), 105—127.

Usiskin, Z. (2015). What does it mean to understand some mathematics? In *Selected Regular Lectures From the 12th International Congress on Mathematical Education*. (pp. 821—841). Berlin: Springer.

Van de Walle, J.A., Karp, K.S. & Bay-Williams, J.M. (2015). *Elementary and middle school mathematics: Teaching developmentally*. (9th ed.). Upper Saddle River, NJ: Pearson.

Wilson, P.S. (Ed.). (1993). *Research ideas for the classroom: High school mathematics*. New York, NY: MacMillan.

Wilson, J.W., Fernandez, M.L. & Hadaway, N. (1993). Mathematical problem solving. In P. S. Wilson (Ed.). *Research ideas for the classroom: High school mathematics* (pp. 57—77). New York, NY: MacMillan.

AN INVESTIGATION OF PRE-SERVICE TEACHERS' PERCEPTIONS OF LOW IMMERSION VIRTUAL SCIENCE LEARNING

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Abstract: With the global education landscape constantly changing as new curricula and learning technologies evolve, it is imperative that pre-service teachers are equipped with a collage of pedagogical approaches to enable them teach in diverse contexts. This study investigated the experiences of third-year pre-service science teachers in low immersion virtual learning environments, as a baseline for enhancing integrated pedagogical skills. A qualitative methodology was employed in collecting and analysing data. Fifty (n=50) third-year pre-service physical sciences teachers where purposively selected to participate in the study. Data was collected through the use of reflection diaries and follow-up focus group interviews. The results of thematic content analysis on textual data revealed that pre-service science teachers held both positive and negative perceptions on the use of low immersion virtual science learning. Some of the emerging themes from data analysis included; virtual learning provides a platform for better visualisation of micro-scientific phenomena; virtual science learning is complementary of inquiry based-learning; virtual science learning is very convenient (time and place are not a limitation); in a low immersion virtual learning space self-directed learning is promoted. For the negative perceptions they indicated that virtual learning is addictive; virtual laboratory learning lacks realism and impairs the development of science process skills. Based on these findings we concluded that virtual science learning (low or high immersion) can be exploited extensively in science education as complementary but not a replacement of traditional experimentation and inquiry-based science teaching and learning. With the realisation that machine learning will only become increasingly relevant in this Fourth Industrial Revolution, we recommend that the use of integrated pedagogical approaches (traditional experimentation, virtual and inquiry-based learning) be included in pre-service teacher training as part of a series of instructional approaches in the teaching and learning of science.

Keywords: low immersion virtual learning, science learning, simulations, visualisation, integrated pedagogies

Introduction and background

From the early 1980s the use of virtual reality (VR) technology has gained more popularity in the field of education. Experts in professional education such as medicine, aviation and astronomy have used virtual and augmented reality extensively in training young professionals studying surgery, piloting and celestial objects respectively (Merchant, Goetz, Cifuentes, Keeney-Kennicutt & Davis, 2014). For example, in the study of medical surgery, students use augmented and virtual reality to first perform trial surgeries before performing real surgeries with the aim of minimising risk and familiarising themselves with internal human anatomy (Hsu, Lin & Yang, 2017). Several benefits have been reported on the use of these virtual learning spaces whether low or high immersion in all spheres of education including school and tertiary levels. In science education in particular, the teaching and learning of abstract scientific concepts are made more explicit in virtual learning spaces through simulations and models which are embedded to emulate real scientific processes and systems (Chiu, De Jaegher & Chao, 2015; Greenlight

& Roadtovr, 2016). With these technologies, learners are then able to visualise certain difficult concepts in 2-dimensional and 3-dimensional formats. Several researchers have reported benefits from introducing the support of virtual learning spaces in their courses and school subjects. These benefits range from improvements in students' achievements in science content tests to increased interest and motivation in pursuing science, technology, engineering and mathematics (STEM) careers (Chiu et al., 2015; Hsu et al., 2017; Ramnarain & Moosa, 2017). Despite the many benefits and possibilities that virtual learning holds for the Fourth Industrial Revolution, extensive research is still needed in the South African context on students' perceptions of these virtual learning spaces. Hence, for this particular study which involved third-year physical sciences education students (herein also referred to as pre-service teachers) at a South African university, we set out to answer the following research question:

How do pre-service teachers perceive the use of low immersion virtual reality (VR) in science learning?

To answer this research question, we employed the use of learning milestone reflection diaries and focus group semi-structured interviews to examine pre-service teachers' perceptions of low immersion (desktop) virtual learning environments for learning abstract scientific concepts. In this paper we first look at what low immersion virtual learning environments are, the theoretical underpinnings for virtual learning in the Fourth Industrial Revolution, the research methodology followed, results, discussions, conclusions and recommendations that emanate from the study.

Low immersion virtual learning

Immersion in a virtual environment is the feeling of being physically present in a non-physical environment, usually referred to as a virtual space (Makransky, Terkildsena & Mayer, 2017). Virtual learning environments can either be high or low immersion. Low immersion or desktop virtual reality (VR) refers to virtual reality simulations and models displayed on a desktop or laptop screen, with sound coming through the speakers and the click of a mouse used to navigate the virtual space (Lee & Wong, 2014; Makransky et al., 2017). Unlike high immersion VR, here learning simulations and associated learning activities are embedded using software to mimic real systems and processes in 2-dimensional formats. On the other hand high immersion VR technologies use head mounted displays in combination with high graphical fidelity screens, tactile motion sensors and sound which is delivered through an earpiece to display 3-dimensional simulations of scientific systems and processes (Makransky & Petersen, 2019). The interphase in this kind of VR is such that interactions are controlled by moving one's head in a 360-degree rotation in order to visualise the content of the space (Makransky et al., 2017; Merchant et al., 2014; Moreno & Mayer, 2002). In the Fourth Industrial Revolution, an era where man and machine are increasingly complementing each other, it becomes relevant that machine learning be accepted and integrated in the pedagogic approaches that are used to prepare future-fit teachers. In science education in particular, where traditional laboratory resources are scarce or limited, virtual laboratories can be used to complement students' learning of abstract scientific concepts (Chiu et al, 2015). These virtual learning enhancers will therefore avail students the opportunity to visualise scientific processes and engage in virtual inquiry-based learning, hence form correct mental representations of learned concepts (Mayer, 2011; Makransky et al., 2017). In this study we particularly focused on the use of low immersion desktop VR to ascertain how pre-service teachers perceive and can integrate machine learning as part of their pedagogical content knowledge (PCK) as emerging teachers. In the sciences, several software have been developed by scientists and researchers to imitate real scientific systems and processes in the form of simulations. The study borrowed extensively from the work physics education technology (PhET) project simulations, developed by the University of Colorado Boulder, which include several chemistry, physics and biology simulation available for free at http://phet.colorado.edu. The simulations provided within PhET virtual laboratories are usually accompanied by guidelines

to assist users in effectively utilising them to achieve desired learning outcomes (Creating PhET Activities, 2013).

Theoretical framework

Virtual learning is underpinned by several education theories hence it constitutes a theory-laden construct. For this particular study we focused on Mayer's cognitive theory of multimedia learning, e-learning and the cooperative learning theories. The cognitive theory of multimedia learning advocates that the use of multiple media in learning by words, sound and pictures can be very beneficial to a learner as it increases visualisation and enhances the formation of long-term mental schemas (Mayer, 2011). On the other hand, the theory of cooperative learning also known as collaborative learning theory postulates that, "The instructional use of small groups so that students work together to maximize their own and each other's learning" (Johnson & Johnson, 1993:9) is instrumental in improving the nature of learning. This implies that learning becomes more meaningful when a learner is able to interact with the subject of learning, but even more so when they are able to do tasks with other students and use the experiences grasped from others to build knowledge (Johnson & Johnson, 2009). The cooperative learning theories are considered to be constructivist in nature as they are mostly student-centred (Johnson & Johnson, 1999). The entire essence of cooperative learning is to ensure that, as a facilitator, learning tasks are well scaffolded in order to achieve effective and successful group experiences (Chamberlain, Lancaster, Parson & Perkins, 2014; Johnson & Johnson, 1999). Based on the underpinnings of these theories, the virtual learning intervention was designed such that students were able to interact in groups, self-teach, self-learn and self-assess all in a virtual learning environment. Peer interaction was also highly promoted in the low immersion virtual learning space as a chatroom was introduced to the virtual class using Google Hangouts. These chatrooms helped the students to brainstorm on how to approach difficult concepts and complete the set learning milestones with very little guidance from the facilitator.

Methodology

The study followed a qualitative methodology, with interpretivism as the main research paradigm since we were focused on making meaning (Leedy & Omrod, 2014) of the perceptions which pre-service teachers had on the use of low immersion VR in science learning. A combination of document analysis and semi-structured interviews was used to enhance the credibility and trustworthiness of the findings obtained (Fraenkel, Wallen & Hyun, 2015).

The sample

The sample for the study constituted 50 third-year pre-service physical sciences teachers who were purposively selected by the researcher. The participants were selected because they were involved in studying physics and chemistry modules which they considered to be abstract. In the initial phase of the study, participants were actively involved in learning selected science concepts which were considered abstract. This phase was followed by the design and implementation of a low immersion virtual learning intervention using online and offline simulations. All participant students provided the relevant consent for the study and were quite elated to be part of the five weeks of virtual learning intervention. This was the first experience participants had with this kind of intervention and we could count on them to provide honest and unbiased insights that would be useful in modifying the principles of virtual science learning. Students were grouped into 10 groups of five members each and allocated eight different learning tasks that were to be done in their groups collaboratively and individually. After the completion of the group tasks, they were expected to reflect on the virtual learning experience in a group reflection diary (one reflection diary per group).

Virtual learning interventions

The virtual learning interventions involved students identifying concepts that they considered as abstract in physics, chemistry and biology. Then the intervention was designed using desktop simulation activities to be conducted during tutorial sessions. Based on the principles of cooperative learning, heterogeneous student groups were created in which students with various levels of achievement abilities were included in each group (Johnson & Johnson, 1999). Students were then assisted in downloading and installing Flash player and PhET simulations to their personal laptops. The tutor (which was one of the researchers) facilitated an introductory session which captured the nature of the simulations and how they could be used to attain the relevant learning outcomes. A sample chemistry concept, spectrophotometry, specifically Beer's law was identified as one of the abstract concepts that students selected. In the introductory phase of the intervention the simulation was downloaded from the PhET website by all participants, who then proceeded in their different groups to complete five group tasks and three individual tasks by the end of a five week intervention period. Several simulations were used to illustrate the relationship between absorbance, concentration and transmittance. A sample screenshot of one of the activities engaged in can be seen in Figure 1 below.

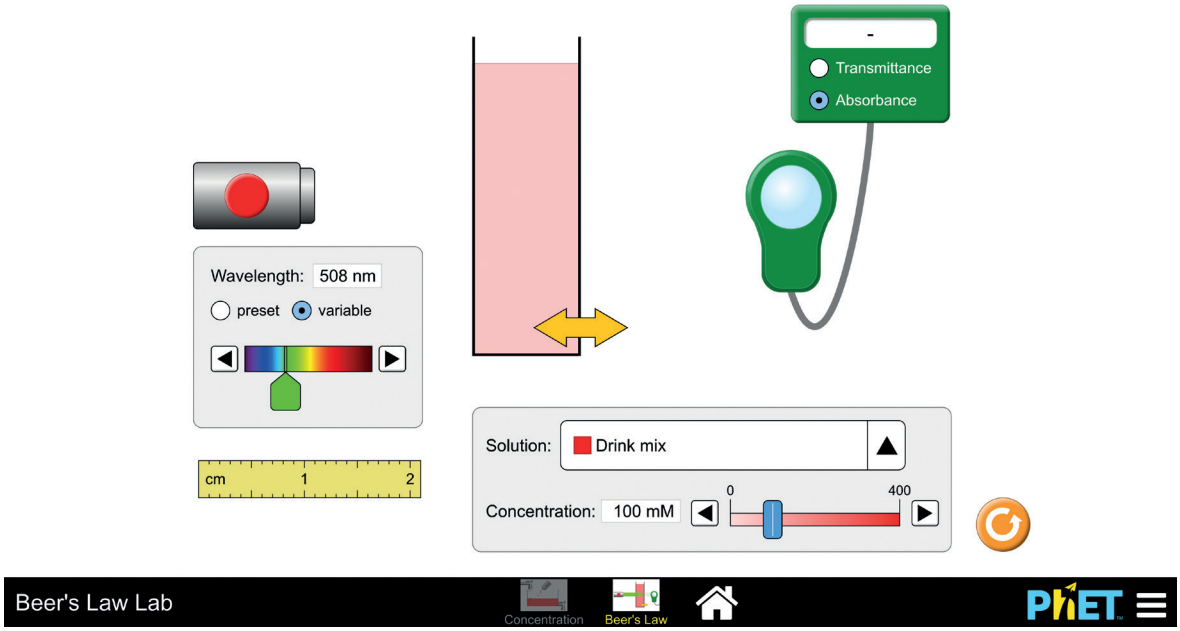

Figure 1 PheT simulation screenshot for investigating Beer's law (source: https://phet.colorado.edu/en/simulation/beers-law-lab)

The screenshot in Figure 1 above came from a laboratory task on spectrophotometry in which students investigated the relationship between the concentration of a solution, the amount of light the solution can allow to pass through it (measured as transmittance) and the amount of light that can be absorbed by the solution (measured as absorbance) informed by Beer's law. The range of experiments covered during this intervention were assessed and graded by peer groups and the tutor (researcher) who worked closely with the students during the intervention. The researcher only played a facilitating role while the students spent time in their groups exploring the simulations during group and individual tasks. At the end of each task they wrote their reflections explicitly stating their perceptions of the simulations, associated tasks, outlined any challenges that they faced and suggested improvements. At the end of five weeks all the reflections were analysed by assigning codes, grouping the codes to form meaningful categories and eventually themes. Based on these analyses, focus group semi-structured

interviews were conducted with all participants and they were also given a content test to assess their performance in all the concepts they engaged with during the intervention (this is not reported herein).

Data collection and analysis

Data was mainly collected using qualitative strategies with student groups completing 10 (n=10) reflection diaries, based on some pre-set reflection prompts, which involved answering the questions below.

- What where the strengths of the virtual learning unit you just completed?
- What were the weaknesses of the virtual learning unit you just completed?
- What would you do differently when next you have to complete the virtual learning units using simulations?

A total of 10 reflection diaries were collected and analysed by means of thematic content analysis facilitated by the use of software Atlas. Ti version 8. Post analysis of the diaries, all participants were then engaged in semi-structured focus group interviews where their experiences were discussed extensively, in order to gain a clear understanding of the thoughts captured in the reflection diaries. Each focus group interview was 45—60 minutes long and four main questions were posed generated from the findings post-analysis of reflection diaries and literature. Questions posed during the semi-structured interviews included:

- How was your overall experience of learning the identified concepts in a virtual space?
- Is the use of low immersion virtual reality something you can add to your teaching practice?
- What are the limitations that you experienced when using this kind of virtual learning?
- What suggestion would you make for the enhancement of your own virtual learning experiences?

Transcribed textual data from the interviews were coded and categorised to generate six themes that will be discussed in the results section below.

Results

This section reports the findings from data analysis of post intervention reflection diaries and focus group semi-structured interviews for all groups of participants.

Findings from the analysis of reflection reports

Reflection diaries produced by each group were analysed by first reading through all the texts, then assigning codes to the sections of the text and subsequently categorising code groups that were closely related. All the categories where then combined to generate themes. Themes and some of the quotations from which they were generated can be seen in Table 1 below:

Table 1: Samples of quotations and themes generated from group reflection diaries.

Themes	Sample quotations
Visualisation of micro concepts was greatly enhanced.	• In our study of atoms and molecules we found that initially after lecture we could not really understand molecular representations till we started with the desktop simulations. We focused on looking at the interactions between different molecules and element which became clearer to me because of the 2-D representations of bonds. • In our group the main excitement for us was that we could visualise certain constructs with spectrophotometry. This is because during lectures we were referred to absorbance and transmittance but did not grasp the concepts as these were all abstract to us. During the virtual learning intervention we were able really visualise the interaction between absorbance, transmittance and concentration of solutions.
Collaborative learning was promoted.	• The hangout chats were cool as we interacted more with our peers that we were accustomed to. • I found that we could actually conference call on the hangouts to discuss some of the challenges we were facing in our diverse groups without going into the campus. • Working as a group was very beneficial to us as we found that we complemented each other's strengths and weaknesses.
The use of virtual tasks was very convenient.	• One of the most interesting features of working in these virtual classrooms were that we did not have to be on campus during the tutorials. • We also realised as a group that we could share learning materials easily in the virtual classrooms. • Working from anywhere any time was like the best thing for our group.
Science process skills could not be developed.	• One of the weaknesses that we found was that certain science process skills like pipetting and measuring could not be attained in this low virtual immersion space. • I feel there is no real authenticity in the virtual learning space as everything is done in the computer. With science there is a need to look at real scenarios.
Inquiry-based learning was enhanced.	• In our group we enjoyed the VR learning as we were able to engage in extensive discovery and guided inquiry learning. We tried our own things and answered some of our own research questions without the aid of the facilitators. In short this experience enhanced our ability to research certain science concepts without necessarily being in a traditional laboratory. • Guided inquiry learning is enhanced in the virtual learning environment. We have prompts which guide the way we answer the investigative questions that we examine in each task.

Transcribed textual data from the semi-structured interviews were also coded for the generation of themes by two coders, and inter-coder reliability of more than 95% was reached. Samples of the generated themes can be seen in Table 2 below.

Table 2: Samples of quotations and themes generated from coding the focus group interviews

Interview question	Sample quotations	Theme generated
How was your overall experience of learning the identified concepts in a virtual space?	• The simulations have a gaming feel but yet enhance visualisation of micro concepts. • I enjoy the simulation labs more as they enhance my visualisation of abstract concepts. • Working anywhere and anytime as we already indicated was very good for us. • The group tasks really help me to easily work on my own after all group discussions finalised. • I did not need anyone to explain the tasks to me. • I read the Beer's law lab manual provided by PhET, then I did all the individual tasks and my peers easily explained some of the concepts I did not understand. • The group discussions in the chatroom were very helpful. • I like the simulations because the lecturer does not have to hover over me like a mother hen as is always the case at the Varsity lab.	Visualisation greatly enhanced. The learning environment was very convenient. Collaborative learning was well nurtured.
Is the use of low immersion virtual reality something you can add to your teaching practice?	• Yes I will really add them to science instruction when I become a fully qualified teacher as I find that they will really make a difference with learners. • Yes for me it will be an avenue for exploring dangerous acid base reactions with my learners before they ever get into a real laboratory. • Yes because in the virtual space learners can try different things without fear of spoiling anything and in such a short space of time. • Yes I will definitely include virtual learning in my practice, I really think it can complement traditional science teaching and learning strategies.	Low immersion VR can complement science learning.
What are the limitations that you experienced when using this kind of virtual learning?	• The simulations created some minor misconceptions. • I found the PhETs simulations can be addictive, because I could stay on the computer and forget the time. • I am not sure if the PhETs cover our specific South African curriculum (CAPS) needs. • I don't think learners can learn science process skills by using these PhETS. • The PhETs are not real, they are just so fake and lack authenticity. • They are all in a machine which is just … not tangible when I think of it. They simply are not authentic or the real thing.	Characterised by a lack of authentic learning experiences. Low immersion VR can foster virtual addictions. Context specific curriculum needs might not be met when using random PhET simulations.
What suggestion would you make for the enhancement of your virtual learning experiences?	• If we could be trained how to create some of the virtual tasks and simulations by ourselves, for our specific curriculum, it would really make a difference.	

Discussions

Virtual learning enhances better visualisation of micro-scientific phenomena

Based on the analysis of the reflection diaries and semi-structured focus group interviews, we found that the available 2-dimensional and 3-dimensional imagery embedded in the virtual learning spaces enhanced pre-service teachers' visualisation of abstract scientific concepts, including forces, charges, current field lines, atoms and molecules that would traditionally be difficult to visualise without aid. These findings concurred with the findings from Hsu et al. (2017) and findings from Chui et al. (2015), in which participant students found that after virtual and augmented reality learning they were able to better visualise concepts. Other groups elaborated that in a traditional chemistry or physics laboratory they would have very little chances to really see the structure of the micro particles as they would do in a virtual laboratory. Other students also concluded that as a result of this ability to visualise their conceptual understandings were improved. This finding confirms the theoretical assumption that learning with the use of multiple media is more beneficial to learning (Mayer, 2011) since the addition of images solidifies semi-permanent mental representations to permanent ones, hence long term memory.

Virtual science learning is complementary of inquiry based-learning

The feedback from reflections indicated that students found the virtual laboratories more helpful in promoting inquiry-based learning. This is because in traditional laboratories, there are not many opportunities given to students to repeat a particular task more than once, due to limited material resources and time constraints. This finding also concurs with findings from other studies (Zacharia & Olympiou, 2011; Penn & Ramnarain, 2018), in which student found the use of virtual laboratories for inquiry was more effective in enhancing their understanding of science concepts than traditional laboratories.

Low immersion virtual science learning convenient

One of the known factors which affects poor implementation of inquiry based learning (IBL) is the time involved in setting up and running tasks in a traditional science laboratory (Ramnarain, 2016). At the end of the virtual interventions used in this study, students felt that they did not have any pressure to complete tasks within an hour as was the case in the traditional laboratory sessions. They indicated that they could work from anywhere and at any time of the day or night, which they considered very convenient and a great benefit for improving their achievement in science.

Self-directed learning is promoted

For all the desktop virtual laboratory activities they where engaged in, students felt that tasks were implicitly scaffolded, and simplified such that embedded instructions within simulations facilitated self-learning and assessment. The nature of this implicit scaffolding was such that it promoted the students to self-teach and be able to carry out several tasks without the assistance of the tutor as also observed in a study by Chamberlain et al. (2014). The feedback from tasks were also instantaneous such that corrections were done immediately. For these participants, this kind of learning was perceived as very empowering and learner-centred.

Virtual learning is addictive

Students indicated that virtual learning had an addictive edge to it such that at the end of the interventions they felt like learning all the remaining concepts using virtual learning classrooms and simulations. Some participants skipped lectures while immersed in these virtual learning engagements, which was not intended, during the planning of the virtual learning interventions. Another group also noted

that learners of the 21st century are already immersed in virtual spaces most of the time through social media and promoting more of such use of virtual learning could impair the development of interpersonal and communication skills which are still some of the fundamental need of the Fourth Industrial Revolution.

Virtual laboratory learning lacks authenticity and impairs the development of science process skills

With regards to the virtual inquiry-based learning tasks students indicated that one of the shortcomings of using low immersion virtual learning was eminent in the poor development of essential science process skills like measuring, pipetting, titration and the manipulation of other scientific equipment. This finding also concurs with findings from Hsu et al. (2017) in which the students also indicated that there was lack of authenticity when learning in virtual spaces. The world of work in science, technology, engineering and mathematics (STEM) careers requires one to be able to think and work like a scientist. This implies that the ability to touch, feel, smell and manipulate other senses cannot all be acquired in virtual learning spaces that are created using low immersion VR. One of the main arguments for this research is the need for learning environments to be complemented and not replaced by virtual learning. However, several researchers have reported contrary findings on the increased cognitive load on the human brain when learning in virtual spaces (Makransky, Terkildsena & Mayer, 2017; Makransky & Petersen, 2019). This implies that every pedagogical approach employed to simplify concepts will always have certain setbacks, and should therefore be utilised in an integrative manner with other approaches.

Conclusions and recommendations

Based on the findings from this study, it is evident that there is a positive reception to the use of low immersion desktop virtual learning for science education. The affordances being that these spaces can be used as complementary learning tools to enhance science concept formation of aspects that have already been learned using traditional lectures and inquiry-based learning approaches. One of the fundamental aspects that resonate with these findings is the confidence that is associated with desktop virtual reality as a learning enhancer that can be accessed from anywhere at any time, unlike traditional lectures where a student must be at a certain place for a specific timeframe. Based on all the above findings we therefore recommend that low immersion VR learning spaces be used to complement science teaching and learning in order to cater for the needs of 21st century learners. In principle, all these finding resonate with the four *Cs* of the Fourth Industrial Revolution, in that within virtual learning spaces students are able to collaborate, create, critically examine concepts and communicate their findings in the given assessment tasks and milestones. For education policymakers, more needs to be included in the curriculum to address the integration of virtual learning. For researchers, we also recommend that a larger scale mixed methods study be considered across different South African universities to further explore students' acceptance and use of VR learning environments.

References

Belini, H., Chen, W., Sugiyama, M., Shin, M., Alam, S. & Takayama, D. (2016). Virtual & Augmented Reality: Understanding the race for the next computing platform. Goldman Sachs report. Available at: http://www.goldmansachs. com/our-thinking/pages/technology-driving-innovation-folder/virtual-andaugmented reality/report.pdf.

Chamberlain, J.M., Lancaster, K., Parson, R. & Perkins, K. K. (2014). How guidance affects student engagement with an interactive simulation. *Chemistry Education Research and Practice, 15*(4), 628–638. doi: 10.1039/c4rp00009a.

Chiu, J.L., DeJaegher, C.J. & Chao, J. (2015). The effects of augmented virtual science laboratories on middle school students' understanding of gas properties. *Computers & Education,* 85, 59—73. Available at: http://doi.org/10.1016/j.compedu.2015.02.007.

PhET. (2008). Creating PhET Activities Using Guiding Inquiry Strategies. PhET Interactive Simulations, 25 Apr. Web. 24 Oct. 2013. Available at: http://phet.colorado.edu/en/for-teachers/activity-guide.

De Jong, T., Linn, M.C., & Zacharia, Z. C. (2013). Physical and virtual laboratories in science and engineering education. Science, 80(340), 305—308. Available at: http://dx.doi.org/10. 1126/science.1230579

De Jong, T. (2017). Instruction based on computer simulations and virtual laboratories. In R. E. Mayer, & P. A. Alexander (Eds.). *Handbook of research on learning and instruction* (pp. 502—521). (2nd ed.). New York: Routledge.

Fraenkel, J.R., Wallen, N.E., & Hyun, H.H. (2015). *How to design and evaluate research in education* (9th Ed.). New York: McGraw-Hill.

Greenlight, V.R. & Roadtovr (2016). Virtual reality industry report. Available at: http://www.greenlightinsights.com/reports/2016-industry-report.

Hsu, Y.S., Lin, Y.-H. & Yang, B. (2017). Impact of augmented reality lessons on students' STEM interest. *Research and Practice in Technology Enhanced Learning, 12*(2), 1—14. doi: 10.1186/s41039-016-0039-z.

Johnson, D.W., & Johnson, R.T. (1993). Implementing cooperative learning. *Education Digest*, *58*(8), 62.

Johnson, D.W., & Johnson, R.T. (1999). *Learning together and alone* (5th ed.). Boston: Allyn & Bacon.

Johnson, R.T., & Johnson, D.W. (2009). *An overview of cooperative learning*. In J. Thousand, A. Villa and A. Nevin (Eds): *Creativity and Collaborative Learning*. Baltimore, US: Brookes Press.

Lee, E.A. & Wong, K.W. (2014). Learning with desktop virtual reality: Low spatial ability learners are more positively affected. *Computers & Education, 79*, 49—58. https://doi.org/10.1016/j.compedu.2014.07.010

Leedy P.D. & Ormrod J.E. (2014). *Practical Research: Planning and Design*, (10th Ed.). New York City: Pearson.

Makransky, G., Terkildsen, T.S. & Mayer, R.E. (2017). Adding immersive virtual reality to a science lab simulation causes more presence but less learning. *Learning and Instruction*, 1–12. doi.org/10.1016/j.learninstruc.2017.12.007.

Makransky, G. & Petersen, G.B. (2019). Investigating the process of learning with desktop virtual reality: A structural equation modeling approach. *Computers and Education, 134* (15—30). doi.org/10.1016/j.compedu.2019.02.002.

Mayer, R.E. (2011). Instruction based on visualizations. In R.E. Mayer & P.A. Alexander (Eds.). *Handbook of Research on Learning and Instruction*. New York: Routledge.

Merchant, Z., Goetz, E.T., Cifuentes, L., Kenney-Kennicutt, W. & Davis, T.J., (2014), Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education, *Computers and Education.*, 70, 29—40. DOI: 10.1016/ j.compedu.2013.07.033.

Moreno, R. & Mayer, R.E. (2002). Learning science in virtual reality multimedia environments: Role of methods and media. *Journal of Educational Psychology, 94*(3), 598—610.

Penn, M. & Ramnarain, U. (2018). Pre-Service Teachers' Understandings of Chemistry Concepts Using Virtual and Hands-On Laboratories. In proceedings of the *9th Annual UNISA ISTE Conference On Mathematics, Science And Technology Education: 21-26 October 2018 Skukuza Camp in Kruger National Park, Mpumalanga, South Africa*. (pp. 240—246).

Ramnarain, U. (2016). Understanding the influence of intrinsic and extrinsic factors on inquiry-based science education at township schools in South Africa. *Journal of research in science teaching,* 53 (4), 598-619. doi: 10.1002/tea.21315.

Ramnarain, U. & Moosa, S. (2017). The use of simulations in correcting electricity misconceptions of grade 10 South African physical sciences learners. *International Journal of Innovation in Science and Mathematics Education, 25*(5), 1—20.

Wu H-K Lee SW Y Chang H Y & Liang J C 2013. Status, opportunities and challenges of augmented reality in education. *Computers & Education, 62*:41-49

Zacharia, Z.C. & Olympiou, G. (2011). Physical versus virtual manipulative experimentation in physics learning. *Learning and Instruction, 21*(3), 317-331. https://doi.org/10.1002/sce.20463

https://phet.colorado.edu

https://phet.colorado.edu/en/simulation/beers-law-lab

DETERMINING VALUE IN PROFESSIONAL DEVELOPMENT: AN EXPLORATION OF ENGLISH TEACHERS' PERSPECTIVES

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Abstract: Professional development forms part of the current discourse in teacher education and development today, especially in the context of the fundamental social changes being brought about by the Fourth Industrial Revolution. It is described as activities that develop an individual's skills, knowledge, expertise and other characteristics as a teacher. English teachers' understanding and perception of their professional development determines the value they place on this growth activity. In short, teachers' professional learning for an integrated curriculum should aim at making teachers, and by extension teaching, life-worthy and lifeready. For this study, data were collected from a sample of twenty-eight (28) teachers of English, who teach English at the fourth and fifth form levels to students preparing to take the Caribbean Examination Council (CXC), examination – Caribbean Secondary Education Certificate (CSEC). The teachers were randomly selected and completed a questionnaire which surveyed English teachers' professional development participation, needs and perceived impact.

The preliminary findings reveal that English teachers 1) recognise the importance of professional development (PD) and find value in activities planned for them; 2) desire minimal content knowledge support, but want professional development in instructional practice, ICT and teaching students with special needs; and 3) value more the impact of self-driven professional development than institutionalised required professional development.

An important significance of these results is how they can be used to help better tailor and develop resources and professional development experiences that can give valued and needed support to teachers of English in their practice, not just for the current context of schooling but also for the English education needs of/for the future.

Keywords: Caribbean education, English teachers, professional development, professional learning, teachers' perspectives, CXC

Introduction and background

Current trends in teacher education worldwide appear to point to the obligation of English language teachers not only to revisit their pedagogy, but in some instances, to demonstrate some urgency in executing the required changes. Indeed, Caribbean English language teachers acknowledge the necessity of keeping pace with this global movement. They have the added awareness that with this shifting in the theory of teaching, professional development (PD) appears to provide facility for some level of efficiency. Moreover, these practitioners are also cognisant that in the quest to establish an environment conducive to student achievement, their knowledge of content can affect their instruction and classroom practices. In fact, much of the research on teachers' pedagogical knowledge points to the assumption that they should possess profound knowledge of the subjects they teach (Grossman et al, 2005; Wilson, Floden & Fenini-Mund, 2001; Shulman, 1987). For this reason, the most effective English language teachers have deep knowledge of this subject, and a large part of their responsibility correlates with this understanding (Coe, Aloisi, Higgins, & Elliott Major, 2014). Further, Dewey (1929) explains that

knowledge of methods and content areas empowers teachers to make the necessary pedagogical decisions. In addition, English teachers' explicit knowledge about the area broadens the language opportunities they provide for learners in their classrooms As a consequence, the global reliance on new technologies as the supplier of knowledge makes it crucial that English language teachers be aware that these mechanisms are not their replacement in the classroom but rather (Schwab, 2016) are created by humans to be utilised by humans. This realisation further reinforces the point that as teachers their pedagogical choices are paramount and are complemented by the application of technological tools.

Even with the required knowledge of content, the English language teacher's duty does not conclude at that point. Freeman and Richards (1996) contend that language teaching will be considerably enriched by deeper and closer examinations of how language teachers come to know what they know, and do what they do in their work. They propose that the core of language teachers' knowledge must "focus on the activity of teaching itself; it should centre on the teacher who does it, the contexts in which it is done, and the pedagogy by which it is done" (p. 397). Bryan (2010) notes too, that the views teachers hold of English as a subject in terms of content and pedagogy also influence language teaching in the secondary classroom. The result is that as teachers acquire a more comprehensive understanding of the material they teach, they must also unravel the way learners think about the content and evaluate the thinking behind the methods which determine the depth of comprehending (Coe, Aloisi, Higgins & Elliott Major, 2014).

To this end, it is imperative that educators comprehend all the interrelated concepts in PD. This means that with the existing paradigms of PD (Christie et al 2004; Edwards 2009) for those who accept the teacher as "the technician", the process of PD is perceived as a way of addressing inadequacies such as inefficiency and lack of training. This perception contrasts with supporters of the teacher as "reflective practitioner" who prefer an approach which attends to teacher growth. As it relates to persons who adhere to the latter perspective, it is vitally important to counter the complicated classroom realities which are in a constant mode of change by developing creative responses (Christie et al, 2004; Edwards, 2009). According to Glattenhorn (1987), the teachers' growth attributed to PD results in their systematic addition to experience and examination of their ability to teach; this is deemed more far reaching than career development. Accordingly, with the focus on overall growth, Kingston-Mann and Sieber (2001) point out that PD offered in isolation does not result generally in meaningful change in pedagogy. This indicates that as the various innovative ideas and concepts emerge, the key is to convert these ideas into changes that guide professional practice in the classroom. Hence, it stands to reason that English language teaching does not escape the leverage from the Fourth Industrial Revolution; this new era of digitisation (Schwab, 2016) impacts all disciplines. As such, the effective development of language skills through learning and teaching requires the teacher's awareness of pedagogical traditions and practices which involve processes as well as knowledge (Cummins & Davison, 2006). Undoubtedly, to facilitate learners' language growth, teachers' adeptness and pedagogy must be inclusive of the appropriate application of the emerging technologies.

In this ongoing technological era (Prabhu, 1990; Kumaravadivelu, 2003), the need for teacher autonomy is clear as these practitioners endeavour to take responsibility for their own knowledge with decisions on the instructional method and the areas for development. In this environment, based on teachers' experience, their views and beliefs of English language and the teaching-learning process are invaluable. With this mind-set, much of the effectiveness of PD is that (Kedzior & Fifield, 2004; Edwards, 2009) it is presented as a protracted dimension of classroom instruction that is integrated, logical and on-going and integrates experiences that are consistent with teachers' goals. It is also noteworthy that continuing PD plays a central role in teachers' ownership along with their levels of competence (Edwards, 2009). To this end, like all other teachers, Caribbean English language teachers seek a high level of satisfaction as

they engage with PDs. Essentially, as practitioners, they must perceive PD as not only a manifestation of the necessary constant development, but also as catering directly to their needs in contributing to the nature of their job which is in a similar state of consistent transition. Their fulfilment is demonstrated when they are equipped with skills to design, plan and deliver instruction more efficiently. Added to this, in an effort to stay current, an important component of the teaching-learning process is for Caribbean English language teachers to make effective use of all (Al-Mahrooqi & Troudi, 2019; Schwab, 2016) the opportunities the current technological revolution affords them in delivering instruction. Certainly, this requirement can be facilitated via the provision of PDs.

Another point to consider is that the currency of language in the wider Caribbean community is undeniable. Therefore, the notion that English language teaching is assigned heavy ideological weight by social, economic and political forces (Bryan, 2010; Protherough 2007) is worthy of consideration. Further, research (Bryan, 2010; Roberts, 2008; Protherough, 2007; Cummins & Davis, 2006; Simmons-McDonald, 2006) shows that language teaching is perceived as increasingly important, but unlike other subjects this area involves processes that do not depend mainly on schools. In addition, the teacher and the pedagogical content knowledge and skills he/she brings to the teaching and learning interaction are central as well. Within this background, the Caribbean Examination Council's (CXC) dissatisfaction with the delivery of English language is evident. To support this position, the annual reports on each year's examination offers a variety of comments as well as suggestions about how classroom practice might be changed (CXC Report, 2016 & 2017). Furthermore, the concerns of researchers and authorities of Caribbean educational institutions verify the continued recognition of the need to improve the teaching and performance of English in Caribbean classrooms.

Thus, the conclusion is that generally in their classrooms, English teachers hold strong commitment to certain beliefs and approaches to language teaching. Research shows that (Sanchez & Borg, 2014; Graus & Coppen, 2015) the precise nature of these beliefs and approaches varies across schools, contexts and culture. In light of this, it is deemed worthwhile to determine if there is an existing link between the group of Caribbean teachers' perceptions of English language teaching and the delivery of PD.

Purpose of the study

This research is placed in the context where there is recognition that improvement in students' performance in English language requires a paradigmatic shift in teachers' pedagogy. Attention is given to a group of Caribbean English language teachers in their preparation of the fourth and fifth form levels students to take the Caribbean Examination Council (CXC), examination — Caribbean Secondary Education Certificate (CSEC). With this focus in mind, the chief aim of the research is to explore the perceptions the English teachers' hold about professional development (PD) to determine their notions of the usefulness of this activity in catering to their specific instructional needs, and facilitating greater improvement in students' achievement in English in a way that is transferable.

Research questions

This research is guided by the fundamental question:

What are the perceptions held by a group of Caribbean English language secondary school teachers about the value of professional development in the context of the fundamental social changes being brought about by the Fourth Industrial Revolution?

The following interrelated questions emerge:

1. How do teachers of English describe/define professional development?
2. What are the professional development needs of English teachers?

3. What are English teachers preferred professional development activities?
4. How do English teachers' perceive the impact of the professional development activities in which they participate?

Literature review

Reconceptualising teacher education

Each transformation in worldwide educational landscapes is influenced by global industrial changes that demand a reconceptualising of what teaching and learning should look like in classrooms. Through the lens of the Fourth Industrial Revolution that is centred on digital, biological and technological advancements, teachers' understandings of how best to prepare students for an ever-evolving world have become a principal concern. Correspondingly, teachers' pedagogical proficiencies have also come under scrutiny (Bernhardt, 2015). In the teaching and learning environment, educators are challenged to find the balance needed in order to teach so that students are able to access, share, communicate, problem-solve and create within the evolving frames of the Fourth Industrial Revolution.

The enduring dimensions of teacher education — knowledge (what we know and understand); skills (how we use what we know) character (how we behave and engage with the world); and meta-learning (how we reflect and adapt) — are necessary components to how teachers are prepared to be versatile to succeed as teachers, no matter how the world changes. As such, success for today's educators is aligned to a clear, collective stance on not only what learners need in the learning environment, but also on what constitutes teachers' professional development needs in such a context. In this regard, professional development with a context of the Fourth Industrial Revolution. Like their learners, educators can only function effectively when they participate in "intellectually challenging experiences and opportunities to think creatively, innovatively, collaboratively, and across the boundaries that typically segregate what is commonly taught in school" (Bernhardt, 2015:3). These kinds of transformations necessitate that educators reconceptualise what and how knowledge is valued; how best to communicate among themselves as well as with their learners and, finally, examine what kinds of skills they need to hone or even access in order to effectively educate. Considerations should also be given to what learning experiences best address the needs of educators and what professional and pedagogical actions best indicate improvement in instructional practices for the 21st century.

Professional development needs of English teachers

Globally, professional development (PD) is the medium through which educators "retool", enhance and strengthen their instructional practice; the same is true for Caribbean teachers. PD for teachers is essential in order to bring about change in areas of instructional practice, attitudes, beliefs and students' learning outcomes (Guskey, 2002). Currently, there is a deviation from traditional approaches that are hinged on instructing teachers and then expecting them to change their pedagogy, to more effective, sustainable professional development. Guskey (2002) strongly suggests that teachers' collaborative and consistent involvement in planning and problem-solving are critical components of successful PD. In fact, early research on professional development in schools indicates that there are certain characteristics that must be present if this feature is to be effective. Thus, PD must be supportive of teachers' individual and collective/staff needs and, in so doing, encourage intrinsic motivation and commitment to the learning process (Flores, 2005). When professional development addresses the needs of teachers as individuals, in relation to specific grades and schools, teachers are more willing to engage in the processes, since their personal and professional needs are accommodated (Flores, 2005).

Effective professional development for teachers must also be authentic and relevant (Flores, 2005; Tate, 2009). This authenticity addresses teachers' pedagogical needs in ways that do not overly interfere

with their other classroom responsibilities. In other words, whatever change is to be implemented and/or sustained must be done in a way that does not overwhelm teachers or interfere with the already demanding daily running of the classroom and by extension the school (Thomas, 2019). In fact, Quick, Holtzman and Chaney (2009) strongly suggest that effective PD for teachers must be embedded in school routines in ways that encourage and support active learning among teachers and allow time for them to learn, plan, attempt strategies and reflect on their learning. Furthermore, the PD activities that teachers consider to be effective generally focus on their active involvement in the learning process, address areas of content knowledge and are clearly connected to other teaching and learning activities that occur in the classroom. In summary, PD should empower participants, be challenging, informative, innovative, ongoing and professionally fulfilling by meeting the identified needs of teachers, staff, schools and districts or zones (Quick, Holtzman and Chaney; Flores, 2005).

An understanding of teachers' PD needs is critical for this experience to be effective. Research shows that teachers generally agree that they need developmental support in their instructional practices. For instance, one study that focused on the needs of the total population of English language teachers in Melaka, Malaysia concluded that teachers perceive that they have a need for PD. In addition, maintaining language skills, assessing students and using cooperative learning were some of the instructional skills for which teachers in this study indicated that they had a high or very high level of need for PD (Khandehroo, Mukundan & Alavi, 2011:45). The study also indicated that the participants' teaching experience, education level and the types or categories of schools in which they taught proved to have significant relationship with the kinds of PD that they required.

The effectiveness of PD for teachers is also defined by the quality of the characteristics embedded in the training teachers receive. Further, teacher training that addresses teachers' knowledge, their skills and their classroom practice are often beneficial to their professional growth. Requirements for instructional success that is influenced by PD embody "a content focus, active learning, coherence, duration, and collective participation (Johnson, Kahle & Fargo, 2007; Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Desimone, 2009). For teachers of English, PD must have a direct impact on their individual and collective growth. More importantly, PD must feed into the contextual needs of teachers, for their classrooms as well as their schools. When these needs are met, professional development is perceived as effective among teachers of English.

Determining value in professional development

Lieberman and Pointer Mace (2008), King and Newmann (2004) and Darling-Hammond (2006) propose that teachers engaging in in-service staff development have varying preferences in activities connected to PD. The results of a study that examined and compared the results of sustained and collaborative PD with sustained but non-collaborative PD found that individual participation was not as effective on teachers' instructional practices nor on student achievement (Cordingley, Bell, Thomason & Firth, 2005). In fact, a collaborative context is beneficial to both teachers and students since teachers can use collaborative planning to prepare work and assignments for teaching and learning. Data collected through collaborative practices that are embedded in pedagogy and student learning are beneficial for further PD (Hutchinson, 2003). As a consequence, collaboration is valued among teachers engaging in in-service training, even though they still seek out ways in which they can grow individually.

Similarly, collaboration among teachers is strengthened when they work together in homogeneous groups in active and interactive ways. Research indicates that the use of professional learning communities is one way in which collaboration can strengthen teachers' pedagogical growth and effect instructional change in their respective classrooms (Hord, 2009; Lieberman & Pointer Mace, 2008; Guskey, 2002). The collaborative process is fostered in learning communities that share problems, ideas and viewpoints,

and work together toward solutions (Guskey, 2002). Through PD sessions, teachers can meet regularly and learn from each other so as to improve their craft. Hence, collaboration is best sustained when the PD in which they engage is supported by school leadership, a sense of accountability among teachers when they meet, a willingness to take professional risks and the maintaining of a "healthy" social interaction among colleagues (Quick, Holtzman & Chaney, 2009). Through the collaborative process, teachers learn to develop trust in each other and in the learning process itself (Hord & Hirsh, 2008). This trust is developed through peer feedback that is respectful and open (Flores, 2005; Guskey & Suk Yoon, 2009). In essence, effective PD must provide learning opportunities for teachers of English in ways that address their instructional needs.

Furthermore, PD is also valued among teachers when the approaches used to problem-solve are authentic, relevant and flexible. As the process of teacher-change is complex in nature, sustainable instructional change is possible through PD that is structured, geared toward the needs of the teachers involved and that simultaneously encourages commitment to the process by teachers themselves. "Support allows those engaged in the difficult process of implementation to tolerate the anxiety of occasional failures ... and it provides the encouragement, motivation, and occasional nudging that many practitioners require to persist in the challenging tasks that are intrinsic to all change efforts" (Guskey, 2002:388). In essence, PD is valued when teachers feel safe enough to make mistakes and to revisit professional activities until they acquire success.

Another perspective that influences the value of PD among teachers of English is the quality of the negotiations that occur between the teachers and facilitators of PD sessions. This relationship is critical to the effectiveness of teacher training events. Consideration must be given to reflective decision making, appropriate communication and interaction, in order to influence the preferences of English language teachers' PD strategies (Kelchtermans, 2004; Day & Sachs, 2004; Hismanoglu, 2010). When PD caters to the participants' needs they seem to be more amenable to pedagogical change in their classrooms (Guskey, 2002). Accordingly, PD activities that teachers consider to be effective generally focus on their active involvement in the learning process, address areas of pedagogical content knowledge and are clearly connected to other teaching and learning activities that occur in the classroom (Darling-Hammond, Hyler & Gardner, 2017; Thomas, 2019). As a result, it is imperative that facilitators consider these characteristics in their planning for PD so that teachers of English are more amenable to the training they are receiving and remain more willing to implement what they learn from their instructional development.

English teachers also share the view that PD should leave them more equipped for instructional practice when they have access to numerous instructional strategies that they can use to improve student achievement. Accordingly, PD for teachers of English can benefit from differentiation so as to effectively meet their content and instructional needs. This differentiation can be organised according to qualification, grades taught, individual teacher needs and so forth. In contrast, PD that does not cater to these underlying teacher needs are deemed as less effective (Guskey, 2002). In fact, Guskey's model of PD suggests that teachers' behaviours and attitudes change after they have experienced the use of strategies and found them beneficial. Similarly, concrete rather than abstract forms of professional learning are important to teachers of English. This is a key requirement since teachers' pedagogical content knowledge is solidified when they are exposed to learning through demonstrations (Chien, 2017). As a consequence, PD activities that occur through demonstrations and observations enable teachers to dialogue and reflect on practice collaboratively; in this way, they can improve their practice and student performance. Through reflective dialoguing, teachers can construct and reconstruct knowledge, competence, experience, and expertise from peers and experts who understand classroom practice (Chien, 2017; Grimm, Kaufman, & Doty, 2014). In such instances, both the teacher who leads the

lesson to be demonstrated and those engaged in reflecting on the lesson strengthen their knowledge through honing their ability to reflect and establishing the PD learning that they have encountered. Time and scope for dialoguing are essential for PD to be effective for teachers of English. In addition, teachers must be continually exposed to explicit skills that foster their professional growth and these skills must also be considered in light of the school's unique context.

What professional development activities do for teachers of English

One of the primary expectations of teachers of English is that they should demonstrate great competency in the English language; competency in the language increases self-efficacy (Omar, 2017). Linguistic competence that is buttressed by teachers' instructional competence through PD facilitates greater classroom success. "More often than not, in-service teachers who [involve] themselves in professional development activities tend to become more competent in teaching due to the pedagogical skills and content knowledge that they had gained during the courses that they [attend]" (Omar, 2017:76). Desimone (2009:184) proposes that beyond the developing of self-efficacy, professional development that is embedded in interactive activities and active learning bears the following results:

1. Increased teacher knowledge and skills and/or changes their attitudes and beliefs.
2. Teachers' use of their new knowledge and skills, attitudes and beliefs to improve the content of their instruction or their approach to pedagogy, or both.
3. Increased student learning that stems from instructional changes that teachers make.

To sum up, the quality of the learning experiences that teachers encounter through PD, the ways in which teachers evolve in their practice and the impact of teachers' instructional change on students' performance are critical markers of what PD activities do for teachers of English. At the heart of the matter is an acknowledgement that teachers would replicate or implement the activities covered in PD activities, only if they share the view that the activities were of personal and collective benefit to their professional growth. Furthermore, the professional growth that these educators receive through consistent PD must also meet the demands of teaching and learning within the ambit of the Fourth Industrial Revolution.

Methodology

The study was designed to examine, at the pilot phase, the nature of teachers' perceptions about professional development based on tenure, school location, academic qualification and professional qualification.

In this pilot phase of the study, the research followed a primarily survey descriptive design approach using a closed- and opened-ended instrument and a focus group. The design facilitated the collection of data to answer questions about the opinions of individuals on topics or issues (Persaud et al, 2019; Gay et al, 2009; Leacock et al, 2009). Determining value in teachers' PD can be considered in terms of the collection and use of evidence. Identifying sources of evidence that can be used to examine teachers' perceptions regarding PD is necessary to ensure that data gathered are high in standards of validity and reliability. This pilot study serves that purpose for a broader study on professional development. It is based on the belief that evidence collected from teachers can be used to determine the focus, approach and strategies for professional growth, particularly for teachers of English.

Participants

The participants comprised a sample of teachers of English across countries in the Anglophone Caribbean. These teachers also teach at the fourth and fifth form levels, preparing students to take

the Caribbean Examination Council (CXC) examination — Caribbean Secondary Education Certificate (CSEC). The teachers were purposively selected (based on characteristics as teachers of English) and conveniently chosen (based on availability and close at hand). They were invited to complete a questionnaire of closed- and open-ended items which surveyed and inquired about their perspectives, as English teachers, of professional development participation, needs and impact.

The instruments

The instruments included a questionnaire and focus group interview. The questionnaire consisted of two sections:

Section A focused on demographics, which included: school location, academic and professional qualification, tenure and levels taught.

Section B examined general perceptions, including planning and oganisation, professional development, materials, lesson implementation, teaching strategies and methods, lesson content and classroom culture and assessment. The pilot study looked at Section A demographics against perceptions about professional development.

The analysis of the data addressed four questions:

1. How do teachers of English describe/define professional development?
2. What are the professional development needs of English teachers?
3. What are English teachers' preferred professional development activities?
4. How do English teachers perceive the impact of the professional development activities in which they participate?

Analysis

The closed-ended items on the questionnaire generated quantitative data which was analysed using mean scores and minimum and maximum scores related to the professional development preferences and perceptions section of the instrument. Overall, perceptions regarding PD as reported by the English teachers, the scores were categorised in questions 1 and 2, which related to PD participation and its impact, as "yes" or "no" and as "no impact", a "small impact", a "moderate impact", or a "large impact". In question 3, which related to the PD needs of the surveyed teachers, scores were categorised as "no need", "low level of need", "moderate level of need" and "high level of need". For question 4, which focused on desire to participate, scores were categorised as "yes" and "no". Questions 5 and 6, which were opens ended items on the questionnaire and focus group responses looked at reasons that encouraged or deterred participation in PD and preferred PD activities. The responses were qualitative in nature and were categorised to generate themes related to the conceptualisation of PD, preferred PD activities and reasons that determined PD participation.

Both the scores and themes linked to the research questions served as the means of gaining insight into the perceptions and experiences of the participants in relation to the four research questions.

Findings

As a pilot, the findings from this study could be considered indicative of current perspectives of teachers of English within the context — the Anglophone Caribbean — investigated. The findings from this pilot study are discussed in relation to the research questions and summarised as follows:

Research question 1:
How do teachers of English describe/define professional development?

Most of the English teachers conceptualised professional development as engendering and comprising five characteristics which were also aligned to what they valued about PD:

1. Continuous development
2. Varied activities
3. Opportunities to improve
4. Structured
5. Capacity building

PD as continuous development was also explained as:

"Professional development is a process of continuous development, from the beginning to the end of one's teaching career, in the pedagogical and content knowledge that are critical to effectively delivering the English curriculum to students in a manner that makes learning: meaningful, memorable, enjoyable and sustainable."

As an activity and opportunity to improve PD was conceptualised as:

"Professional development is any activity or program or engagement that allows a professional (in this context, a teacher of English), the opportunity to improve his/her craft."

And described as structured and varied in that:

"Such activities/engagements/[professional development] programmes may take many different forms and may be either structured (such as a seminar), semi-structured (such as an informal discussion with a head of department or other colleague) or unstructured (such as observing a colleague)."

Teachers' characterisation of PD as capacity building:

"Basically, anything that helps to build capacity and allow the teacher to improve any one or more of the following skills: cognitive, language arts, emotional, or social skills can be classified as professional development."

Overall, the sample of English teachers described professional development as an activity "structured" and geared towards impacting practice. Additionally, the themes generated from the responses of the sample of English teachers regarding their description of professional development, pointed to two components: structure and improvement/growth.

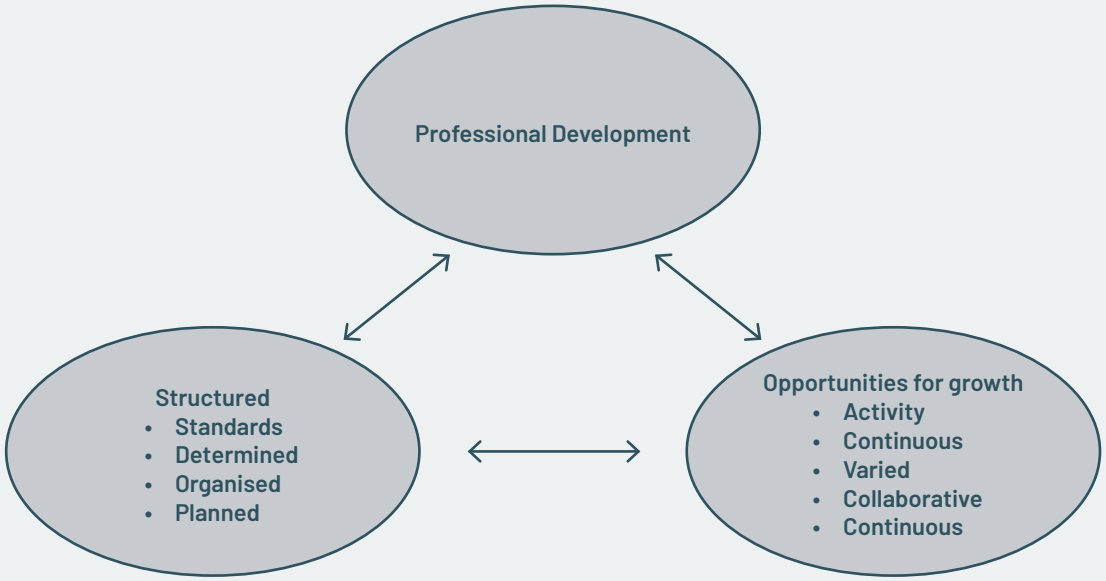

Figure 1: Thematic components of professional development

Research Question 2

What are the professional development needs of English teachers?

While current research point to providing content knowledge development for teachers (**Content Focus**) as leading professional development in math and science, this was not the case with this sample of English teachers surveyed:

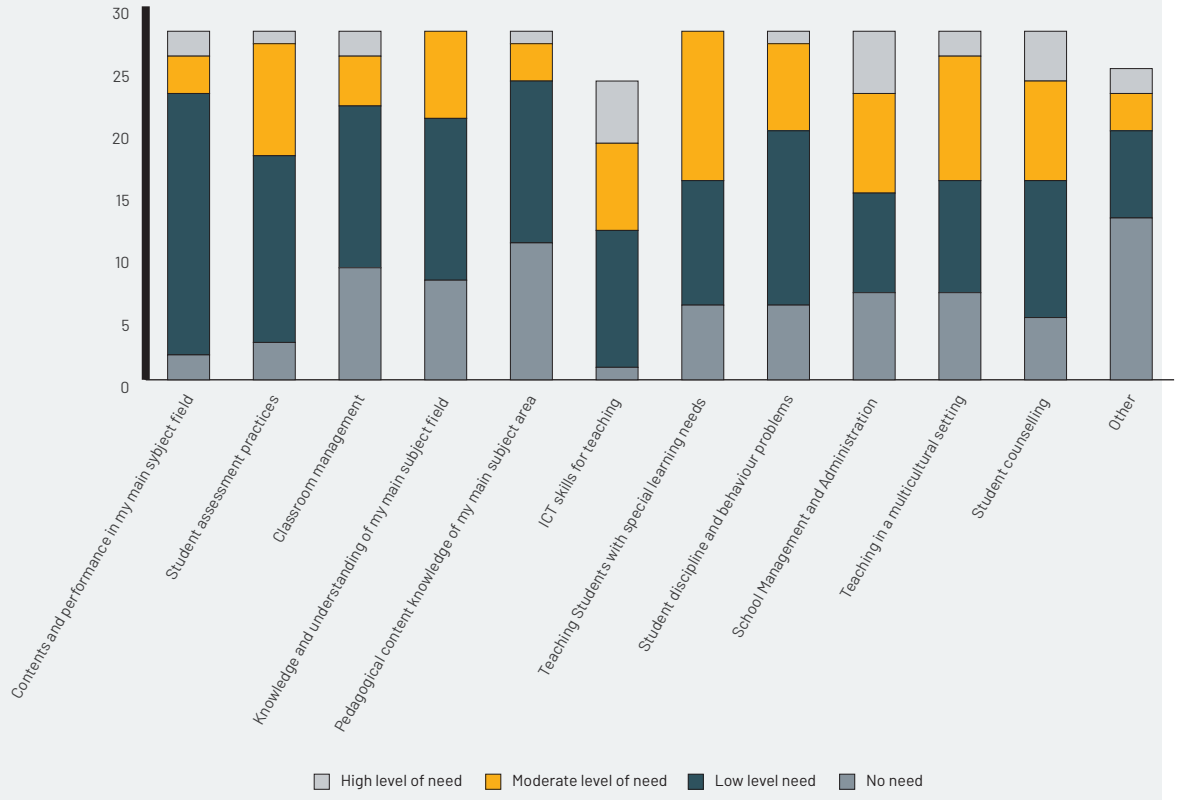

Figure 2: Indicated areas of PD needs

Figure 2 captures the English teachers' perceptions of the PD activities they rated as a significant need. Eleven areas of needs were presented to teachers to indicate the extent to which they had needs in each of the areas. The extent of the need was determined by whether it was a "high level need" or "no need at all". Teachers' ratings of significant PD needs focused primarily on four areas of need: school management and administration 46 per cent, ICT skills for teaching, 25 per cent (25%), Teaching Children with Special Learning Needs twenty-five percent (25%), and teaching in a multicultural setting 25 pecent. Of significance was the rating of knowledge of content and performance in main subject area with an overall "no need/low level" response of 48 per cent, and Pedagogical Knowledge in main subject area with an overall "no need/low level" response of 48 per cent.

Research Question 3

What are English teachers preferred professional development activities?

Teachers' preferred professional activities were signalled by the level of participation in both structured and formal PD and informal self-directed PD.

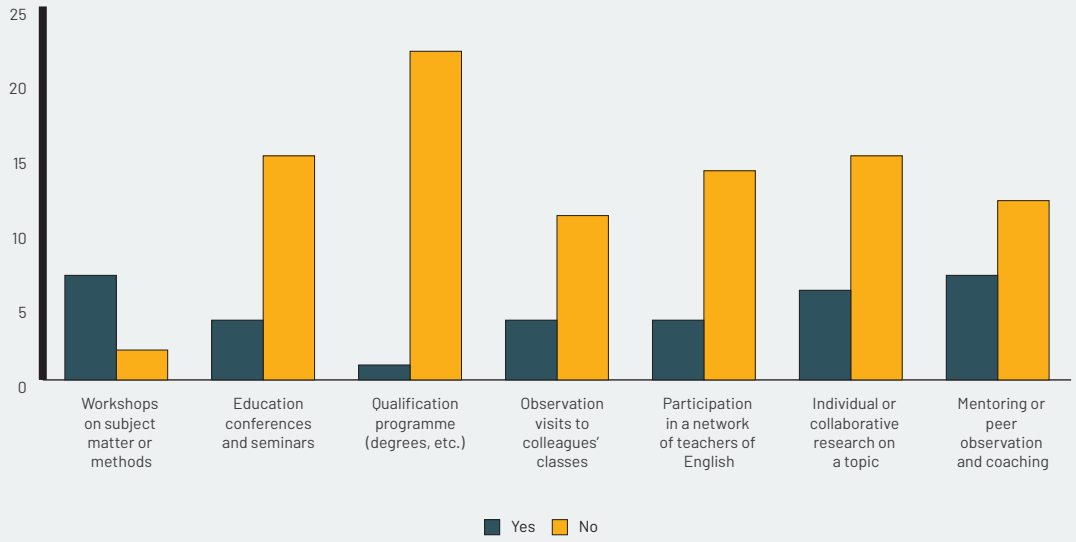

Figure 3: Participation in formal PD activities

Workshops on subject matter (14. 3%) and mentoring peer observation (14.3%) both indicated the highest participation, though low overall. Individual or Collaborative Research on a Topic followed with thirteen percent (13%). Figure 3 above shows the extent of teachers reported participation in formal PD.

When PD participation was informal and self-driven teachers' reported greater participation and indication of preference, though still small. In this instance, as is evident in figure 4 below, the preferred reported PD activities were Personal Professional Reading (18.7 %) and Engaging in Informal Dialogue with Colleagues (22.1 %).

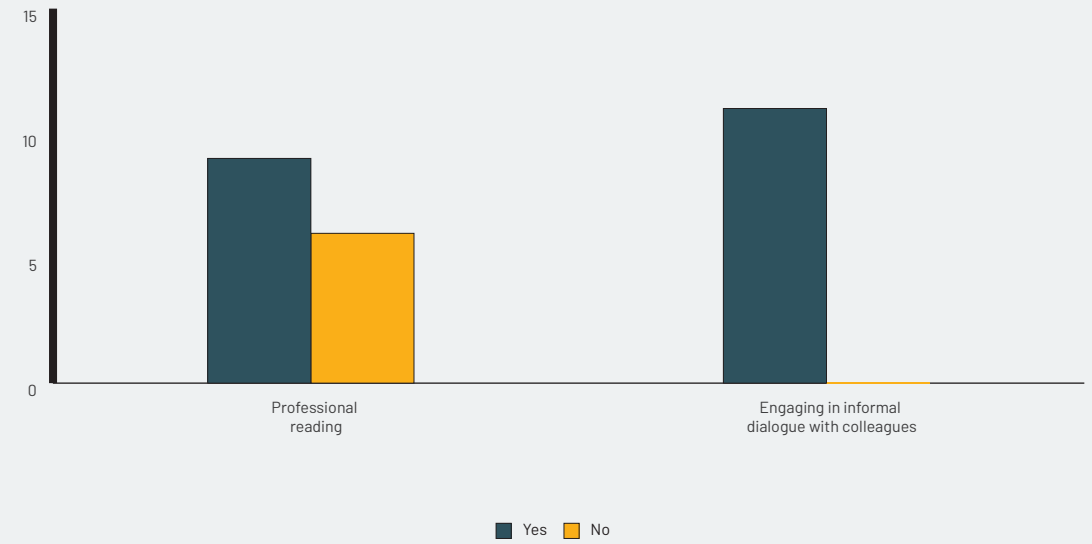

Figure 4: Informal professional development

Other preferred PD activities as reported by teachers included:

"Researching current trends in language and literacy from trusted online sources."

"... the opportunity to discuss the articles and salient themes with other teachers from across the island and even from across the region."

"...session organised by CXC to give more specific information about the implementation of the new syllabus, in particular the SBA component."

"A professional development activity that tells teachers how to teach English rather than show and engage them in activities aimed at honing their craft in the teaching of English. Like some of those which take place by means of Webinars for the Caribbean Examinations Council (CXC)."

Teachers also reported that their preferred PD activity and subsequent attendance were also influenced by:

- Personal interest in area of focus
- Mandate by a superior
- Perception about who will be facilitating the session and potential of learning something new
- Date, time and place where session is to be held
- Opportunity to connect with other professionals in the field
- The benefits that the PD could bring to students achieving the learning outcomes necessary to facilitate their proficiency in English
- The innovativeness of the PD in the form of active learning strategies and methods that would facilitate student learning
- Interest in the area of English teaching that the PD is focusing on
- The perceived relevance of the PD focus to the Caribbean and classroom context in which [one is] functioning

Research Question 4

How do English teachers perceive the impact of the professional development activities in which they participate?

Though workshops on subject matter were not reported as a highly preferred PD activity among the surveyed teachers, Figure 5 indicates that when the teachers attended this activity they reported, though moderate, the highest impact (22.9%).

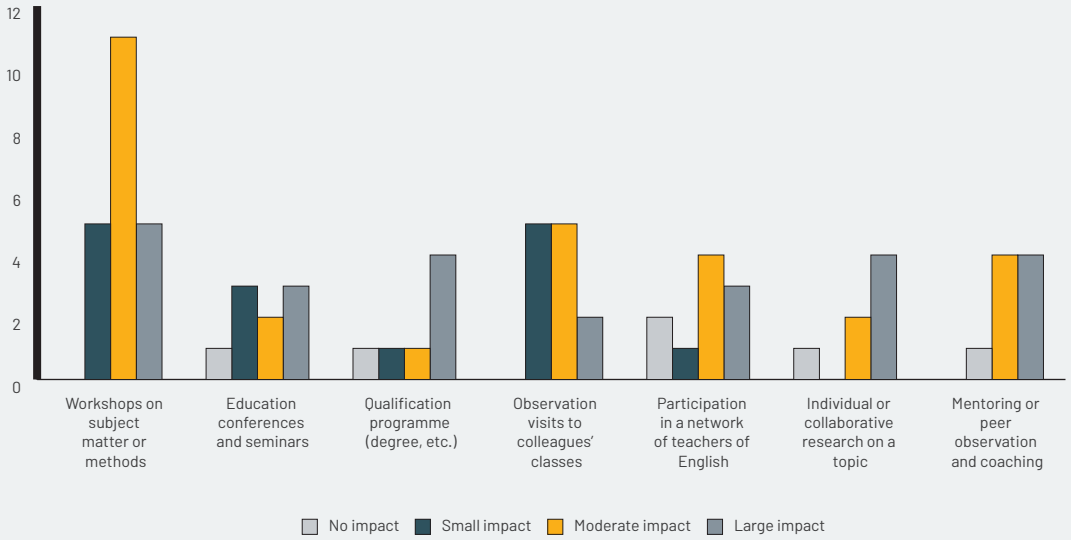

Figure 5: Level of impact from formal PD participation

Of significance, is that the Figure 6 below reveals that personal professional reading reported "moderate to high impact" for 25 per cent of the surveyed teachers; while Engaging in Informal Dialogue with Colleagues reported a "moderate to high impact" for 33 per cent of the teachers.

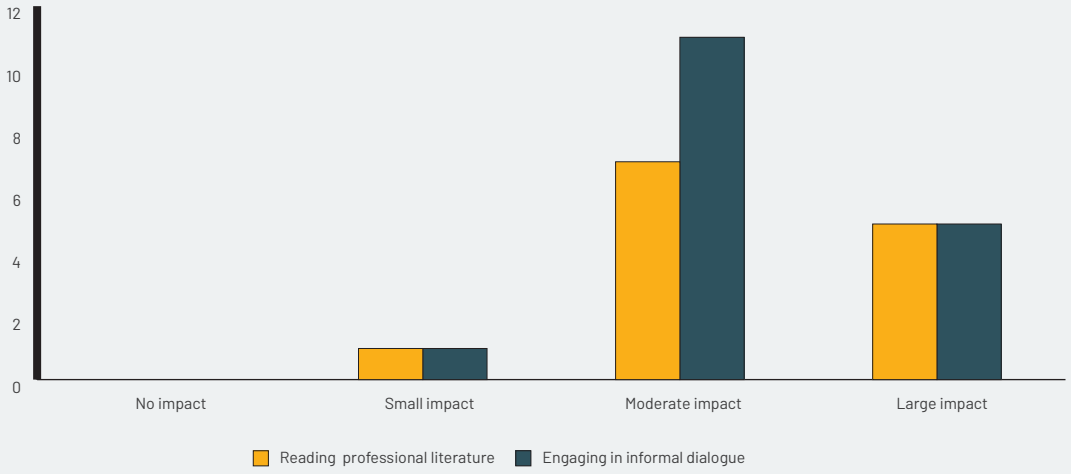

Figure 6: Level of impact of informal PD

Discussion and conclusion

This paper explored the perceptions of a sample of English teachers regarding what is valued as professional development. The findings of the study were examined and guided by four research questions which considered how PD is conceptualised/described, the professional needs of English teachers, their preferred PD activities and the perceived impact of PD.

The findings revealed that English teachers' description of PD were consistent with the perspectives of PD as an activity that provides improvement opportunities geared towards impacting practice, yet "structured" in a way that suggests a more controlled approach to the activities.

Research describes professional development as "activities that develop an individual's skills, knowledge, expertise and other characteristics as a teacher." Additionally, Leaning Forward, an organisation focused on improving professional development to enable student learning, suggest seven standards which characterise high-quality professional development. These include: learning communities, leadership, resources, data learning designs, implementations and outcomes. The description of professional development (PD) offered by the sample surveyed English teachers, while aligning with the notion of PD as a "capacity building" activity as it relates to skills and knowledge, stop short of recognising the value of PD as an opportunity to build learning communities and provide and enable instructional leadership. As such, understanding the degree to which a "structured" approach, such as nationally nominated, selected or required PD programmes, meets the criteria of high-quality PD, characteristic of the standards indicated by Leaning Forward or is valued by teachers for whom they are planned, is central to understanding teachers' conceptualisation of professional development as an activity with the promise of making them "future ready".

The observation that school management and administration, ICT skills for teaching, teaching children with special learning needs and teaching in a multicultural setting are considered by these teachers of English as areas of needs for professional development is significant. This contradicts the perception that teachers require more development in content knowledge (CK) and pedagogical content knowledge (PCK), the areas teachers indicated were their least needs.

Often in the Anglophone Caribbean PD decisions are guided by schools' or Ministries of Education (MOE) priorities. But there is little research on what characteristics PD should have in order to impact teachers' practice in ways that translate to improved student learning. A policy or goal which focuses on improving reading may emphasise PD focused on developing teachers' literacy skills in reading, to ensure all teachers are prepared to teach reading. However, this is done without a needs assessment to determine if all teachers require this training. Alternatively, the teachers' indicated lack of need for PD in CK or PCK may also point to a deficient and inadequate perspective about what counts as content knowledge and pedagogical content knowledge.

Teachers preferred PD activities — were influenced and determined by structured elements — who planned and organised it, date and time, mandated by a superior — and opportunities for growth that related to interest. Additionally, there was a strong proclivity towards PD activities that were informal and self-driven.

PD may be a tool to help teachers improve several characteristics of practice such as content knowledge, pedagogical content knowledge, classroom management and assessment, but determining which type or model of PD is preferred, or is of value to teachers, is of greater significance when making decisions about how to guide teachers' growth. Archer et al (2011) suggest an important step in planning PD for teachers is to take an inventory of current PD opportunities and make decisions, with teachers, about what should be eliminated and where gaps exist.

They offer five features that support teachers, preferred PD activities, which support the above perspectives of the surveyed teachers:

- Aligned PD with school goals
- Focus on content and modelling of teaching strategies for the content
- Include opportunities for active learning
- Provide opportunities for collaboration among teachers
- Include planned follow-up and continuous feedback

Not all PD activities are/will be equal in quality and benefit for all teachers in their particular context. However, while perceptions and preferred content and format regarding PD may vary, Griffin (1993) contends that a common purpose regarding PD among teachers and for teachers must be to "alter the professional practices, beliefs and understanding of school [administrative personnel] toward a more collaborative articulated end." Indeed, this raises questions about what PD activities are to be valued and who decides. The findings suggest teachers are shouting loudly for autonomy against a culture that is tended to teacher heteronomy and "unfreedom" as it relates to whose preference reading PD activities should count.

Perceived impact is an important aspect of how teachers determine value in/of PD activities. When impact was high, PD was informal and self-driven. Low impact was emblematic of structured and formal PD activity. Determining impact, and by extension value in teachers' PD, also has implications for how to support teachers' choices and voices amid the culture of increased standards and regulations aimed at both teachers' professional development and accountability.

Finding ways to determine value in English teachers' PD is a priority at a time when the work of teachers within this subject discipline continues to be critical and criticised. If there is to be accountability, yet learning and growth from these professional learning activities, teachers must be included in decisions about what should bring value to them. At times, urgency pushes ahead of the research on the subject and sound decision making. This has been true of the Caribbean context. Indeed, the conundrum of trying to catch up while addressing needs is problematic at best. The challenge is finding a balance between matching the activities teachers announce are impactful and advancing PD practice at a pace that is fair for all. Schools, MOEs, teachers and most importantly students must benefit from this alignment.

The findings discussed above serve as a beginning critical discourse and lens in determining not only the structure and nature of professional development for teachers of English, but also the key perspectives, processes, methods and tools that are likely to matter in the lives teachers are likely to live. The findings codify what teachers of English, at least this sample within the Anglophone Caribbean, value as it relates to the context and approach to PD within their discipline. They provide, as aspects of this pilot study, a platform to invite and provoke conversation and understanding for this increasingly major focus of educational policy and research within the context of the Fourth Industrial Revolution. Most importantly, they provoke the need for deeper discourse and understanding about the value of the type of professional learning required by teachers of English to be able to acquire and engender 21st century competencies and in both teaching and learning for knowledge transfer.

Future research directions

In addition to perspectives of the PD organised for teachers, improving teacher education through PD won't matter if teaching conditions worsen. As such, the issue of social justice is equality an important 21st-century implication for teacher education and development. Also, the challenge of preparing teachers for the schools that exist today as well as considering and becoming ready for the education needs of the future is worthy of greater exploration.

An assessment of the current teacher education curricula using a "life-readiness" lens and how this can both foster and sustain deep learning and knowledge transfer can help to focus English teachers' education and development towards greater engagement with and awareness of 21st-century skills.

The fact is that the literacy demands of modern society are changing to reflect the social and workplace changes of the times (Castek et al. 2007; Elkins & Luke, 1998; Luke, Freebody & Land, 2000; Millar, 2014; Paris, 2005). With this transformation comes the need for a greater focus on multiliteracies, a moving away from a concentration on discrete or "constrained" skills (Paris, 2005) or comprehension in isolation from their contextual use. This reality points to the need to examine the issue of language arts and literacy from a broad perspective that addresses attitude, socio-economic status, effectiveness, gender, instructional approach and social and school contexts, (Robinson 2015).

References

Al-Mahrooqi, R. & Troudi, S. (2019). *Using Technology in Foreign Language Teaching*. New Castle: Cambridge Scholars Publishing.

Bernhardt, P.E. (2015). 21st Century Learning: Professional Development in Practice. *The Qualitative Report 20*(1), 1—19.

Bryan, B. (2010). *Between two grammars: Language learning and teaching in a creole speaking environment*. Kingston, JA: Ian Randle Publications.

Bryan, B. & Burnette, R. (2006). Language variation in Dominica: Perceptions, practice and policies. *Caribbean Journal of Education*, 28(1), 26—50.

Caribbean Examination Council (CXC). (2016, 2017). Reports on English A. CXC, Barbados.

Chien, C. W. (2017) Elementary school English teachers' professional learning from teaching demonstrations as professional development, Cogent Education, 4:1, DOI: 10.1080/2331186X.2017.1294229

Christie, J., Enz, B.J. & Vukelich, C. (Eds.). (2011). *Teaching language and literacy: Preschool through the elementary grades*. Boston, MA: Pearson Education.

Coe, R., Aloisi, C., Higgins, S. & Elliot, I. (2014). What makes great teaching? Review of the underpinning research. (PDF File) London: Sutton Trust. Available at: https://www.excellencegateway.org.uk/content/etf2733.

Cordingley, P., Bell, M., Thomason, S. & Firth, A. (2005). The impact of collaborative continuing professional development (CPD) on classroom teaching and learning. Review: How do collaborative and sustained CPD and sustained but not collaborative CPD affect teaching and learning? Research evidence in education library, EPPI Centre, Social Science Research Unit, Institute of Education, University of London, London.

Cummins, J. & Davison, C. (Eds.). (2007). *International handbook of English Language teaching*. New York, NY: Springer.

Darling-Hammond, L. (2006). Constructing 21st-century teacher education. *Journal of Teacher Education* 57, 300-314. doi: 10.1177/0022487105285962

Darling-Hammond, L., Hyler, M.E., Gardner, M. (2017). *Effective Teacher Professional Development*. Palo Alto, CA: Learning Policy Institute.

Davies, C. (2000). *What is English teaching?* Philadelphia, P.A.: Open University Press.

Desimone, L. M. (2009). Improving impact studies of teachers' professional development: toward better conceptualizations and measures. *Educational Researcher, 38* (3), 181—199.

Dewey, J. (1929). *The sources of a science of education*. New York, NY: Martino Publishing.

Edwards, V. (2009). *Learning to be literate: Multilingual perspectives*. Bristol, UK: Multilingual Matters.

Flores, M. (2005). How do teachers learn in the workplace? Findings from an empirical study carried out in Portugal. *Journal of In-service Education, 31*(3), 485—508.

Freeman, D. & Richards. J. (1996). *Teacher learning in language teaching*. London, UK: Cambridge University Press.

Glattenhorn, A. (1987). *Cooperative professional development: Peer-centered options for teacher growth*. Educational Leadership, (3)45, 31—35.

Graus, J. & Coppen, P.A. (2015). Student teacher beliefs on grammar instruction. *Language Teaching Research*. 20 (5), 571—599.

Grossman, P., Hammerness, K., & McDonald, M. (2005). Redefining teacher: Re-imagining Teacher Education: Teachers and teaching. *Theory and Practice*, 15(2), 273-290.

Grimm, E. D., Kaufman, T. & Doty, D. (2014). Rethinking classroom observation. Professional Learning: Reimagined, 71, 24—29. Available at: http://www.ascd.org/publications/educational-leadership/may14/vol71/num08/Rethinking-Classroom-Observation.aspx.

Guskey, T. (2002). Professional development and teacher change. *Teachers and Teaching: Theory and Practice*, 8(3), 381 – 391.

Guskey, T. & Suk Yoon, K. (2009). What works in professional development? *Phi Delta Kappan,* 90(7), 495—500.

Hismanoglu, M. (2010). Effective professional development strategies of English language teachers. *Social and Behavioural Sciences (2)*. 990 – 995.

Hord, S. (2009). Professional learning communities. Educators work together toward a shared purpose – improved student learning. *National Staff Development Council, 30*(1), 40—43.

Hord, S.M. & Hirsh, S.A. (2008). Making the promise a reality. In A.M. Blankstein, P.D. Houston, & R.W. Cole (Eds.), *Sustaining professional learning communities*. Thousand Oaks, CA: Corwin Press.

Hutchison, D. (2003). The effect of group level influences on pupils' progress in reading. *British Educational Research Journal* 29(1), pp. 25—40.

Johnson, C., Kahle, J. & Fargo, J. (2007). A study of the effect of sustained, whole-school professional development on student achievement in science. *Journal of Research in Science Teaching*, 44(6), 775—786.

Kedzior, M. & Fifield, S. (2004). Teacher professional development. *Education Policy Brief*, 15(21), 76–97.

Kelchtermans, G., Day, C. & Sachs, J. (Eds). (2004). CPD for professional renewal: Moving beyond knowledge for practice. *International handbook on the continuing professional development of teachers*. pp. 229—237. Open University Press, Maidenhead.

Khandehroo, K., Mukundan, J. & Alavi, Z. K. (2011). Professional development needs of English language teachers in Malaysia. *Journal of International Education Research 7*(1), 45—52.

King, B. & Newmann, F. (2004). Key link: Successful professional development must consider school capacity. *Journal of Staff Development, 25*(1), 26—30.

Kingston-Mann, E. & Siber, T. (Eds.). (2001). *Achieving against the odds: How academics become teachers of diverse students*. Philadelphia, PA: Temple University Press.

Kumaravadivelu, B. (2003). *Beyond methods: Macrostrategies for language teaching*. New Haven, CT: Yale University Press.

Lieberman, A. & Pointer Mace, D. (2008). Teacher learning: the key to education reform. *Journal of Teacher Education, 59*(3), 226—234.

Omar, R. (2017). The impact of professional development activities on teachers perceived competency in teaching English. *Journal of Applied Environmental and Biological Sciences*, 7(2), 75—78.

Penuel, W. R., Fishman, B., Yamaguchi, R. & Gallagher, L. P. (2007). What makes professional development effective? Strategies that foster curriculum implementation. *American Educational Research Journal, 44*(4), 921—958.

Prabhu, N. S. (1990). There is no best method — why? *TESOL Quarterly*, 24(2), 161—176.

Protherough, R. & King, P. (Eds.). (2007) *The challenge of English in the national curriculum*. London, UK: Routledge.

Quick, H., Holtzman, D. & Chaney, K. (2009). Professional development and instructional practice: Conceptions and evidence of effectiveness. *Journal of Education for Students Placed at Risk (JESPAR), 14*(1), 45—71.

Richardson, V. (2003). The dilemmas of professional development. Phi Delta Kappan, 84(5), 401—406.

Roberts, P. (2008) *West Indians and their language*. London, UK: Cambridge University Press.

Robinson, S. (2015). The Role of Context in Defining Secondary Language Arts Instruction: A Cultural Perspective. In P. Smith, & A. Kumi-Yeboah (Eds.). *Handbook of Research on Cross-Cultural Approaches to Language and Literacy Development* (pp. 421—445).

Hershey, PA: IGI Global.

Sanchez, H.S. & Borg, S. (2014). Insights into L2 teachers' pedagogical content knowledge: A cognitive perspective on their grammar explanations. *System, 44(1)*, 45—53.

Schwab, K. (2016). The Fourth Industrial Revolution: What it means, how to respond. World Economic Forum, 14 January. Available at: https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/. Accessed 15 August 2019.

Simmons-McDonald, H. (2006). Attitudes of Teachers to St Lucian language varieties. *Caribbean Journal of Education*, 28(1), 51—84.

Shulman, L. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), 4—14.

Tate, M.L. (2009). Workshops: Extend learning beyond your presentation with these brain- friendly strategies. *Journal of Staff Development*, *30*(1), 44—46.

Taylor, M. (2007). The Experience of Teaching and Learning in Jamaican (Creole): Phenomenological Account. *Caribbean Journal of Education* 29 (2), 222—39.

Timperley, H., Wilson, A., Barrar, H. & Fung, I. (2007). Best evidence synthesis on professional learning and development. Report to the Ministry of Education, Wellington, New Zealand.

Thomas, K.S.C. (2019). Critical thinking: Centering teachers' knowledge and understanding in language arts instruction. In S.P.A Robinson & V. Knight (Eds.), *Handbook of Research on Critical Thinking and Teacher Education Pedagogy* (255—276).

Wilson, S. Floden, R.E. &Ferrini-Mundy, J. (2001). Teacher Preparation Research: Current Knowledge, Gaps, and Recommendations: A Research Report Prepared for the U.S. Department of Education and the Office for Educational Research and Improvement. Center for the Study of Teaching and Policy.

LIFELONG EDUCATION PROMOTION FOR PEOPLE IN RURAL AREAS OF THAILAND BY THE ELDERLY LOCAL WISDOM

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Abstract: In Thailand, a number of elderly people have knowledge and experience which were accumulated and developed for many years and can be regarded as local wisdom of the country. Local wisdom is very useful and related very much to the way of life of people. This study was carried out in order to identify guidelines for letting them employ their wisdom to promote lifelong education to people in rural areas. The research samples comprised 45 elderly local wisdom, 30 committee members of the elderly clubs, 60 local primary and secondary school administrators and teachers, 60 administrators and teachers of non-formal education centres and 50 informal education organisers in five provinces in the central part of the country. Structured interviews and questionnaires were used as research instruments. The data were then analysed using frequency, means, standard deviation and content analysis. After that all the data were synthesised to formulate guidelines for promoting lifelong education for people in rural areas by the elderly local wisdom. The guidelines were later approved by 17 experts and related people.

The main finding showed that the guidelines of promotion of lifelong education for people in rural areas by the elderly local wisdom comprised two main parts. The first part was scope of activities of which the elderly local wisdom could take part in order to promote lifelong education. The second part was strategy for enabling the elderly local wisdom to promote lifelong education.

Keywords: elderly local wisdom, lifelong education, people in rural areas, Thailand

Introduction

At present, many countries are entering ageing society. A number of the elderly people are continuously increasing due to progress of medical services and development of technology. In Thailand, like many other countries, a number of the elderly are also continuously increasing. According to the Office of National Social and Economic Development (2014), a number of the elderly people aged over 60 years old in 2014 were 9.93% out of 65 million people. It was expected to be 19.1% in 2020 and 26.6% in 2032. According to people's way of life in Thailand, especially those in rural areas, elderly people usually live in an extended family where father, mother, children, aunt, uncle, grandfather and grandmother live together in the same household. In each community, elderly people are respected as relatives of people in the same community. The elderly people have accumulated valuable knowledge and experience during their life time. Members of the family or even young people in the community usually learn a lot of things in their way of life from the elderly people such as cooking, making farming instruments, going about their occupations and involving in their tradition and culture.

A number of the elderly people have accumulated knowledge and experience in certain fields. For an extended period of time, the expertise is developed by trial and error until they become the experts in those fields. The fields that they have expertise are, for example, agriculture, soil improvement, herbal doctor, silk weaving, Thai massage, etc. These elderly people can be regarded as a source of local wisdom in their community and we call them the elderly local wisdom. According to renowned educators in the field such as Amonwiwat and Srisalab (1998), Officers of Department of Agriculture Promotion (2003) and Nilmoke (2015), local wisdom is defined as knowledge, skills, thoughts, intelligence and experience

related to people's way of life in their context. These people accumulated such wisdom through the process of learning, thinking, analysing, selecting, trying out and making improvements for a long time from generation to generation. Such local wisdom can be used as guidelines for living, going about their occupations, solving problems and adapting themselves to social and environmental changes.

The Office of National Education Commission (2002) has categorised expertise of local wisdom in Thailand into nine aspects. These are: agriculture, manufacture and industry work, Thai herbal doctor, management of environment and natural resources, community business and finances, arts and culture, language and literary works, philosophy, religions and customs, and traditional food and dessert. The elderly local wisdom can be found in all parts of the country, in every province at district, sub-district and village levels.

Generally, many people believe that elderly people need assistance and support from younger people. But, in fact, the elderly would like to give some contributions to their family and their society. They would like to share and make use of their experience for the family and community development. According to the theory of the elderly, it is the nature of the elderly that they are happy when they have a chance to serve their society. The elderly who participated in community activities such as serving as advisors or being volunteers would feel that their lives were still valuable and they did not feel lonely (Jarurungsri, 2015). Parker (2016) concluded that older adults play critical roles in the lives of young people. When older adults volunteer to work with children, both sides benefit. Younger people obtained guidelines in various aspects for developing their lives while the older adults gain emotional satisfaction which led to better physical health. Similar to Cybulki and others (2013) who found from their study that young people would benefit from life experience of the elderly while the elderly were more active in many areas of life.

As for the aspect of education in Thailand, the National Education Plan, 1999 and the later educational policies and plans since then have strongly focused on promoting lifelong education for all Thais. To reach that goal, all sectors such as government agencies, non-government agencies and local communities, including various group of local people, are encouraged to take part in providing lifelong education activities. When considering valuable knowledge and experience of the elderly local wisdom as mentioned earlier, the researchers believe that the above can take part in provision and promotion of lifelong education for people in all age groups in their community. This also related to the government policy on the elderly people. In responding to the aging society, Thai government has issued the policy of developing quality of life of the elderly people like those in a number of countries in Europe, America and Asia (Goldman and others, 2018). One of the aspects in the policy was focusing on encouraging broader engagement of the elderly in their society which included promotion of education for younger people. With these reasons, it is reasonable to conduct a study in order to identify guidelines of letting the elderly local wisdom play the role of promoting lifelong education for people in rural areas. In this project, the researchers conducted the study in the central part of the country first. This is because the researchers work in this region and generally rural areas in every part of the country has similar context.

Objectives of the study

- to study present situation, needs and readiness of the elderly local wisdom for promoting lifelong education for people in rural areas;
- to identify viewpoints of committee members of the elderly clubs, school;
- administrators and teachers, administrators and teachers of non-formal and informal education centres concerning guidelines for promoting lifelong education for people in rural areas by the elderly local wisdom; and

- to synthesise and propose guidelines for promoting lifelong education for people in rural areas by the elderly local wisdom.

Method of the study

The study was carried out in three steps:

Step 1: studying present situation, needs and readiness of the elderly local wisdom in promoting lifelong education for people in rural areas.

The research sample was 45 elderly local wisdom from five provinces in the central region of the country. They were purposively selected to cover nine aspects of local wisdom expertise: agriculture; manufacture and industry work; Thai herbal doctor; environment and natural resources management; community business and finances; arts and culture; language and literary works; philosophy, religious and custom; and traditional food and dissert. Research instrument was a structured interview. The researchers obtained assistance from the administrators and teachers of the provincial and the district non-formal and informal education centres in five provinces to make appointments to interview 45 elderly local wisdom. Data obtained was analysed by content analysis.

Step 2: Identifying viewpoints of committee members of the elderly clubs, school administrators and teachers, administrators and teachers of non-formal and informal education centres about guidelines for promoting lifelong education for people in rural areas by the elderly local wisdom.

From the five provinces where the sample of the elderly local wisdom were drawn in step 1, the researchers randomly selected 10 districts, two from each province. From each district, one sub-district was randomly selected which make the total of 10 sub-districts. From each district, the following samples were drawn:

1) Samples from the elderly clubs, 30 committee members of the elderly clubs in 10 districts were randomly selected.
2) Samples from formal education, 10 administrators and 20 teachers from 10 randomly selected secondary schools in 10 districts and 10 administrators and 20 teachers from 10 randomly selected primary schools in 10 sub-districts.
3) Samples from non-formal education, 10 purposively selected administrators and 20 randomly selected teachers of 10 district non-formal and informal education centres and 30 randomly selected officers of related local agencies in 10 districts.
4) Samples from informal education, 10 purposively selected administrators and 10 librarians from 10 district libraries in 10 districts, 30 organisers from other learning resource centres such as museums, information centres, recreation centres, art and craft centres in 10 districts.

Total samples from the four groups was 200 people. Research instruments were an interview for committee members of the elderly clubs and questionnaires for the rest of the three groups of the samples. The data obtained were analysed by frequency, mean, standard deviation and content analysis.

Step 3: Synthesising and proposing guidelines for promoting lifelong education for people in rural areas by the elderly local wisdom. The researchers synthesised all data obtained from field study in step 1 and step 2 to formulate the guidelines for promoting lifelong education for people in rural areas by the elderly local wisdom. Then the guidelines were presented at a focus group meeting among these experts and related people: three elderly local wisdom, three community committee members, three elderly club committee members, two local school teachers, two non-formal education teachers, two informal education organizers and one officer of the local administration office. After that feedback and suggestions from these related people were used for adjusting the guidelines before proposing in the research report.

The main findings

The main findings of the study were:

1. Present situation, needs and readiness of the elderly local wisdom in promoting lifelong education for people in rural areas. Result from interviewing 45 elderly local wisdom in five provinces showed that most of them usually had some opportunities to promote lifelong education in the forms of informally transferring their knowledge and experience to people in their communities. Only sometimes that some of them were invited formally to transfer their knowledge and experience or to be resource persons for school children in formal education of the local schools or for adult learners in non-formal education activities. They stated that, in fact, they were very pleased to serve every type of education whether formal education, non-formal education or informal education. But they did not know where and whom they can contact for this purpose and which role they should do to serve each type of education. They could help in the forms of lecturing, vocational practicing and being learning resources. The elderly local wisdom were also asked whether they needed any support in doing this role, they indicated that they would like to have guidelines about how to transfer their knowledge and experience to the target groups, to have some financial supports in organising activities in their learning resource centres and to let related agency disseminate their knowledge through various forms of media such as printed media, CD, VCD.
2. Viewpoints of committee members of the elderly clubs, school administrators and teachers, and administrators and teachers of non-formal education centres and informal education organisers in 10 districts of the five provinces about guidelines for promoting lifelong education for people in rural areas by the elderly local wisdom. Results from the study showed that every group of the samples agreed that knowledge and experience of the elderly local wisdom were very valuable and they could provide a lot of assistance to promote lifelong education for people in their communities. They believed that the elderly local wisdom were willing to take this role. Since lifelong education covered formal education, non-formal education and informal education, their suggestions on how the elderly local wisdom could help each type of education were as follows.

   For formal education, school administrators and school teachers proposed that the elderly local wisdom could serve as learning resources where school students could come for vocational practicing most. Next were serving as learning resources where school students could come for searching information for their studies and giving lectures in the field of their expertise respectively, as shown in table 1. The committee members of the elderly clubs had similar idea with school administrators and school teachers.

Table 1 Opinions of school administrators and teachers toward activities that the elderly local wisdom could help formal education

Types of activities which the elderly local wisdom can help formal education	Opinions		
	X	S.D.	level
1. helping to develop local curriculum of schools	3.88	0.94	high
2. giving lectures in the fields of their expertise	4.06	0.75	high
3. being learning resources for students searching information for their studies	4.38	0.78	high
4. being learning resources for vocational practicing of students	4.46	0.65	high
5. helping for making learning media	3.56	1.09	high
6. serving as member of school committee	3.81	0.85	high
Total	4.02	0.34	high

For non-formal education, both of the administrators and teachers of non-formal education agreed that the elderly local wisdom could provide a lot of help to non-formal education. The advantages from inviting the elderly local wisdom were that adult learners and the general public could obtain knowledge and experience that could apply to their occupations and their day-to-day living. They proposed that the elderly local wisdom could act as resource persons for vocational practicing of non-formal education learners. Next were they could provide lecturers in the fields of their expertise and organising vocational trainings for the learners respectively, as shown in table 2. The committee members of the elderly clubs had similar ideas. They added that the elderly local wisdom could also serve as learning resources where adult learners could come for searching useful information.

Table 2 Opinions of administrators and teachers of non-formal education toward activities that the elderly local wisdom could help non-formal education

Types of activities which the elderly local wisdom can help non-formal education	Opinions		
	X	S.D.	Level
1. helping to develop short-course curriculum	3.60	0.88	high
2. giving lecture in the fields of their expertise	4.45	0.67	high
3. being resource person for vocational practicing	4.46	0.65	high
4. organising vocational training for people in communities	4.18	0.89	high
5. being learning resources for learners searching information for their studies	3.66	0.98	high
6. helping for making learning media	3.20	0.79	moderate
7. serving as member of the institution committee	3.40	1.04	moderate
Total	**3.62**	**0.56**	high

For informal education, the informal education organisers such as librarians, personnel of information centres, personnel of local museums, etc. agreed that the elderly local wisdom could provide a lot of assistance to informal education. They proposed that the elderly local wisdom could help most in terms of giving lectures in the fields of their expertise to the general public. Next were being resource persons for exhibition activities and for local radio broadcasting respectively, as shown in table 3. The committee members of the elderly clubs proposed most that the elderly local wisdom with the assistance of related agencies could create learning resource centres for their communities. Next were transferring their knowledge through various kinds of media such as printed media, radio, CD, VCD and giving lectures in the field of their expertise respectively.

Table 3 Opinions of the informal education organisers toward activities that the elderly local wisdom could help informal education

Types of activities which the elderly local wisdom can help informal education	Opinions		
	X	S.D	level
1. giving lecture in the fields of their expertise to the people in community	4.04	1.06	high
2. being resource persons for exhibition activities	3.92	1.04	high
3. being resource persons for local radio broadcasting	3.68	1.16	high
4. being resource persons for local newspapers	3.58	1.25	high
5. being resource persons for libraries activities	3.26	1.17	moderate
6. transferring knowledge through various types of media	3.55	0.78	high
7. serving as member of library committee	3.34	0.98	moderate
8. serving as advisors of learning resource centres	2.84	0.78	moderate
Total	3.52	0.41	high

As for inviting the elderly local wisdom to help each type of education, the organisers of each type of education would like to have some related information. These were a database of the elderly local wisdom, their works, contacting address and their travelling situation.

3. Proposing guidelines for promoting lifelong education for people in rural areas by the elderly local wisdom. The guidelines for promoting lifelong education for people in rural areas by the elderly local wisdom developed from this study comprised two main parts. The first part was scope of activities of which the elderly local wisdom could perform in order to promote lifelong education. The second part was strategy for enabling the elderly local wisdom to promote lifelong education.

   1) Scope of activities of which the elderly local wisdom could take part or perform in order to promote lifelong education for people in their communities. It was proposed that the elderly local wisdom could promote every type of education as followed. For formal education, the elderly local wisdom could take part in these activities: being learning resources for school students to come for vocational practicing and searching information for some subjects, giving lectures in the field of their expertise and helping to develop local curriculum. For non-formal education, the elderly local wisdom could take part in these activities: being resource persons for workshops, giving lecture in some certain fields, organising vocational trainings and being learning resources for adult learners. For informal education, the elderly local wisdom could help in terms of giving lecture to the general public, being resource persons for exhibition activities, creating learning resource centres for their communities and transferring their knowledge through various kinds of media.

   2) Strategy for enabling the elderly local wisdom to promote lifelong education. In order to let the elderly local wisdom promoted lifelong education for people in their communities successfully, this strategy was proposed. It comprised nine components: employing community-based approach, setting up community lifelong education committee, having policy and plan in applying local wisdom to each type of education, setting up coordination unit, developing the elderly local wisdom database, forming the elderly local wisdom group, compiling and disseminating body of knowledge of the elderly local wisdom through various types of media, promoting understanding about the value of local wisdom among education organisers and providing support to the elderly local wisdom. The details of each aspect was, for example: For community-based approach,

needs and problems of people in each community should be analysed in order to provide suitable learning activities. For community lifelong education committee, each community should form this committee to operate lifelong education activities of the community. For elderly local wisdom database, the committee of each community should survey and collect all information about the elderly local wisdom available in their own community and keep them as a database for utilization. When employing this strategy in each community, all of the nine components should be integrated and run continuously.

Discussion

The study proposed guidelines for promoting lifelong education for people in rural areas by the elderly local wisdom which comprised two aspects: 1) types of activities of which the elderly local wisdom could perform in order to promote lifelong education, and 2) strategy for enabling the elderly local wisdom to promote lifelong education. For types of activities of which the elderly local wisdom could take part in order to promote lifelong education, the study found that the elderly local wisdom were willing to employ their knowledge and experience to promote every type of education for people in their communities. For example, they could serve as learning resource persons, lecturers, vocational trainers, etc. This result related to Yodpech (2015) who stated that one of the methods which enabled the elderly people to have good quality of life was making themselves useful to society. She found that the elderly local wisdom had transferred their knowledge and experience to people in various age groups. They could help to solve a number of problems existed in the community, be volunteers for the community, organised educational activities to school children, provided advice and exchanged ideas with people in the community, be resource persons for religion, arts and cultural activities, etc. For strategy for enabling the elderly local wisdom to promote lifelong education proposed from the study comprised nine items. They were, for examples, employing community-based approach, setting up community lifelong education committee, having policy and plan in applying local wisdom to each type of education, setting up coordination unit, etc. These items were necessary to make lifelong education promotion by the elderly local wisdom successful. Most of these items related to coordination and participation of people in each community and local organisations. This result was similar to the study of Chockworgul (2012) who studied the development policy for quality of life of the elderly in the local administrative organisations in the northeastern provinces. He found that the main factors which made policy implementation successful were the relevance of the policy to the needs of the elderly and cooperation of local people and local organisations. It was also similar to results of the study of Kanoklertwons (2018) who studied factors affected the policy management to improve quality of elderly's life of local province administrative office. He found that local people participation was one of the main factors for the success of policy management.

Conclusion

In Thailand, local wisdom is available in every part of the country, at district, sub-district and village level. Knowledge and experience of the elderly local wisdom is regarded as a very valuable learning resource for people in each local community. In order to serve the main policy of the country in "Promoting Lifelong learning for All", the elderly local wisdom can play a significant role. This research has proposed guidelines for promoting lifelong education for people in rural areas by elderly local wisdom. With the appropriate administer and application of these guidelines together with the cooperation of people in local community, promotion of lifelong education for all by elderly local wisdom will be successful. Even though this study was carried out in Thailand, the author believes that it can provide some ideas and directions for promotion of lifelong education for people in rural areas of other countries.

References

Amonwiwat, S. & Srisalab, N. (1998). Chapter 1: Thai local wisdom. *Thai encyclopedia for youth*. Vol. 25. Bangkok: Project of Thai encyclopedia for youth.

Chockworgul, S. (2012). The Development Policy for Quality of Life of the Elderly in the Local Administrative Organisations in the Northeastern Provinces. *Journal of political science and law, Kalasin Rajabhat University*. 1(1), 2012:146—165.

Cybulki and others. (2013). Elderly Peoples' Perception of Young People – A Preliminary Study. *Iranain Journal of Public Health*. 2013 Oct; 42(10): 1099—1105.

Department of agriculture promotion, Local wisdom section.(2003). *Basic knowledge about local wisdom*. Bangkok: Department of agriculture promotion.

Goldman, D.P. and others. (2018). Opinion: Measuring how countries adapt to societal agi*Proceedings of the National Academy of Sciences of the United States of America*. 2018 Jan 16; 115(3): 435—437.

Jarurungsri, A. (2015). Concept and theory about adult and elderly people. *Text-book on development of adult and elderly people*. Vol 1, chapter 1, School of human ecology, Sukhothai Thammathirat Open University. Nonthaburi: Sukhothai Thammathirat Open University printing house.

Kanoklertwongs, P. (2018). Factors affected the policy management to improve quality of Elderly's life of local province administrative office. *Eastern Asia university academic journal*. 8(2), 2018:249—264.

Nilmoke, V. (2015). Local wisdom and community learning resources for lifelong education. *Text-book on professional experience in non-formal education*. 2(9) School of educational studies, Sukhothai Thammathirat Open University. Nonthaburi: Sukhothai Thammathirat Open University printing house.

Office of National Education Commission. (1999). *National Education Act, 1999*. Bangkok: Office of National Education Commission.

Office of National Education Commission. (2002). *Data of local wisdom in Thailand*. Bangkok: Office of National Education Commission

Office of National Social and Economic Development. (2014). *Expected number of the elderly people in Thailand*. Bangkok: The Office of National Social and Economic Development.

Parker, C.B. (2016). Older people offer resources that children need. Available at: https://news.stanford.edu/2016/09/08/older-people-offer-resource-children-need-stanford-report-says/ (accessed July 2018).

Yodpech, S. (2014). *Research report on best practice of the elderly clubs and schools*. Available at: http://thaitgri.org/?p=37882 (accessed June 2017).

VIRTUAL LEARNING ENVIRONMENT: EXPERIENCES OF HIGHER EDUCATION STUDENTS IN GHANA

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Abstract: The Fourth Industrial Revolution (4IR) is powered by robotics, the internet of things and artificial intelligence. It is said that 4IR will transform the workplace, and that routine tasks performed by humans will be replaced by it. Further, the activities in the physical world of reality will be supplemented by 4IR tools and people will collaborate across the globe within immersive virtual environments. Therefore, there is an imperative for more innovation in teaching and learning, using virtual learning environments (VLE) that collect data about students' experiences of digital environments to identify deficiencies in their digital skills acquisition. Several studies conducted in higher education settings have found that virtual learning environments (VLE) are effective in supporting teaching and learning, and also for digital skills development. Studies in higher education institutions in Ghana indicate that students are less receptive to VLEs due to factors such as access to digital technology and students' low level of digital skills. In this paper, we seek to describe our understanding of students' experiences with VLEs at higher education institutions in Ghana, as we seek to understand the extent of students' use of digital technology in the courses in which they are enrolled. We surveyed 1937 final year degree and postgraduate students in three dual mode higher education institutions in Ghana using an "intact" survey developed by the Joint information Systems Committee (JISC). The results revealed that students' preference for learning in the virtual learning environment is differentiated by mode of study. Distance learners are more likely to prefer to study in groups compared to face-to-face students who prefer individual learning. However, most students wanted VLEs to be used in more of their courses. Almost all students wanted VLEs to be accessible on their mobile devices and they wanted to use the collaborative features of the tool. However, students found the institutional VLEs to be poorly designed and fail to meet their learning needs. The results show that students in Ghana are receptive to VLEs for learning, but that their expectations are that higher education institutions are not responsive to their learning preferences using VLEs.

Keywords: virtual learning environment, students' experiences, ICT in education, Fourth Industrial Revolution

Introduction

The Fourth Industrial Revolution will use more advanced technologies, such as artificial intelligence, virtual reality, internet of things, cloud technology, robotics, Big Data etc., thereby redefining the essence of living, learning and work. It will cause a lot of people without digital skills to lose their jobs, their rights as humans or even their lives (Morrar, Arman & Mousa, 2017). In this era, physical reality and the virtual environment will melt together with people collaborating across the globe within immersive virtual environments (Schuster, Plumanns, Grob, Vossen, Richert, & Jeschke, 2015). This is why higher education institutions which provide training for the next generation workers need to use VLEs; encourage more interactive and collaborative components; and gather data about students' experiences. In spite of the potential, the adoption and use of VLEs in higher education institutions in Ghana has been painfully slow. Faculty continue to use passive lecture method. This is because earlier research indicates that students in Ghana are less receptive to VLEs due to factors such as access

to digital technology and students' low level of digital skills (Hubackova & Semradova, 2016; Ulmane-Ozolina & Preidolina, 2017). This study therefore seeks to understand from the students' perspective what their experiences of institutional VLEs are.

It is well established that VLEs are invaluable for teaching and learning (e.g. Newman, Beetham & Knight, 2018; Galanek, Gierdowski & Brooks, 2018). In the learning environment VLEs can be used for information transmission and to engage students in synchronous and/asynchronous learning environments. Earlier studies suggest that VLEs can be used in the learning environment to enhance the digital experiences and capabilities of students for learning and beyond. For example, when used in teaching and learning, VLEs can help manage and develop students' digital competencies (Ulmane-Ozolina & Preidolina, 2017). VLEs are also crucial for developing 21st-century skills such as creativity, collaboration, communication, problem solving and critical thinking skills (Mery, Newby & Peng, 2012; Posey, Burgess, Eason & Jones, 2010; Ulmane-Ozolina and Preidolina, 2017; Walton and Hepworth, 2011).

Rather than confining to silo teaching and learning the education sector, particularly higher education institutions and faculties who are preparing the next generation of students for future jobs and living needs to rethink how students will meet the demands of the Fourth Industrial Revolution and future employments by adopting appropriate technologies such VLEs for learning. We believe that by understanding students' preferences for learning and their experiences of VLEs, faculties can design courses that are adaptive and appealing to students. This study aims to understand from the students' perspective what their experiences are with the institutional digital learning environment. The study used a survey method to collect data from students in three dual mode universities in Ghana. Next is a review of related literature followed by methodology, the findings and discussions of students' preference for learning and their experiences of the universities, VLEs. The conclusion of the study will draw on the contributions and suggestions for future study.

Literature review

JISC (2010) defines a virtual learning environment as a web-based system, which incorporates digital tools and activities for teaching and learning. It can also be defined as a centralised web-based platform designed with the potential to incorporate heterogeneous technologies and activities for facilitating the digital aspect of courses in education, vocation and the workplace setting (Mueller & Strohmeier, 2011).

The main benefit of VLEs is to ease and create engaging, motivating, efficient and success-oriented learning environments that go beyond the classroom as well as help students to stay focused. It also provides a wide range of course delivery methods such as collaborative and independent learning activities (Derboven, Geerts & De Grooff, 2017; Gedera, Williams & Wright, 2013). VLEs are also used to enhance teaching and learning (Dahlstrom & Bichsel, 2014). It is further used to present resources, activities and interactions within a course structure. VLEs are used to improve students, access and use of the technological tools and resources they provide, conduct tests and self-assessment, develop individual and collaborative learning activities and to clarify questions with students and lecturers (Brown, Dehoney & Millichap, 2015; Lefever & Currant, 2010;). In some cases, VLEs are used to continue class discussions, sustain motivation, offer a safe and supported environment for exchange and to promote active learning (Merchant, Goetz, Cifuentes, Keeney-Kennicutt & Davis, 2014; Xu, Huang, Wang & Heales, 2014).

Virtual learning platforms can be used to deliver courses completely online, complement or as a supporting feature for on-campus courses (Herrera & Mosquera, 2017). According to Lefever and Currant (2010), VLEs enable students, especially distance learners, to progress at their own pace and they are

able to fit learning into their daily lives (Newman, Betham & Knight, 2018). Mueller and Strohmeier (2011) assert that VLEs are more reliable and secure if the system itself as well as its users do not modify or delete the students' personal data, respectively their learning history, progress/outcome, and corresponding resources.

In addition, VLEs could have some level of integration with institutional systems (Derboven, Geerts & De Grooff, 2017). According to Lameras, Levy, Paraskakis and Webber (2013) some HEIs use VLEs "to support information transfer, application and clarification of concepts, exchange and development of ideas, resource exploration and sharing as well as collaborative-knowledge creation and development of process awareness skills". Technologies such as artificial intelligence which are incorporated in modern VLEs are also used by institutions to improve students' retention, enhance their experience and to make the institution more productive.

VLEs must be adaptive to student devices and enable students to rely on them to do their coursework. The teaching rooms or courses should be designed to enhance the learning experiences of students. In other words, the virtual learning environment should be student-centred, self-paced format, and encourage students to take responsibility for their own learning. The rooms should contain course materials such as lecture notes, and self-paced assessment modules. It should also support peer interactions in the form of simple discussions. Students should also be able to contact lecturers and fellow students through the teaching rooms for discussion and collaborative activities (Brown, Dehoney & Nancy Millichap, 2015; Newman, Beetham & Knight, 2018; Xu, Park & Baek, 2011).

Research support that a suitably designed VLE must accommodate a variety of learning styles and approaches, including active approaches to learning. It must include a variety of resources and activities that will accommodate all learning styles (Demain & Morrice, 2012)

Earlier studies by Galanek, Gierdowski and Brooks (2018) identified that most students prefer face-to-face interaction along with VLE used on their course. They suggested that face-to-face students are quite satisfied with the use of VLEs for distributing resources, collaboration, communication and submission of assignments. Newman, Beetham and Knight (2018) suggest that only a few students prefer to learn in groups. They allude that most higher education students prefer to learn on their own when digital technology is used on their course.

Students' experience about VLE in higher education institutions in developing countries seems to not have attracted the attention of researchers, as only a few studies have been published in this regard. This is more true for research that quantified VLE experiences in the context of teaching and learning in Ghana. There is a clear need to determine how students in Ghana experience VLEs in their institution. This study is therefore being conducted on the premise that there has not been enough empirical evidence on students' experiences of VLEs in the university campuses in Ghana.

Methodology

This survey study targeted higher education students in Ghana from the perspective of students' experiences with VLEs in context of their course disciplines including distance learners and full-time students in three dual mode institutions – dual mode institutions offer traditional/on-campus and distance learning modes (Muyinda, 2012). Earlier studies indicated that more than 98 per cent of students own and use their digital devices to support learning (Galanek, Gierdowski and Brooks, 2018). Accordingly, our study seeks to answer the questions:

1. What are the virtual learning environment experiences of students in Ghana?
2. Is there any difference on students experience of VLEs by mode of study?
3. What are the students' preferences of learning in the higher education institutions?

Similar to the framework proposed by (JISC), we believe that the differences in experiences between full-time students and distance learners in VLEs on their course will lead to an understanding of students' preferences for learning with VLEs and eventually could inform the design of effective digital learning environments that are responsive to students, learning styles, and that will increase the students' use of VLEs on their course.

Study sample

The population of the study is final year undergraduate and postgraduate students in higher education institutions in Ghana. Due to the limitations of resources (such as transport to travel to other universities to collect data), approval and acceptance of the participants in the study, the researchers administered the surveys in three leading dual-mode universities. The total population was 32127. In all 1937 representing 6.0 per cent of the total population responded to the survey.

Sampling technique

The study used the census sampling approach where the entire population is given equal opportunity to respond to the questionnaire. It's worth mentioning that students in Ghanaian universities share similar characteristics in terms of admission requirement into the higher education system. After getting the ethical approval from the universities, the researchers administered the survey online via the JISC online system through students' email, and group social media platforms. The participants were informed that their participation is entirely voluntary in the study and their responses are completely confidential. All other measures to ensure ethical research as prescribed by the institutions were applied.

Surveys structures

The study adopted a survey designed by JISC developed for the UK education sector and also used by several higher education institutions in Australasia and Africa (UNISA) — dubbed 'Student digital experience tracker'. The survey is delivered and managed in JISC online survey system. The survey comprises four dimensions: digital lives of students, digital in the institution, digital at course level and students' attitude to digital learning. This paper targets the fourth dimension which seeks to determine students' experiences with their institutions VLE. The nine items are reported on in this paper. Section one of the survey consisted of two nominal scale questions. The second section of the survey consisted of seven Likert scale items that determine the students' experiences with VLEs in their institutions. Students could choose to agree, remain neutral or disagree with the statements. Exploratory factor analysis (reported in another study) yielded an Eigenvalue of 1.728 explaining 4.32 per cent of the total variance, Cronbach alpha = .813. Data were collected over a period of three months.

Measurement analysis

An independent sample t-test was used to determine the variation in the students' experiences with VLEs. Further, a Pearson chi-square of independence test was used to determine the students' preference for learning when VLE is used on their courses.

Demographic information

The respondents were predominantly education (30%) and business students (21%). Some were engineering students (9.9%), psychology students (5.4%), and agriculture students (5.1%). Others were from biological and biomedical sciences (4.2%), physical sciences (4.2%), medical and health professions (3.5%), legal studies (2.7%), architecture (2.1%), liberal arts and humanities (2.7%), communication and journalism (2.1%), and visual and performing arts (1.3%). The majority of respondents were final year undergraduate students (86%), only 14 per cent were masters'/postgraduate students. Some 54 per cent were fulltime students and 46% distance learners. More than half of the respondents (80.2%)

were aged between 17 and 30. About 19,8% were aged between 21 and 62 years. Male students were the majority (57%), compared to female students (43%).

Results

Student experience with VLEs can help them develop 21st century skills such as collaboration, creativity, communication, critical thinking and problem solving. When students were asked about their experiences with the institutions, VLEs, it was identified that their experiences with VLEs was below expectations (see figure 1 and figure 2). The results show that only about 27.7 per cent of fulltime students and 26.4 per cent of distance learners in Ghana said the 'VLE used on their course' is up-to-date. In addition, 41.8 per cent of fulltime students and 38.4 per cent of distance learners said that online assessments are delivered and managed well. Students (fulltime: 25%, distance learners 29.8%) also opined that they enjoy using the collaborative features in the VLEs. Less than four out of 10 students (fulltime: 39.5%, distance learners: 39.4%) said they can access their institutional VLEs on their mobile phone. Only 28.8 per cent of fulltime students and 33.9 per cent of distance learners relied on their institutional VLEs to do their coursework. Some full-time students (37.8%) and distance learners (39.1%) complained that the VLEs were not well designed.

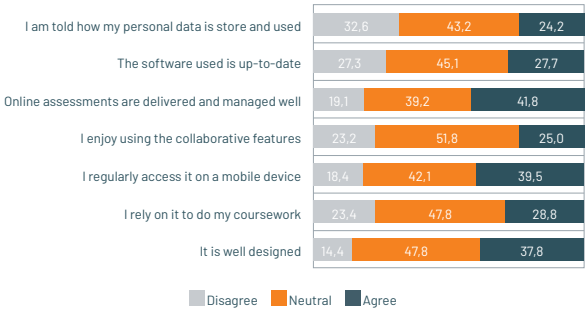

Figure 1: Full-time students' experiences with VLEs

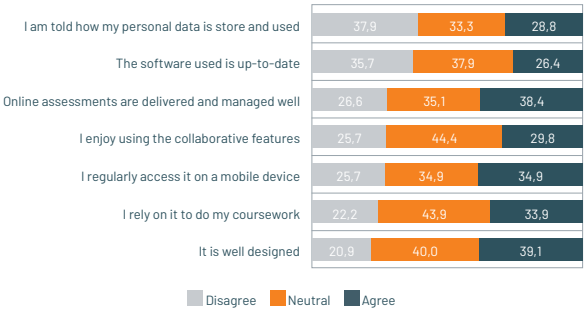

Figure 2: Distance learners' experiences with VLEs

Further analysis was conducted using an independent sample t-test to compare the differences in the students' response. Table 1 shows the descriptive statistics of students' experiences of VLEs.

Table 1: Students' experiences by mode of study: Descriptive stats

	Mode of study	N	Mean	Std. Deviation	Std. Error Mean
VLE use	I am a full-time student	1037	2,1660	0,52804	0,01640
	I am a distance learner	883	2,1378	0,58685	0,01975

From table 1, it can be seen that fulltime students (N = 1037, M=2.17, SD=0.53) appears to experience VLEs more in their course than distance learners (N=883, M=2.14, SD=058).

Further, the data was computed to determine whether the difference in the students' experiences with VLEs in the learning environment was significant. The result is shown in table 2.

Table 2: Independent sample t-test, mode of study by experiences with institutional virtual environment

		F	Sig.	t	df	Sig. (2-tailed)
VLE use	Equal variances assumed	15,955	0,000	1,108	1918	0,268
	Equal variances not assumed			1,099	1792,142	0,272

An independent sample t-test was conducted to determine the difference in students' experiences with institutional VLEs by mode of study. There was no significant statistical difference in the students experiences between the full-time students (M=1.811, SD=0.529) and distance learners (M=1.832, SD=0.598) on the institutions VLEs, (t(1792.14) = 1.099, p = .272)(table 2)

Table 3 shows the percentage difference in preference of learning with VLEs between students by mode of study.

Table 3: Students' preference as a learner

		I prefer to learn in a group	I like a mix of individual and group work	I prefer to learn on my own
Mode of study	I am a fulltime students	13.6%	48.8%	37.6%
	I am a distance learner	20.0%	45.9%	34.1%

From table 3, it can be seen that the difference in students' preference for learning by mode of study is small. For instance, both groups of students preferred a mix of individual and group work the (full-time students: 48.8%, distance learners: 45.9%). More fulltime students (37.6%) preferred to learn on their own compared to distance learners (34.1%). On the other hand, distance learners preferred to learn in groups compared to full-time students, but this was in small percentages. Further analysis using chi-square independent test identified a significant difference between the groups, X2(2, N=1811) = 13.629, p=0,001), Crammer' V = 0.087 indicating a very weak relationship between distance learners and full-time students.

We also asked the students their expectation of VLEs in their course. Table 4 shows the percentage result.

Table 4: Students' expectations of VLEs on their course

		Less than they are now	Same as they are now	More than they are now
Mode of study	full-time student	2.4%	12.9%	84.7%
	distance learner	2.1%	8.2%	89.7%

From table 4 it can be seen that, almost nine out of every ten students (fulltime: 84.7%, distance learners: 89.9%) said they want more VLE to be used on their course more than they are now. Few students (fulltime: 2.4%, distance learners: 2.1%) said they want less technology on their course.

Discussion

The study sought to understand the VLE experiences of higher education students in Ghana. We identified that only a few of the students agreed that the VLEs in their institutions VLEs are well designed.

According to the students the online assessments in the VLEs are not well designed or managed. Some said the VLEs in the institutions are not accessible on their mobile devices and that they do not enjoy the collaborative task in the VLEs, consequently they do not rely on it to do their coursework. Further analysis using the t-test indicated no significant difference between full-time and distance learners' experiences with the institutional VLEs. We also found little difference in the student preference for learning. Full-time students preferred to learn on their own (Newman, Beetham & Knight, 2018). A small minority of distance learners preferred group learning. Both groups of students are likely to prefer more of a mix of group and individual work (Galanek, Gierdowski and Brooks, 2018) however, a higher percentage of full-time students agreed with this. Further analysis indicated a significant difference in the students' (distance and full-time) preference for learning; however this was a very weak relationship and practically insignificant. Finally, both groups of students said they would prefer using VLEs more on their courses than they were currently. In sum, the results confirm that students are more positive about VLEs, however they are not comfortable with the design of the VLEs in the institutions.

Conclusion

VLEs have features such as analytics, artificial intelligence, integrated communication as well as social collaboration tools to develop students, digital experiences and capabilities necessary for the 4IR.The main contribution of this paper is to explore students' experiences of VLEs, which in turn will support the use of VLEs in teaching and learning in higher education institutions in Ghana to prepare the learners for the Fourth Industrial Revolution. We identified that though students irrespective of mode of study would want more VLEs to be used on their courses, poor design, outdated software and lack of access to VLEs on students' mobile devices inhibit the students using VLEs to support their learning. However, distance learners though this is in minority are more likely to prefer to study in groups in the VLE. We therefore, suggest that higher education institutions in Ghana should encourage conversations and discussions between students (distance and full-time students) in a form of engagement to design courses on VLEs that are adaptable to individual students' particular needs. Further studies should target devices students use to support learning to allow for flexible design and just-in-time learning. Modern VLEs should be acquired to allow for continuous learning experience (that allow students to use their devices even in areas with less/no connectivity) via their mobile devices. Also, faculty should continuously investigate students' preferences of learning so they can embed VLEs and accompanied digital skills in the learning requirement.

References

Brown, M., Dehoney, J. & Millichap, N. (2015). The next generation digital learning environment: A report on research. *EDUCAUSE Learning Initiative paper.*

Demian, P. & Morrice, J. (2012). The Use of Virtual Learning Environments and their Impact on Academic Performance. Engineering Education, 7(1), 11—19.

Derboven, J., Geerts, D. & De Grooff, D. (2017). Appropriating virtual learning environments: A study of teacher tactics. *Journal of Visual Languages & Computing, 40*, 20—35.

Derboven, J., Geerts, D. & De Grooff, D. (2017). Appropriating virtual learning environments: A study of teacher tactics. *Journal of Visual Languages & Computing, 40*, 20—35.

Dahlstrom, E., Brooks, D.C., & Bichsel, J. (2014). The current ecosystem of learning management systems in higher education: Student, faculty, and IT perspectives.

Gedera, D., Williams, J. & Wright, N. (2015). Identifying factors influencing students' motivation and engagement in online courses. In *Motivation, Leadership and Curriculum Design* (pp. 13—23). Springer, Singapore.

Hubackova, S. & Semradova, I. (2016). Evaluation of blended learning. *Procedia-Social and Behavioral Sciences*, 217, 551-557.JISC, (2010).

Lameras, P., Levy, P., Paraskakis, I. & Webber, S. (2012). Blended university teaching using virtual learning environments: conceptions and approaches. *Instructional Science, 40*(1), 141—157.

Lefever, R. & Currant, B. (2010). How can technology be used to improve the learner experience at points of transition. *Higher Education Academy*.

Merchant, Z., Goetz, E.T., Cifuentes, L., Keeney-Kennicutt, W. & Davis, T. J. (2014). Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis. *Computers & Education, 70*, 29—40.

Mery, Y., Newby, J. & Peng, K. (2012). Why one-shot information literacy sessions are not the future of instruction: A case for online credit courses. *College & Research Libraries, 73*(4), 366—377.

Mueller, D. & Strohmeier, S. (2011). Design characteristics of virtual learning environments: state of research. *Computers & Education, 57*(4), 2505—2516.

Newman, T., Beetham, H. & Knight, S. (2019). *Digital Experience insight survey 2018*. [online] Repository. jisc.ac.uk. Available at: http://repository.jisc.ac.uk/6967/1/Digital_experience_insights_survey_2018.pdf [Accessed 29 Apr. 2019].

Posey, G., Burgess, T., Eason, M. & Jones, Y. (2010). The Advantages and Disadvantages of the Virtual Classroom and the Role of the Teacher. In *Southwest Decision Sciences Institute Conference, March* (pp. 2—6).

Schuster, K., Plumanns, L., Groß, K., Vossen, R., Richert, A. & Jeschke, S. (2015). Preparing for Industry 4.0–Testing Collaborative Virtual Learning Environments with Students and Professional Trainers. *International Journal of Advanced Corporate Learning (iJAC), 8*(4), 14—20.

Ulmane-Ozolina, L., & Priedolina, M. (2017) Digital competence and blended learning. *ICLEL2017*.

Walton, G., & Hepworth, M. (2011). A longitudinal study of changes in learners' cognitive states during and following an information literacy teaching intervention. *Journal of Documentation, 67*(3), 449—479.

Xu, D., Huang, W. W. Wang, H. & Heales, J. (2014). Enhancing e-learning effectiveness using an intelligent agent-supported personalized virtual learning environment: An empirical investigation. *Information & Management, 51*(4), 430—440.

Xu, Y., Park, H. & Baek, Y. (2011). A new approach toward digital storytelling: An activity focused on writing self-efficacy in a virtual learning environment. *Journal of educational technology & society, 14*(4), 181—191.

Morrar, R., Arman, H., & Mousa, S. (2017). The Fourth Industrial Revolution (Industry 4.0): A social innovation perspective. *Technology Innovation Management Review, 7*(11), 12—20.

Muyinda, P.B. (2012). Open and distance learning in dual mode universities: A treasure unexploited. *International perspectives of distance learning in higher education*, 33—50.

BEYOND LEGISLATION: EFFORTS AT INCREASING TEACHER DIVERSITY IN DIVERSE-BY-DESIGN CHARTER SCHOOLS

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Abstract: Research has found that students with teachers of the same race are less likely to be suspended, more likely to be referred to gifted programmes, and more likely to complete high school and go to college. Despite these benefits, the diversity of the teacher workforce in the United States has not kept pace with increases in student diversity. States have adopted aspirational legislation aimed at increasing teaching diversity, but have fallen short of diversity targets. This qualitative study examines efforts to increase teacher diversity at 26 diverse-by-design charter schools across five locales. Approaches uncovered include grow-your-own credentialing programmes targeting diverse teacher candidates and the use of data to refine national recruitment efforts. We end by offering implications for policy, practice, and future research.

Objectives

The diversity of the teacher workforce in the United States has not kept pace with increases in student diversity. "At the national level, students of color make up more than 40 percent of the public school population. In contrast, teachers of color ... are only 17 percent of the teaching force" (Boser, 2011). To this end, states have adopted aspirational legislation aimed at increasing teaching diversity, but such attempts have fallen short of diversity goals. For example, Oregon legislators enacted the Minority Teacher Act in 1991 to increase the diversity of the teacher workforce to better reflect the diversity of the state's student population. These goals remained unmet for over 20 years; as the diversity of Oregon's students increased over that time period, the vast majority of the workforce has remained white, with 36 percent of students in the state of Oregon identified as ethnic minorities, but only 8 percent of the teaching population (Chief Education Office, 2016). In 2013, Oregon legislators renewed efforts to increase teacher diversity with the passage of Senate Bill 755, and in 2015, House Bill 3375, legislation aimed at holding colleges of education responsible for credentialing a diverse teacher workforce. However, the state's 2016 Educator Equity report found an overall increase in teacher diversity of just slightly over 1 percent, falling far short of legislative goals (Chief Education Office, 2016). Clearly, legislation alone is insufficient to attain a diverse teacher workforce. This qualitative study explores the efforts of diverse-by-design charter schools to recruit and retain diverse teachers.

Prior research on the benefits of teacher diversity

Research suggests diverse teachers contribute to improved student outcomes for diverse students (Dee, 2004; Egalite, Krisida & Winters, 2014; Ehrenberg, Goldhaber & Brewer, 1995; Sohn, 2009). Having just one African American teacher in grades 3—5 reduces the probability of low-income African American boys' dropping out of high school by 39 percent and increases the likelihood of both sexes aspiring to attend a four-year college (Gershenson, Hart, Lindsay & Papageorge, 2017). Moreover, increasing the diversity of the teacher workforce has been shown to benefit all students, as minority teachers bring a varied set of experiences and perspectives beyond those of homogenous teaching populations (Irizarry, 2007).

The estimated percentage of teachers identifying as members of minority ethnic groups increased from 12.4 to 17.3 percent between 1987 and 2012, with over 660,000 minority teachers in 2012 compared to 325,000 in 1988 (Ingersoll, Merrill, & Stuckey, 2014). Despite this increase, minority teachers have higher rates of attrition compared to white teachers. Lack of influence in school decision-making and classroom autonomy were the most commonly cited reasons for minority teachers leaving schools, and minority teachers tend to work in schools with more negative organisational conditions (Ingersoll & May, 2011). Torres, Santos, Peck and Cortes (2004) concur that attrition is a major factor contributing to the underrepresentation of minority teachers in the workforce, in addition to inadequate academic preparation, desire for more lucrative or prestigious careers, negative working conditions, lack of cultural or social support groups, financial considerations, and increasing standards and competency testing for teachers. Additionally, hostile racial climates within schools may contribute to high rates of minority teacher attrition (Kohli, 2018).

Given the underrepresentation of minority teachers in the workforce and an increasingly diverse student population, many schools, districts, and states have made efforts to increase the number of minority teachers through different policies such as expanding the pipeline of minority teachers and offering incentives for minority candidates (Kirby, Berends & Naftel, 1999; Hirsch, Koppich & Knapp, 2001; Aragon, 2018). "Home-growing" teachers, or recruiting potential educators to work in the communities they grew up in, is one promising method of increasing teacher diversity, despite persistent challenges stemming from state licensure exams and feelings of isolation among minority teaching candidates at predominantly white institutions (Irizarry, 2007). Rigorous screening processes for selecting potential candidates, mentorship, and sustained institutional commitment are important factors in successful "home-growing" programmes to recruit and develop minority teachers (Lau, Dandy & Hoffman, 2007).

Much of the existing research into teacher employment decisions has focused on the effect of student characteristics like achievement and race. As teachers become more experienced, they tend to move to schools with higher-achieving students and fewer minority students (Lankford, Loeb & Wyckoff, 2002; Hanushek, Kain & Rivkin, 2004; Boyd, Lankford, Loeb & Wyckoff, 2005). White and Hispanic teachers tend to move out of schools with higher proportions of black students, while black teachers tend to move to schools with higher proportions of black students, perhaps due to residential patterns (Hanushek, Kain & Rivkin, 2004; Boyd, et al. 2005). However, based on analysis of Charlotte-Mecklenburg schools after the end of forced desegregation, Jackson (2009) contends that students' race is a salient factor in teacher decisions to move schools. While these students have linked student race to different outcomes in teacher employment decisions, we found little existing research on the effects of racially or economically integrated schools on teacher employment patterns.

Teachers as role-models: Counteracting stereotypes

Akerlof & Kranton (2002) describe how students' identities can inform behavior by a process of students choosing to associate or disassociate with different social groups and the perceived normal characteristics and behaviors of group members. According to Akerlof & Kranton, schools can leverage this peer effect by creating multiple "ideals" with whom students can associate. This model of student identity formation aligns with research suggesting that "stereotype threat" can negatively affect short-term academic performance and long-term academic outcomes for stigmatized groups (Steele & Aronson, 1995). Priming female students with negative stereotypes about female math ability was associated with these students being less likely to report aspirations in mathematics or math-related careers (Steele, 1997), indicating that schools may have an important role in counteracting negative stereotypes by fostering positive student-teacher relationships and maintaining high expectations of stigmatised groups.

Recent research has highlighted the specific role of teachers in counteracting negative stereotypes: female math teachers in China were associated with improved attitudes, aspirations, and math performance among their female students possessing negative self-perceptions of their own math ability (Eble & Hu, 2017). Additionally, the impact of female instructors may not be limited to lower-performing female students, as female college instructors in science and math were associated with eliminating gender gaps in grades and STEM majors for their highest-achieving female students (Carrell, Page & West, 2010). Targeted social-psychological interventions can cause seemingly small shifts in student attitudes and self-perceptions that lead to major changes in behavior and academic outcomes (Yeager & Walton, 2011). The presence of teachers who defy negative stereotypes associated with different stigmatized groups seems to act in a similar fashion, helping students to reframe their aspirations and choices.

Diverse teachers and improved student outcomes

The impact of teacher identity on student performance is not limited to gender. A wide array of empirical research shows that teachers tend to misevaluate students of different races on subjective assessments (Ehrenberg, Goldhaber & Brewer, 1995; Burgess & Greaves, 2003; Bates & Glick, 2013; Gershenson, Hold & Papageorge, 2016). Furthermore, some research has linked race congruence of teachers and students to higher average test scores (Dee, 2004; Egalite, Ksida & Winters, 2015) and improved academic outcomes (Fairlie, Hoffman & Oreopoulos, 2014). While the exact mechanism of how teacher identity influences student outcomes is unclear, it may be linked to teachers' expectations of students and how those expectations inform teacher behaviors. Ferguson (2003) described how teachers' biases may affect how they treat different groups of students, potentially perpetuating existing racial achievement gaps. The past performance of different ethnic groups seems to inform how teachers evaluate current students of the same ethnic group (Burgess & Greaves, 2003), which may contribute to a self-perpetuating cycle of misevaluation and differential treatment.

This qualitative study used a perspective that posits three benefits of teacher diversity: Students with teachers of the same race are 1) less likely to be suspended (Lindsay & Hart, 2017), 2) more likely to be referred to gifted programmes (Grissom, Rodriguez & Kern, 2017), and 3) more likely to complete high school and go to college (Gershenson, Hart, Lindsay & Papageorge, 2017). The following research question guided this slice of a larger study: What approaches do diverse-by-design charter schools utilize to recruit diverse teachers?

Methods

To answer the above research question, we employed a qualitative approach to examine the recruitment and retention of diverse teachers in 26 diverse-by-design charter schools across 12 organisations — independent charter schools as well as schools that are part of a charter management organisation (CMO) — in five locales. We selected charter schools that met the following inclusion criteria: schools that have been in operation for at least three years, are members of the Diverse Charter Schools Coalition and have an explicit commitment to diversity/integration in their school mission statement. At the school level, we interviewed school leaders and members of the school leadership team, as well as personnel involved with school discipline, guidance counselors, and parent liaisons. For the CMOs, individuals were recruited to participate in the study from the CMOs' leadership teams, including staff involved with diversity initiatives, staff recruitment and hiring, and professional development.

The study design draws from a theoretical paradigm in which knowledge is constructed through participants' experiences (Merriam, 2009). As such, interviews followed a semi-structured protocol (Patton, 2002) developed by the research team, with questions tailored to role in the organisation (see Appendix A). Interviews were recorded and lasted approximately 60 minutes. Data triangulation

was attained by including multiple perspectives from each school (Maxwell, 2013). All interviews were transcribed and coded with a mix of deductive and inductive approaches (Miles, Huberman & Saldaña, 2013), creating an initial coding list based on the interview topics and questions and then comparing incidents to properties of a given category, refining and redefining the categories as new information emerged with the existing categories (Charmaz, 2006). The larger study examined a range of topics under the goal of intentional diversity — student recruitment, staff recruitment and hiring processes, curriculum and instruction related to classroom integration strategies, teacher professional development related to diversity and integration, school discipline practices, and parent and community engagement — narrowed for this paper to approaches to recruiting diverse teachers.

Findings

Preliminary findings are presented below to answer our research question: What approaches do diverse-by-design charter schools utilize to recruit diverse teachers? The charter schools included in the study sample strive to have a diverse teacher workforce that matches the diversity of the students served. As one interviewee noted, "There's a lot of research, more and more research about how important that really is to make sure that … the faculty, and the principals are representative of the student population. We've done a really good job of that."

In contrast, meeting teacher diversity goals was a challenge for some of the schools and networks. As one interviewee noted, "Many schools are struggling [with] recruiting top flight faculty and staff of color." Another noted, "It's not lost on us that it's a national epidemic that we have so few teachers of color." Interviewees noted that increasing diversity in their teaching and leadership staff is a key area for growth. Ten of the schools and networks described how the teacher shortage created a limited pool of applicants, as many described how few teachers of color and few male teachers applied for positions. Additionally, three networks described that the credentialing process may act as a barrier for potential teachers from diverse backgrounds, as a cost as well as a process that may be inherently discriminatory.

Cost was also an issue, as teacher recruitment firms focused on diversity were expensive, as were programmes such as the Network B teacher residency described below. As another way in which cost was a challenge, three networks noted that the cost of living was high in the urban areas in which they were located, a factor that, when combined with the salary they were able to offer, limited applicants from diverse backgrounds. Services such as placement firms and consultants are expensive, with perceived limited success.

The paucity of diverse teacher applicants required that these schools engage in strategic efforts to recruit and retain diverse teachers. One technique was the use of job fairs specifically focused on recruitment of diverse candidates, described by two networks; another strategy was the use of online job boards also specifically focused on reaching diverse teacher candidates, described as used by four of the study schools and networks. This included "grow your own" approaches, wherein charter schools partner with a university to credential teacher candidates recruited from colleges serving predominantly minority students rather than relying on existing credentialing programmes to produce the diverse candidates sought by the schools. These "grow-your-own" approaches were described by interviewees from three networks, in which they supported teaching assistants in accessing and completing a credential so they could move up into full-time teaching positions. As one study participant described:

> [The university partner] recruits the teachers, they come to us for a year and in terms of a residency, we pay them $20,000, they get a master's degree at night. After a year, they leave, they complete their residency with a full year of full time employment at [the charter school], so … it's not like a student teaching thing; … they are fulltime employees with us. They're in classes six hours a day [and] they have a mentor teacher. There's also gradual release models. By the end of

> the year, they are actually fully taking over these classes. They're also graduating with a master's degree … and then, we take the pick of the group. A hundred percent of those [teachers] until this point have been teachers of color. We tell them to go out to Spelman and Howard and state universities and other top tier places and get us faculty of color. That's their charge.

Four networks described how important it was to build upon the personal networks of teachers they already had on staff, with some providing financial incentives for teachers to refer persons from their network to the charter. Other charter schools involved in the study used consultants to solicit interest from diverse candidates, relying on the availability of enhanced data to track progress toward teacher diversity goals. One described working with a search firm, although it was described as cost-prohibitive. One network also described how they had an explicit policy where, for each vacancy, they had to interview a candidate from a diverse background. As one network leader noted, "We have a diversity consultant coming in to do an audit for the whole organisation in the next few weeks and they'll put up a set of recommendations." Another interviewee described the role of national recruiters:

> We want a diverse pipeline. For example … the recruiter group, their goals are around ensuring at the pipeline that they have the certain percentage of diversity in it. They won't be considered successful if they aren't doing that. I mean the thing we have today too, that we didn't have 15 years ago, it's just data. We have so much more data on this. Both because we're aware of it and gathering it. Then two, because we have systems and ability to have much more data today than we did then.

Beyond recruitment, we also found that some networks focused on specific hiring practices to diversify their teaching staff. More than one network described a firm policy of blind screening resumés and applications to counter implicit biases in the process. Another network described how, during the interview process, the school solicited input from students and families with regard to candidates to guide the selection of candidates.

Select schools with innovative recruitment and hiring approaches

In addition to the strategies used by our sample schools and networks, we found three charter networks that were particularly innovative with regard to their recruitment and hiring approaches of diverse teachers and staff. We profile the practices of these three networks — Network A, B, and C — below.

Network A

Across the interviews done with Network A school and home office staff, it became apparent that the network was investing a great deal of resources into increasing the diversity of their teaching staff. The network has in place a credentialing and teacher residency program in its second year, described by one interviewee to have "the lens of diversity of the teacher pipeline [and] training specifically for the [Network A] learning program."

The program was initially designed to streamline a cohort of Americorps tutors in accessing their teaching credential, but now operates through an open application with teacher candidates from an array of backgrounds. Interviewees described how the program has a very diverse group of students, with specific racial and gender diversity targets for recruitment and admission into the program. One staff member described the network as "pretty successful" in meeting these diversity targets. Another staff member described the goals of the program as:

> What we're trying to do is bring people who might not have had the opportunity to go to grad school or do some of the things that would be traditional barriers … we are trying to get a more diverse cohort of educators who more represent our community into our schools.

Overall the program was described as an asset for the school. From the first cohort, 20 out of the 21e graduates were hired on after completion, and the single graduate who was not hired on was planning to return after travel to teach with the network. One interviewee's perception of the program, which resonated across interviews, was, "That is gonna be the game changer as far as I can tell" for supporting a more diverse teaching staff.

Network B

Network B had different innovative practices and policies with regard to diverse teacher recruitment and hiring. The network has in place a partnership with a nearby four-year university through which students receive both a teaching credential and an MA. In doing so, they complete a teaching residency at the network while attending night courses at the university. The charter provides financial support to the student for their residency, and the university does the recruitment and credentialing. One interviewee described the partnership as,

> We tell them to go out to Spelman and Howard and state universities and other top tier places and get us faculty of color. That's their charge and [University Partner] has national reach, not international reach, and they're able to recruit people for us.

Interviewees described how the cohort of student teachers is incredibly diverse; one noted "…One hundred percent of those EMAT's until this point have been teachers of color".

The residency also comes with the support of a mentor teacher. One interviewee described the process as … they complete their residency with a full year of full time employment at [one of the network schools], so, they're not — it's not like a student teaching thing … they are full-time employees with us. They're in classes six hours a day, they have a mentor teacher. They're also gradual release models. By the end of the year, they are actually fully taking over these classes.

The program is an intensive resource investment, yet one that the network is hoping will ultimately prove a beneficial one. One home office staff member described, "It's expensive, it's a long term play … It's like a yearlong interview". Overall, the partnership to recruit and hire diverse teacher candidates, as well as hire on the teacher candidates as residents, was described as a unique asset to the charters. One interviewee stated "… in charters, you have a little bit more flexibility with the percentage of people who can be in process of certification and teaching and then, I think that opens up a lot more opportunities for people.

Network C

Network C engages in another unique and effective system to recruit and hire diverse teachers. The network has the ability to credential student teachers while the teachers are in their first two years, described as a "great avenue" for diversification of the teaching work force, as the program "… has the potential to bring in some teachers with diverse perspectives who maybe don't have the qualifications yet to be in the classrooms."

The charter also has in place its own graduate program, with a leadership focus. The graduate school cohort is described as very diverse; however, the mission is not so much to hire those graduates but support them in starting new schools.

Implications

Findings offer implications for policy, practice, and research. First, policy alone is insufficient to attain states' teacher diversity goals. Research suggests that there are institutional barriers to minority attainment of a teaching credential. Hanushek and Pace's (1995) longitudinal study showed that only 8 percent of African American and only 10 percent of Hispanic/Latino high school students who expressed interest in a teaching

career went on to become teachers. Policies should incentivize minority teacher candidates to enroll in and complete a teaching credential, as well as incentivizing assuming a teaching position. Second, schools and districts — charter and traditional public schools alike — should build training to advance into school leadership positions into their professional development priorities. Clear career ladders can help attract and retain diverse teachers. Finally, once schools hire diverse teachers, they then must work to retain them. One strategy to retain diverse teachers is to create internal growth opportunities, wherein diverse teachers have a pathway to become school leaders. As one interviewee noted, "We promote internally faculty of color to leadership roles, in the hopes that they'll be principals." More research is needed into the experiences of diverse teachers to investigate the conditions that facilitate and hinder their retention.

References

Boser, U. (2011). *Teacher diversity matters: A state-by-state analysis of teachers of color*. Washington, DC: Center for American Progress.

Chief Education Office. (2016). 2016 *Oregon Educator Equity Report*. Salem, OR: Chief Education Office.

Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis*. Los Angeles: Sage Publications.

Dee, T.S. (2004). Teachers, race and student achievement in a randomized experiment. *The Review of Economics and Statistics, 86*(1), 195-210. doi:10.1162/003465304323023750.

Egalite, A., Kisida, B. & Winters, M. (2015). Representation in the classroom: The effect of own-race teachers on student achievement. *Economics of Education Review,* 45, 44—52. doi:10.1016/j.econedurev.2015.01.007

Ehrenberg, R., Goldhaber, D. & Brewer, D. (1995). Do teachers' race, gender, and ethnicity matter? Evidence from NELS88. *Industrial and Labor Relations Review,* 48(3), 547—561.

Gershenson, S., Hart, C., Lindsay, C. & Papageorge, N. W. (2017). The long-run impacts of same-race teachers. *IZA Discussion Paper No. 10630.* Available at SSRN: https://ssrn.com/abstract=2940620.

Grissom, J.A., Rodriguez, L.A. & Kern, E.C. (2017). Teacher and principal diversity and the representation of students of color in gifted programmes: Evidence from national data. The Elementary School Journal, 117(3), 396—422.

Hanushek, E.A. & Pace, R.R. (1995). Who chooses to teach (and why)? *Economics of Education Review,* 14(2), 101—117.

Irizarry, J.G. (2007). "Home-Growing" teachers of color: Lessons learned from a town-grown partnership. *Teacher Education Quarterly,* 34(4), 87—102.

Lindsay, C.A. & Hart, C.M.D. (2017). Teacher race and school discipline: Are students suspended less often when they have a teacher of the same race? *Education Next,* 17(1), 72—78.

Maxwell, J.A. (2013). *Qualitative research design: An interactive approach* (3rd ed.). Sage Publications: Los Angeles.

Merriam, S.B. (2009). *Qualitative research: A guide to design and implementation*. San Francisco: Jossey-Bass.

Miles, M. B., Huberman, A.M. & Saldana, J. (2013). *Qualitative data analysis*. Sage.

Patton, M.Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Sohn, K. (2009). Teacher turnover: An issue of workgroup racial diversity. *Education Policy Analysis Archives, 17*(11), 1-26. doi: 10.14507/epaa.v17n11.2009.

Appendix A: Interview protocol

Your background

1. Can you tell me the story of how you came to work (found) at this CMO?
    a. What is your educational background post-secondary school?
    b. How would you characterize your SES status when you were growing up?
    i. If having difficulty answering: Affluent, middle class, or working class?
    c. How would you characterize your race/ethnicity?
    d. Did you have any experience with intentionally diverse schools prior to working at this school?
    e. If so, when, where and what impact did that experience have on you? If not, why were you drawn to this idea?
2. Please describe your role.
3. How does the DBD model reflect the (your) vision for the school?

Understanding Priorities for diversity & integration

4. How do you define diversity with regard to your school community?
    a. What does this include: SES, race/ ethnicity, gender, religion, languages [other than English], and persons with physical/intellectual disabilities?
    b. Can you talk more about how you define SES? Is it just free- and reduced-price lunch, or are there other student and family characteristics you look at?
5. Has your school achieved its diversity goals? In what ways? Why or why not?
6. Does your school differentiate between diversity and integration?
    c. If yes, can you describe the difference?

Making meaning of policies & practices

7. What are the practices or policies that you feel differentiate your schools from others?
    a. Can you give examples? In particular, are any policies or practices with respect to curriculum & instruction, student recruitment, school discipline, staff recruitment, professional development, parental involvement, or community building that really stand out to you?
8. Do your schools/Does your school have strategies in place to integrate students during class time?
    a. How about during recess or lunch time?
    b. How about outside of the school day?
9. Who was involved in creating/designing or selecting these policies and practices?
    a. Why did you involve these groups?
    b. Do these groups continue to play a role in informing policies and practices, or have other groups replaced them?

Student recruitment

10. How would you describe your approach to student recruitment?
11. What do you think attracts parents and students to your schools?
12. What are the responsibilities of the network office with regard to student recruitment?
13. What role do school leaders/classroom teachers play with regard to student recruitment?

14. Are current parents involved in your recruitment efforts?
15. Do you target certain student populations in your recruitment efforts?
    a. Which groups do you target specifically?
    b. Do you target by neighborhood?
16. Is diversity a factor in selecting your school locations? Please explain.
17. What approaches have you found to be most effective with respect to recruiting a diverse student population?
18. What are the challenes to recruiting a diverse student population?
19. Do you differentiate your outreach practices based on family SES or race? Please explain.
20. To what extent is marketing important?
    a. Can you describe any recent marketing campaigns and their outcomes?
21. In thinking about your admissions lottery, are there preferences in the lottery?
    a. Is the lottery weighted according to SES?
22. Do you require parents to visit your schools before submitting their child's application?
23. Is transportation available to students between home and school?
    a. Is transportation based on family income?
    b. Is transportation available for programmes outside the school day?
24. How does your charter school authorizer deal with fluctuations in the diversity of your schools' student populations?

Parent involvement

25. What strategies are in place to ensure that teachers and school leaders are connecting with parents of all students? Please give specifics.
26. What strategies are in place to ensure that parents from diverse backgrounds are connecting with each other? Please give specifics.
27. Please describe what is done to make parents from diverse backgrounds feel welcome in the school and classroom.
    a. Which strategies do you feel have been most effective?
    b. Which strategies have been least effective?
28. When do you invite parental input into school and network decisions, if at all? If yes, please give some examples.
29. Do parents receive professional development in this area? What about network office staff and school-level staff?

Community building

30. How do you foster a sense of community among students from diverse backgrounds, many of whom live in separate neighborhoods? Please give examples of what has been most effective.
31. Who is primarily responsible for determining what strategies and activities to implement to build community?
    a. What is the role of network staff?
    b. To what extent are individual schools involved in building community within their own schools?

32. What are the challenges to building community across your network?
33. What are the challenges to building community in your school?
34. Have you noticed any positive changes in school discipline or in staff retention, for example, as a result of your community building efforts?
35. Do network office staff or school staff receive professional development in how to build community?

Staff recruitment & hiring

36. Who is involved in the hiring process for new staff? What are the responsibilities of the network office? What is the role of individual schools in the hiring process?
37. What qualities are you looking for when hiring a new teacher?
38. What qualities are you looking for when hiring a new administrator?
39. What qualities are you looking for when hiring new home office staff?
40. To what extent does a candidate's SES background or race/ ethnicity figure into your hiring decision?
    a. To what extent do these matter: From the neighborhood? Grew up in poverty? Work experience with students of different backgrounds?
41. Are there any challenges to recruiting a diverse team of teachers and staff members? If yes, what are they?
    a. How do you maintain a diverse team?

Professional development

42. What is the primary focus of professional development for staff and teachers?
43. How was this determined — who was involved?
44. How effective is your staff at serving students from diverse backgrounds? Please provide some examples of how they demonstrate this effectiveness.
45. What challenges do your staff face when trying to serve students from diverse backgrounds?
46. Are there any specific professional development activities that you've used to help ameliorate these difficulties?
47. Do you provide professional development (PD) for school staff/ do you participate in professional development to learn strategies about how best to integrate students during the school day?
48. Do you provide regular feedback to teachers and school staff about how they are meeting or not meeting the needs of students from diverse backgrounds?
49. How do you gauge if an integration strategy is having its intended effect?

Student discipline

50. How do you characterize your school's discipline practices? Can you give us some examples?
51. Are you aware of differences in discipline incidences among SES and/or racial/ethnic groups?
52. Do you have any strategies or policies designed to mitigate discipline disparities? Please give examples.
    a. How do you gauge if they are working?
53. What strategies or policies do teachers employ in the classroom to mitigate discipline disparities?
    a. Have they been effective?
    b. How could they be improved?

Curriculum & instruction

54. To what extent do you encourage school leaders and/ or teachers to use pedagogies that integrate of students from diverse backgrounds?
55. How did you develop the curriculum at your school? Did you import it? Did you create it from scratch?
    a. What was most important in your considerations?
    b. Who was involved in developing the curriculum?
56. How often is the curriculum reviewed to ensure that it is meeting students learning needs and inclusive of the school's diversity?
57. What role do teachers play in shaping the curriculum and determining instructional practices?
58. What are the strengths of the curriculum with respect to serving a diverse student population? Please provide examples.
59. How would you characterize the instructional approach you have chosen? E.g., differentiated instruction?
60. Are there any other program supports your schools have in place to support students from diverse backgrounds?

Rules & regulations

61. What public laws and regulations (federal, state, local policies) facilitate your CMO's ability to achieve your integration goals?
62. What public laws and regulations pose impediments or are not supportive of your integration goals?
63. Can you briefly touch on the role of the district and district leaders in fostering school integration? To what extent is district leadership important?

Strategy (ask head of CMO/independent charter schools; optional for others)

64. Can you tell us about the long-term strategy for your CMO/school?
65. What are the biggest challenges that you foresee?

Wrap-up

66. Is there something I should have asked you related to understanding the policies and practices of your DBD charter school but didn't?

THE INTERSECTION OF LEARNING AND WORK: AN EXAMINATION OF AN OREGON ADMINISTRATIVE LICENSE PROGRAM

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Abstract: The intersection of work and learning does not occur without careful forethought and planning in professional development programmes or professional certifications. Although public school administrators in Oregon are required to hold an active administrator license (AL), the state's educator licensing agency provides no specific guidelines for this certification. Rather, institutions offering ALs set their own coursework, assessments, and competencies for this professional training intended to advance practitioner-oriented learning about how to engage in the effective organisation and management of schools and school systems. This mixed methods study examines the intersection of learning and work in an Oregon AL program. Themes uncovered include the sense that coursework is largely disconnected from the reality of the workplace and that students are primarily motivated by professional advancement rather than intellectual growth. We end by offering implications to increase the intersection of learning and work.

Keywords: adult learning, intersection of learning and work, mixed methods, andragogy

Introduction

Mulcahy (2011) posits that "far from being disjunctive domains, work and learning are intricately interrelated" (p. 204), further arguing that "the worlds of work and learning tend to be conceived as disjunctive domains of knowledge (theory, words) and experience (practice, things) that require linkage through practices of transfer integration and boundary crossing" (p. 206). This intersection of work and learning does not occur without careful forethought and planning, though, in professional development programmes or professional certifications. Prior research has found that learning at work is facilitated by social interactions that apply concepts to lived experiences (Chisholm, Larson & Mossoux, 2004; Van Dellen & Yurtmaz; 2017). As Van Dellen (2018) notes, "Essential learning (in our case for work) may be on the one hand something very personal — even individualistic and psychological — and on the other at the very same time also something very context-related (sociocultural)" (p. 12). Linking learning and work involves transformative learning processes that enable learners to become agents of learning whereby they negotiate and act upon their own purposes, values, feelings and meanings, both internally and externally driven (Jarvis, 2009; Mezirow 2000; Stetsenko; 2017). Transformative learning occurs when cognition, emotional experiences, and applicable contexts change information into new patterns of meaning, understanding, and valuing (Damasio, 1994).

Van Dellen (2018) argues that "Learning for work is never something simple, as is often suggested by policymakers and human resource practitioners and advisors. 'Just learn and behave.' Learning for work is complex because it does have not only one but two contexts. Moreover, the work context sometimes seems to be dominant over the personal life context" (p.18). Van Dellen (2018) concludes that "transformative learning for work happens only in the curve between enough autonomy ... and enough connectedness ... [and] requires a great deal of scaffolding" (p. 21). We examine whether the curve between autonomy and connectedness is present in an administrative licensure program in Oregon. Before presenting our findings, we provide some context for the study and describe the framework that informs our data collection and analysis.

Oregon context

Public school administrators in Oregon are required to hold an active administrator license (AL). The Teacher Standards and Practices Commission (TSPC), the State's educator licensing body, requires that students earn credits in the following standards: visionary leadership; instructional improvement; effective management; inclusive practice; ethical leadership; socio-political context; and practicum experience. Beyond these broad standards, there are no specific course requirements for this professional certification intended to advance practitioner-oriented learning about how to create, implement, and evaluate education reforms and engage in the effective organisation and management of schools and school systems. Institutions offering an AL program establish their own coursework, assessments, and competencies. This lack of direction in State policy may result in programmes that do not necessarily meet the demands of administrators' jobs, and as such, represent disconnects between policy, professional development, and the practice of educational leadership.

In order to investigate the alignment between TSPC requirements in Oregon and the professional development coursework experience AL students enrolled in University of Oregon's AL programmes, we employed the lens of Knowles's (1980) andragogy framework to examine their perceptions of their learning experiences. Using a mixed-methods approach to examine the intersection of learning and work, the following research questions guided the study:

1. To what extent do administrators in a license program perceive an intersection of learning and work?
2. How do program requirements meet the needs of adult learners?
3. How could adult learning theory be used to improve administrative license programmes?

Conceptual framework

We used Malcolm Knowles's (1980) concept of andragogy as the conceptual framework to explore the intersection of learning and work, examining how practicing school administrators describe their learning in an administrative license program from an adult learning perspective. Andragogy as defined by Knowles (1980) is the art and science of helping adults learn. Knowles's concept of andragogy is the best-known framework of adult learning — differentiated from pedagogy which focuses on how children learn — and has been used for nearly forty years (Merriam, Caffarella & Baumgartner, 2007).

According to Knowles (1980), the learning needs of adults differ from those of children, and the field of adult education should be defined separately from other areas of education. Andragogy is regarded as learner-focused while pedagogy is more teacher-focused. Merriam (2001) notes, "Knowles proposed a program-planning model for designing, implementing, and evaluating educational experiences with adults" (p. 5). McGrath (2009) credited Knowles's andragogy as the most learner-centered method in adult education. Knowles's andragogy includes six principles that address the unique needs of adult learners and eight design elements (Knowles, Holton & Swanson, 2015; Holton & Bates 2010): The six principles of andragogy are:

1. Need to know: The extent to which the learning experience is perceived to occur at the right time in a learner's life to meet current changes or challenges.
2. Self-directed learning: The extent to which individuals feel responsible for setting learning goals, controlling the learning process, and making decisions about the learning effort.
3. Prior experience: The degree to which the learning experience builds on a learner's prior experience as a source of learning.
4. Readiness tolearn: The degree to which the learning experience is perceived to address real life or work needs.

5. Orientation to learning: The degree to which the learning experience is perceived to be task or problem-centered.
6. Intrinsic motivation to learn: The degree to which learners are motivated to learn by internal fulfillment or enjoyment that accompanies a broadening of knowledge or skills.

In addition to the six principles of andragogy, Knowles (1980) posited that authentic, effective learning experiences for adults would attend to the following eight andragogy design elements:

1. Prepare the learner: The degree to which the learner is engaged in preparing for the learning.
2. Climate setting: The perception that the learning climate is supportive and fully collaborative.
3. Mutual planning: The degree to which one is a full partner with other learners and the instructor in planning.
4. Diagnosis of learning needs: Opportunities for the learner to diagnose development/learning needs.
5. Setting of objectives: The extent to which learners are able to take part in meaningful input or collaboration for setting objectives for learning.
6. Design of the learning experience: The degree to which activities are collaboratively designed/adapted to individuals.
7. Learning activities: The extent to which there is a utilization of a variety of methods encouraging engagement and solutions.
8. Evaluation: The extent to which evaluation methods are appropriate and meet the learner's needs.

The six principles and eight design elements of andragogy served as a lens for examining administrator perspectives regarding the intersection of learning and work in their AL program; study findings were analysed and interpreted through these principles.

Study methods

To answer the above research questions, we employed a mixed-methods approach (Johnson & Onwuegbuzie, 2004) to examine the experiences and perceptions of AL students enrolled in continuing education credits at the University of Oregon. In order to capture a comprehensive sense of the intersection of learning and work, we employed a sequential inquiry method: focus groups with current AL students followed by a survey.

All 222 current AL students were invited via email to participate in the study. Twenty students volunteered to participate in the focus groups. Although several follow-up emails were sent, not all AL students check their university email when not enrolled in a program course, limiting the response rate and generalizability of findings. After the focus groups were completed, we again emailed all currently enrolled AL students, requesting participation on the survey. Seventy students participated, for a response rate of 31.5 percent. Some respondents skipped certain items, and as such our complete listwise N was 54 respondents.

Focus groups

Eight focus groups were conducted, with two to four participants per group for a total of 20 participants. The focus groups followed a semi-structured protocol (Miles, Huberman & Saldaña, 2013) developed by our research team and lasting approximately 60 minutes. Questions were informed by the six andragogic assumptions, with the intent to capture a macro-level view of student experiences and reflections on their learning, focused not on individual course structures or instructors, but the program at large. A copy of the instrument is included in Appendix A. During the focus groups, conducted via an online meeting platform to accommodate the dispersed nature of students in the program who live and work across the

state, one research team member led the data collection by asking questions and related probes, while the other two team members took verbatim notes; focus groups were recorded for accuracy.

Survey

After the focus groups, we utilised the Andragogy in Practice Inventory (API) Version 3 (Holton & Bates, 2010) survey instrument to a) capture a sense of generalizability of the focus group findings to a broader range of students, and b) quantitatively measure the perceptions of students. The API was utilised to evaluate the extent to which participants felt andragogic principles and design elements were present in their license coursework. The revised API is a 60-item survey instrument that consists of a series of questions that are rated on a five-point Likert scale with 1 being strongly disagree and 5 being strongly agree. Previous research has found the API to meet sufficient validity and reliability thresholds in both domestic contexts (Leigh, Whitted & Hamilton, 2015) as well as international (Park, Robinson & Bates, 2016).

The 60 items map onto 14 domains, with six domains capturing the degree to which the respondent felt the principles of andragogy (e.g., orientation to learning, intrinsic motivation to learn) were part of the learning experience, and eight capturing the degree to which the andragogic design elements were perceived as present in the construction and execution of the learning experience. With our sample, internal reliability values for the 14 domains ranged from Cronbach Alpha values of .70 (prior experience) to 0.95 (intrinsic motivation to learn), all above the recommended Cronbach's Alpha of > .70.

We emailed our raw survey data to the developers of the API Version 3 (Holton & Bates, 2010) for the preliminary analyses, receiving domain-specific means and Cronbach Alpha values in return.

Data were analysed sequentially, with findings from the focus groups informing the survey (two additional questions were added to the survey to capture ideas that emerged from the focus groups), followed by analysis of the survey data. The qualitative data from the focus groups were coded deductively (Miles, Huberman & Saldaña, 2013), with a codebook informed by the six andragogy assumptions (Knowles, 1980), as well as a positive or negative subject orientation. Survey responses were analysed for descriptive results, looking for patterns of response to support or challenge the qualitative findings.

Results

Study findings indicate that participants feel the administrator license (AL) coursework is overall fairly disconnected from the demands of the workplace, limiting actualization of autonomy, mastery, and purpose. Table 1 highlights the common enablers and hindrances mentioned by study participants, organised by andragogy assumption, described below. Survey items were aligned with the andragogy assumptions.

Table 1 Andragogy assumptions enablers and hindrances

Andragogy assumption	Enablers	Hindrances
Need to know	• Opportunities for deep learning increase effectiveness	• Focus on writing mechanics over capacity-building • Disconnect between class and work, instructors not in the field
Self-directed learning	• Opportunities to determine course content and/or projects	• Predetermined course topics • Inflexible credit options
Prior experience	• Courses incorporate students' expertise	• Some courses include masters, doctoral students • Mix of new and veteran administrators
Readiness to learn	• Overlap with course content and work issues	• Future applicability unclear • Little discretion in course selection • Limited opportunities to address pressing problems of practice
Orientation to learning	• Build network of colleagues • Pragmatic tools and practical learning options	• Theory focus • Limited urgency • Internal motivation • Compliance mentality
Intrinsic motivation to learn	• Love or lifelong learning • Clear applicability to job	• External motivation to keep job/license • No internal motivation when it feels like "just checking boxes"

Means and Cronbach Alpha values for each domain are shown in Table 2. The higher the mean score, the stronger the survey participants' perception that their licensure program coursework facilitated learning based on the principles of andragogy. As with the focus group responses, survey results indicate mixed feelings about the extent to which andragogic principles were evident in the implementation of the AL program. While some felt there were opportunities to link learning and work, the intersection could be stronger.

Table 2 Andragogy assumption survey results

Andragogy design element	N	Alpha	Mean	SD	Variance
Need to know	64	.86	3.77	.76	.57
Self-directed learning	63	.83	3.69	.70	.49
Prior experience	66	.70	4.22	.52	.27
Readiness to learn	65	.85	3.59	.75	.56
Orientation to learning	67	.89	4.01	.69	.47
Intrinsic motivation to learn	63	.95	4.20	.73	.53

Need to know

The need to know domain measures the degree to which the learner feels that the learning experience coincides with current needs. Survey findings indicated that this domain ranked 4th out of the 14 domains (*M*=3.77, *SD*=0.75), indicating moderate agreement. Despite the generally positive survey result around the need to know construct, focus group participants reported multiple disconnects between courses and work. These included requiring competencies without explanation of expected learning outcomes, more focus on writing ability than capacity-building, and course instructors who lacked field-based expertise. As one focus group participant noted, "In some classes, I'm learning a lot but it's not applicable to my work." In contrast, participants reported a recognition that the program provides an opportunity for deep learning for those who engage fully in learning opportunities and felt that the online platform for course delivery was convenient and supportive of students' professional responsibilities. As one participant noted, "I'll go above and beyond if it's going to be applicable, if the skills and tools are going to be directly applicable." This sentiment was more aligned with the survey results, suggesting dissatisfied participants may have been outliers.

Self-directed learning

The self-directed learning domain measures the degree to which learners feel they have voice and agency in the learning process. Survey findings indicated that this domain ranked 5th out of the 14 domains (M=3.69, SD=0.70), indicating moderate agreement. Focus group participants expressed a range of obstacles to self-directed learning, somewhat in contrast to the survey results. These included the desire to be able to select their own learning topics to ensure greater relevance to their work demands but reported that courses and topics were generally predetermined and inflexible, with no credit options for learning outside of the prescribed university courses. In addition, respondents reported that they needed to ask permission (which was not always granted) to self-direct their learning on course assignments. However, even when courses offered self-directed learning opportunities, findings revealed a deficit of power to handle workload was common, with students reporting a paucity of resources to offset the demands of work, school, and family obligations.

Prior experience

The prior experience domain measures the degree to which the learner feels that prior knowledge is being built upon. Survey findings indicated that this domain ranked highest out of the 14 domains (M=4.22, SD=0.52), indicating agreement that the AL program builds upon prior knowledge. However, focus group participants reported mixed experiences, noting that some courses recognize students' expertise as professionals in the field, but this is often minimized by a mix of students from other programmes (e.g., masters and doctoral students) in the same course as well as a blend of veteran and new administrators, limiting opportunities for peer-to-peer learning. As one focus group participant noted, "Sometimes in classes, I am the only veteran administrator, and the coursework is more directed to doctoral students who are not in the field or new administrators who are at a completely different time in their careers. My position and knowledge as an experienced administrator is not recognised, and I'm not learning from others who are in like-positions."

Readiness to learn

The readiness to learn domain measures the degree to which learners feel that work needs are addressed in their learning. Survey findings indicated that this domain ranked 6th out of the 14 domains, and lowest of the six andragogy assumptions (M=3.59, SD=0.75), indicating disagreement that the AL program addresses real life work concerns. However, not all focus group participants reported a lack of readiness to learn. One noted, "A discussion of gender-neutral bathrooms was very timely because it was a district-wide conversation that we were having, and two classmates were also in the district, so

we would be talking about it in the district and then go into class and talk about it and problem solve." Obstacles to readiness to learn included the sense that often coursework is seen as too theory-driven to be applicable, and course content lacks the urgency to address pressing issues.

Orientation to learning

The orientation to learning measures the degree to which the learner feels the learning experience is problem-centered. Survey findings indicated that this domain ranked 3rd out of the 14 domains (M=4.01, SD=0.69), indicating agreement that the AL program provided learning experiences centered on tasks and problems of practice. Participants noted an appreciation for the creation of a network of colleagues and identified some pragmatic tools and practical learning options offered in their courses. "When you are in one district, you have the sense that this is how we do things, but you don't know how they do it in another district." However, hindrances to orientation to learning included the limitation of taking a course when it is offered, not when it is needed. Respondents noted that not enough attention is given to the timing in a school year, with some assignments in the spring more applicable at the start of the school year, for example. There was a prevalent feeling expressed that course materials were "filed away" for later, with the hope that it eventually applies to work problems of practice.

Intrinsic motivation to learn

Finally, the intrinsic motivation to learn domain measures the degree to which the learner feels internally motivated to learn. Survey findings indicated that this domain ranked 2nd highest of the 14 domains (M=4.20, SD=0.73), indicating general agreement that the AL program provides internal fulfillment or enjoyment. However, focus group participants reported being generally extrinsically goal-oriented, reporting primarily feeling motivated to complete the license for professional advancement rather than intellectual growth. Some students reported activity-oriented motivation, choosing to enroll in the program with a cohort of peers from their school or district and appreciating the opportunity to work together on authentic problems of practice.

Eight andragogy design elements

Other survey items were aligned with each of the eight design elements of andragogy. The number of survey respondents, Cronbach Alpha values, means, standard deviations, and variance for each domain are shown in Table 3.

Table 3 Andragogy domain survey results

Andragogy design element	N	Alpha	Mean	SD	Variance
Prepare the learner	61	.73	3.5	.58	.33
Climate setting	58	.88	3.55	.70	.50
Mutual planning	59	.86	3.19	.81	.66
Diagnosis of learning needs	59	.89	3.08	.83	.69
Setting of objectives	59	.84	3.10	.70	.49
Design of the learning experience	59	.85	3.09	.79	.63
Learning activities	59	.73	3.55	.66	.44
Evaluation	59	.8	3.49	.74	.55

As above, the higher the mean score, the stronger the survey participants' perception that their licensure program coursework facilitated learning based on the principles of andragogy. Survey results indicate that our respondents held less favorable views with regard to the eight domains than the six andragogy assumptions. The mean response values for all eight domains regarding the design were lower than the mean response values for the principles, indicating that survey respondents were less likely to agree that the andragogy design domains were evident in the implementation of the AL program. Focus group findings (see Table 4) mirrored the survey results, identifying a range of obstacles limiting the intersection of learning and work. Findings related to each andragogy design element are described below.

Table 4 Focus group andragogy design elements

Andragogy design element	Focus group ideas
Prepare the learner	Ability to apply work problems to course assignments
	Avoiding the sense of doing busy work
Climate setting	Importance of instructors with experience in the field
	Opportunity to tap learners' knowledge and experience
Mutual planning	Need for material to feel relevant to work
	Value of opportunities to collaborate with peers
Diagnosis of learning needs	Learning activities matched to work task demands
	Skill-misalignment issues
	Assignments matched to zone of proximal development
Setting of objectives	Benefits of the specific over the general
	Need for nuance
Design of the learning experience	Importance of matching class material with professional interests
	Need to self-direct and internalize content
Learning activities	Discussions, small groups, sharing, and problem-solving over paper-writing
Evaluation	Completion of work doesn't always mean meaningful learning
	Value of informal learning opportunities

Prepare the learner

The prepared learner domain measures the degree to which the learner feels engaged in preparing for the learning. Survey findings indicated that this domain ranked 9th out of the 14 domains (M=3.54, SD=0.58), indicating disagreement that the AL program prepares the learners sufficiently. Focus group participants echoed this finding. As one focus group participant noted, "You should be able to bring your problem and make it the class." Another focus group participant reported, "I would much rather spend the time tackling a work problem … I get bitter at having to check a box since time is so valuable."

Climate Setting

The climate setting domain measures the learner's perception that the learning climate is supportive and fully collaborative. Survey findings indicated that this domain ranked 8th out of the 14 domains (M=3.55, SD=0.70), indicating some disagreement that the AL program provides a supportive, collaborative learning environment. Focus group participants reinforced this finding. As one focus group participant

noted, "The instructor has to have a pulse on the room and know their stuff." Another noted the value in learning "from someone actually doing the work," a sentiment echoed by another participant who opined, "When we are able to offer parts of ourselves, it's better. Sometimes in classes there's a quiet recognition that we already know what is being presented, so we'll keep quiet and check the boxes, but the depth of understanding of those in the course is amazing, untapped potential."

Mutual planning

The mutual planning domain measures the degree to which learners feel they are full partners with other learners and the instructor in planning. Survey findings indicated that this domain ranked 11th out of the 14 domains (M=3.19, SD=0.81), indicating that participants felt that they were not generally given the opportunity to be full partners in planning. Focus group participants' sentiment help explain this finding. As one focus group participant noted, "I felt like I was just doing the coursework; I wanted to make it relevant." Others had similar perspectives, noting, "The class didn't connect to anything I was doing at the time;" "We should be able to choose our own adventure." Value was found in implementation of the mutual planning domain when "by being able to work with colleagues, we have been able to complete assignments with a shared vision, shared context, and are able to apply our learning to current or upcoming district discussions."

Diagnosis of learning needs

The diagnosis of learning needs domain measures learners' perception of opportunities to diagnose development/learning needs. Survey findings indicated that this domain ranked at the very bottom of the 14 domains (M=3.08, SD=0.82), indicating a sentiment that the AL program lacked opportunities to diagnose learning needs. Focus group participants' comments supported this finding. As one focus group participant noted, "School Finance was not any part of my job; I wasn't involved; it didn't pertain to my day-to-day." Lack of relevance was coupled with skill-misalignment in some cases: "If my skills are past where the class information is, I downshift and don't put more time in than needed." Adult learners, especially education leaders, understand the value of assignments that target the zone of proximal development. As one focus group participant noted, "Knowing what I am deficient in and then having a menu of choices would be *most beneficial*."

Setting of objectives

The setting of objectives domain measures the extent to which learners feel they are able to take part in meaningful input or collaboration for setting objectives for learning. Survey findings indicated that this domain ranked 12th out of the 14 domains (M=3.10, SD=0.70), indicating a lack of meaningful input in learning objectives. Focus group participants supported this finding. As one focus group participant noted, "A lot of what we study in the program isn't designed for my current experiences. It's more general." Another noted, "Overall, the information was theoretically sound, but after three years in my position, I find that it lacked the dimension that my position requires."

Design of the learning experience

The design of the learning experience domain measures the degree to which activities are collaboratively designed/adapted to individuals. Survey findings indicated that this domain ranked 13th out of the 14 domains (M=3.09, SD=0.79), indicating limited collaboration in designing activities in the AL program. Focus group participants echoed this finding. As one focus group participant noted, "There is a gap between my interests and the prescribed [AL] courses. They are not personally interesting for me." In some classes, participants reported resorting to "creating my own project on my own time so I could internalize the material." In other cases, participants felt, "I have not had a chance to self-direct."

Learning activities

The learning activities domain measures the extent to which there is a utilization of a variety of methods encouraging engagement and solutions. Survey findings indicated that this domain ranked highest of the eight andragogy domains, but still less favorably than the six assumptions (M=3.55, SD= 0.66), indicating some agreement that the AL program uses a variety of teaching methods. Focus group participants reported a range of experiences related to this domain. As one focus group participant noted, "We need more opportunities to collaborate together ... it is essential to continued learning." Collaboration, enacted in different instructional design elements, is necessary, while other required assignments proved to be less useful, according to focus group participants. As one participant explained, "Discussions, small groups, sharing, and solving problems are all very helpful. Writing a 25—40 page paper is just more of a grind and least useful."

Evaluation

The evaluation domain measures the extent to which evaluation methods are appropriate and meet the learner's needs. Survey findings indicated that this domain ranked 10th out of the 14 domains (*M*=3.49, *SD*=0.74), indicating mixed feelings about the AL program's evaluation methods. Focus group participants had similarly mixed feelings. As one focus group participant noted, "If you don't get to choose the topic, and it's just a long paper, yes, we'll do it, but it isn't meaningful." Another noted, "It would be beneficial for TSPC [the State's licensing body] to recognize professional development in a district and link it to a University."

Implications

Findings offer implications for administrator license program revisions to increase the intersection of learning and work. First, AL programmes should emphasize problems of practice over theory acquisition. As one focus group respondent noted, "The theory pieces are one step removed, not as useful as hearing how different administrators are handling different situations."

Second, AL programmes should consider increasing the variety of course formats, resources, and assignments. As one respondent noted, "the math conference was a powerful experience where my head was exploding with all the new knowledge, being surrounded by people doing the same work, compared to a class where it's just jumping through hoops."

Finally, offering more options for self-directed learning would increase the intersection of learning and work. As one respondent noted, it would be beneficial if "the course starts as a blank slate and the students identify what they need to address and then that's what the course focuses on." Education professionals expanding their knowledge and skills through required license programmes have the potential to capitalize on the intersection of learning and work; program refinements can help achieve this goal.

References

Chisholm, L., Larson, A. & Mossoux, A.F. (2004). *Lifelong learning: Citizens' views in close up, findings from a dedicated Eurobarometer survey*. Luxembourg: Office for Official Publications of the European Communities.

Damasio, A. (1994). *Descartes' error: Emotion, reason and the human brain*. New York: Avon Books.

Holton, E.F. & Bates, R.A. (2010). Andragogy in practice inventory (version 3) [Instrument]. Unpublished instrument.

Jarvis, P. (2009). Learning to be a person in society. In K. Illeris (Ed.), *Contemporary theories of learning* (pp. 21—34). New York: Routledge.

Johnson, R.B. & Onwuegbuzie, A.J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational researcher*, 33(7), 14—26.

Knowles, M.S. (1980). *The modern practice of adult education: From pedagogy to andragogy* (Rev. and Updated Ed.). Wilton, Conn. Chicago: Association Press; Follet Pub. Co.

Knowles, M.S., Holton, E.F. & Swanson, R.A. (2015). *The adult learner: The definitive classic in adult education and human resource development* (8th ed.). New York, NY: Routledge.

Leigh, K., Whitted, K. & Hamilton, B. (2015). Integration of Andragogy into Preceptorship. *Journal of Adult Education*, 44(1), 9—17.

McGrath, V. (2009). Reviewing the evidence on how adult students learn: an examination of Knowles' model of andragogy. *Adult Learner: The Irish Journal of Adult and Community Education*, 99—110.

Merriam, S.B. (2001). Andragogy and self-directed learning: Pillars of adult learning theory. *New Directions for Adult and Continuing Education*, (89), 3—13.

Merriam, S., Caffarella, R.S. & Baumgartner, L. M. (2007). *Learning in adulthood: A comprehensive guide*. San Francisco, CA: Jossey-Bass.

Mezirow, J. (2000). Learning to think like an adult. In: Jack Mezirow & Associates (Eds.). *Learning as transformation: Critical perspectives on a theory in progress* (pp. 3—34). San Francisco: Jossey Bass.

Mulcahy, D. (2011). Between work and learning: on pedagogic practice and interstitial space. *Studies in Continuing Education*, 33(3), 2013—2017.

Miles, M.B., Huberman, A.M. & Saldana, J. (2013). *Qualitative data analysis*. Sage.

Park, S., Robinson, P. & Bates, R. (2016). Adult learning principles and processes and their relationships with learner satisfaction: Validation of the andragogy in practice inventory (API) in the Jordanian Context. *Adult Education Research Conference.* Available at: http://newprairiepress.org/aerc/2016/papers/28.

Van Dellen, T. & Yurtmaz, D. (2017). The experience of adult learning professionals work workplaces as learning space. In A. Ostendorf & C. K. Permpoonwiwat (Eds.), *Workplaces as learning spaces — conceptual and empirical insights* (pp. 55—84). Innsbruck: University Press.

Van Dellen, T. (2018). Learning for work from the past, in the present, and into the future? *Studia Paedagogica*, 23(2), 9—24.

Appendix A: Focus Group protocol

Internal motivation

Tell me about a time you experienced strong internal motivation while engaged in coursework.

Tell me about a time when external motivation drove you to complete coursework.

Need to know

How does the structure of the licensure program support your learning as an administrator?

What types of coursework or experiences support your learning best? [Prompts: project-based learning, research papers, presentations, field-based studies, tool/protocol/rubric-creation, in-person/distance, peer feedback, small group discussion, readings, guest lecturers, etc.]

Self-directed

Talk about a time you were able to direct your own learning.

Can you tell me about a time when you felt you were not directing your own learning?

Prior experiences

How does coursework make use of your accumulated professional experiences?

Readiness to learn

Can you give me an example of continuing education coursework that did integrate into your daily work as an administrator?

Can you provide an example of continuing education coursework that didn't integrate into your work as an administrator?

How often are educational experiences timed to actual tasks you need to complete at work?

Problem-centered

Tell me about a specific problem of practice coursework directly addressed?

Are there specific areas of need that are not addressed in your coursework?

Policy implications

What recommendations would you make to Teacher Standards and Practice Commission about policy changes to help increase relevance of licensure requirements?

TSPC requires you earn credits in the following standards: Visionary Leadership, Instructional Improvement, Effective Management, Inclusive practice, Ethical Leadership, Socio-Political Context, Practicum Experience

In what ways do you feel your program tries to meet those standards for professional learning?

Please reflect broadly on your experience in the program. Is there anything else you'd like to share?

Appendix B: API Survey

Please read each of the following statements and choose the number (1, 2, 3, 4 or 5) that most closely reflects your opinion of the learning experience you have just completed" to be this instead: "Please read each of the following statements and circle the number (1, 2, 3, 4, 5) that most closely reflects your opinion of the licensure program at the University of Oregon. **Please think about your experience in the U of O licensure program as a whole rather than specific courses or instructors.** There is no right or wrong answer. Your first impression or reaction is usually the most accurate.

1 - Strongly disagree		2 - Disagree		3 - Neither agree nor disagree		
4 - Agree		5 - Strongly agree				

1.	The things I learned will assist me in resolving a work or life problem.	1	2	3	4	5
2.	I learn because of the personal satisfaction it gives me.	1	2	3	4	5
3.	I felt my prior life and work experiences helped my learning.	1	2	3	4	5
4.	Mastery of this material will benefit my life or work.	1	2	3	4	5
5.	This learning experience will make a positive change in my life or work.	1	2	3	4	5
6.	I felt responsible for my own learning.	1	2	3	4	5
7.	We did things that illustrated how this learning could help me address real tasks or problems.	1	2	3	4	5
8.	I learn because of the inner fulfillment it provides.	1	2	3	4	5
9.	The knowledge gained in this learning experience can be immediately applied to my life or work.	1	2	3	4	5
10.	My life and work experiences were a regular part of the learning experience.	1	2	3	4	5
11.	The instructor helped me understand why the learning methods were right for me.	1	2	3	4	5
12.	I learn because of the pleasure of discovering new things that interest me.	1	2	3	4	5
13.	I needed this learning at this time in my life.	1	2	3	4	5
14.	I set my own goals for learning.	1	2	3	4	5
15.	The instructor explained how this learning would help me deal with changes in my life or work.	1	2	3	4	5
16.	I had control over what was learned.	1	2	3	4	5
17.	I felt my life and work experiences were a resource for this learning.	1	2	3	4	5
18.	Steps were taken to make clear how the learning would fit my needs.	1	2	3	4	5
19.	I learn for the enjoyment of broadening my knowledge and skills.	1	2	3	4	5
20.	This learning was necessary to help me meet the changes happening in my work or life.	1	2	3	4	5
21.	I had a role to play in my own learning.	1	2	3	4	5
22.	This learning helped me develop the knowledge and skills I need at this time.	1	2	3	4	5

23.	I made the decisions about how learning progressed.	1	2	3	4	5
24.	This learning was necessary for the challenges I face.	1	2	3	4	5
25.	Sufficient steps were taken to prepare me for the learning process.	1	2	3	4	5
26.	I had the opportunity to work with others to plan our learning.	1	2	3	4	5
27.	The way I was prepared for this learning experience gave me confidence I needed.	1	2	3	4	5
28.	The facilitator/instructor developed strong rapport with the learners.	1	2	3	4	5
29.	Before this learning experience, I was given exercises or activities that prepared me to learn.	1	2	3	4	5
30.	There was an adequate amount of dialogue with my facilitator/instructor regarding my learning needs.	1	2	3	4	5
31.	We shared responsibility for planning the learning process.	1	2	3	4	5
32.	The learning expectations were clear to me before this learning experience began.	1	2	3	4	5
33.	Learners were full partners with the facilitator/instructor in this learning experience.	1	2	3	4	5
34	I was helped to diagnose my learning needs.	1	2	3	4	5
35	The facilitator/instructor and I worked together to prepare me for this learning experience.	1	2	3	4	5
36	The way learner responsibilities were clarified was appropriate for this learning experience.	1	2	3	4	5
37	Learners and instructors cooperated in planning the learning.	1	2	3	4	5
38	The facilitator/instructor acted as a rich resource for my learning during this learning experience.	1	2	3	4	5
39	We collaborated in planning the learning/instruction.	1	2	3	4	5
40	The climate in this learning experience was collaborative.	1	2	3	4	5
41	I was helped to assess my weaknesses and identify my developmental needs.	1	2	3	4	5
42	I completed activities that helped me identify my learning needs.	1	2	3	4	5
43	The facilitator/instructor and the learners negotiated the learning objectives.	1	2	3	4	5
44	Learners were encouraged to set their own individual learning objectives.	1	2	3	4	5
45	Learners and the facilitator/instructor became partners in setting learning objectives.	1	2	3	4	5
46	There were mechanisms in place to collaboratively design which learning activities would be used.	1	2	3	4	5
47	The learners determined what learning objectives to pursue.	1	2	3	4	5

48	Many different kinds of activities were used to help learners explore and apply new knowledge or skills.	1	2	3	4	5
49	As a part of this learning experience, I did some analysis to figure out the best direction for my learning and development.	1	2	3	4	5
50	The instructor and I worked together to design learning activities that work for me.	1	2	3	4	5
51	Steps were taken to adapt the learning experience to my capabilities.	1	2	3	4	5
52	An effort was made to adjust the design of the learning to fit this situation.	1	2	3	4	5
53	The facilitator/instructor relied heavily on lecture.	1	2	3	4	5
54	The methods used to evaluate my learning in this learning experience were appropriate.	1	2	3	4	5
55	The learning methods kept me actively involved in the learning process.	1	2	3	4	5
56	Learners were encouraged to work together to make decisions about how learning would occur.	1	2	3	4	5
57	All of the learning activities required my full and active participation.	1	2	3	4	5
58	Evaluation methods used during this learning experience met my needs.	1	2	3	4	5
59	The learning activities required little action on my part.	1	2	3	4	5
60	Evaluation methods helped me diagnose my needs for further learning.	1	2	3	4	5
61	If offered, I would utilize alternative opportunities to earn some of my licensure credits, for example: conferences, personal research, workshops, or mentorships.	1	2	3	4	5
62	I think there should be more practicing professionals instructing my licensure courses.	1	2	3	4	5

63 Which program(s) were you enrolled in at U of O?

a. IAL/PreAL

b. CAL/ProAL

c. Both

64 What type of position do/did you hold while enrolled in your most recent administrative licensure program?

a. District level administrator

b. Building level administrator

c. TOSA/Teacher/Counselor

d. Other _____

65 How many years had you been in an administrative position when you began your licensure program? (0—3, 4—6, 7—10, 10+)

READINESS OF TEACHERS TO TEACH MATHEMATICS WITH TECHNOLOGY: A CASE STUDY OF A SCHOOL IN GAUTENG

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Abstract: The purpose of this study was to investigate the readiness of teachers in a selected high school in the Gauteng Province, to integrate mathematical technologies in the teaching of mathematics. One-on-one and focus group interviews were conducted to collect qualitative data to ascertain the available technology at the school, to determine teachers' orientations towards technology adoption and how, if at all, they used technology for mathematics teaching. One teacher was interviewed as an individual and three others participated in a focus group interview. Findings suggest that although the school was well resourced with information and communication technology (ICT) infrastructure, and teachers were positively disposed towards ICT use, they adopted the ICT tools mainly for mundane communication and administrative routines rather than for the teaching of mathematics. Teachers attested that although they understood the benefits of ICT, they did not have the technological, pedagogical and content knowledge (TPACK) to integrate it meaningfully into the teaching of mathematics. Individual isolated attempts to integrate technology were made, they were sporadic, largely teacher-centred, lacking technical support, and less learner-centred except possibly for the scientific calculator. Teachers also felt that parents were more concerned about whether or not their children passed high stakes assessments than anything else, hence teachers also viewed obsessing themselves with technology for teaching mathematics to be an unnecessary waste of time and misdirection of effort. The study recommends intensification of training that leads to immediate, meaningful, learner-centred applications in the classroom and the provision of onsite technical support services in order for teachers to be able to equip learners adequately with 21st-century skills necessary in the era of the Fourth Industrial Revolution. Mathematical problem solving with the new digital tools is one such repertoire of 21st-century skills.

Introduction and background

The integration of technology into the teaching and learning of mathematics is advocated globally for its potential benefits of enhancing conceptual understanding of difficult concepts, enabling active learning, construction of knowledge and negotiation of meaning, as well as affording learners an affective opportunity to enjoy learning mathematics. For example, Drijvers et al. (2016) posit that the use of technology allows for outsourcing of laborious calculations so that time saved can be used to focus on higher order thinking skills such as conceptual understanding, modelling, and problem solving which are critical Fourth Industrial Revolution and 21st-century skills. For Stols, Venter and Louw (2016) technology does not only provide visual representations but it also provides immediate feedback to the teacher and learners. The integration of technology into the classroom has also been considered to have the potential of enhancing learner autonomy by increasing learners' responsibility for their own learning (Chang, et al. 2015), increasing inquiry-based learning by giving learners the opportunity, not just to solve textbook - or teacher-driven problems, but also to pose and solve their own problems (Ndlovu et al., 2013). The latter potential resonates with Paulo Freire's (1970) advocacy for a problem-posing approach which he reckoned to be more liberating than a teacher dominated banking concept of pedagogy of the oppressed. To deny teachers and students the opportunity to teach and learn mathematics with technology is, therefore, an antithesis of critical pedagogy and the development of critical thinking skills reminiscent of 21st-century labour market requirements.

While on the one hand, some developing countries like South Africa have made significant progress in creating ICT policies and following them through by rolling out ICT infrastructure in schools, most of the infrastructure and resources remain largely misunderstood, underutilised and inadequately supported most notably because teachers lack the ICT skills to use the technologies and integrate them fully into the classroom. It is therefore imperative, not only for in-service education providers, but also teacher education institutions to rethink the technology readiness of both in-service and pre-service practitioners, more so as we sit at the threshold of the 4IR. It is irrational to have ICT lying idle in schools only because teachers in the field are not ready to use it or those graduating from university are unable to lead technology integration even in such gateway subjects as mathematics, the language and syntax by which most 4IR programming is written.

In its revised five-year strategic plan 2016—2020, South Africa's Department of Basic Education (DBE, 2016), for example, has elevated the integration of ICT into teaching and learning to a core part of the strategy. This is in line with the Education White Paper 7 (Government Gazette, 2004) which views e-Education as a lever to accelerate the achievement of national educational goals via effective combinations of pedagogy and teaching to connect learners and teachers. A related goal of the DBE strategy is to train teachers first, on how to use technology themselves and, second, how to use it in their teaching (DBE, 201:16). A cornerstone of the DBE strategy is to strengthen the teaching of the gateway subjects of science technology, engineering and mathematics (STEM) by improving schools' access to ICT resources. The delivery of the Curriculum and Assessment Policy Statement (CAPS) for Mathematics, in turn, encourages the use of ICT not just in the form of scientific calculators but also in any other available digital technologies to teach topics such as graphs of functions (DBE, 2011, p. 13), as an example. Regrettably, even from its own investigation into the implementation of mathematics, science and technology education, as contained in the Ministerial Committee Report (Government Gazette, 2013), the DBE concedes that while technology has permeated the economy, practicing teachers and subject advisors still lack digital literacy skills. The report further laments that technology is yet to become the norm even in teacher education programmes at universities. By 2013 only two provinces, Gauteng and the Western Cape, had instituted systematic training of teachers in ICT through the Sci-Bono Centre and the Khanya Project respectively. As a result universities, for their part, largely continue to produce teachers with gaps in basic computer skills while the DBE, for its part, continues to lack the capacity to upgrade teachers' digital literacy skills even in such economically advantaged provinces as Gauteng where there has been an elaborate rollout of ICT infrastructure to schools. It is an indictment that many subject advisors are neither qualified for the subjects that they supervise nor are they appropriately skilled in the use of technology as a teaching and learning resource (DBE, 2013:24).

These shortcomings in teachers (and teacher support personnel) are consistent with international findings. With reference to the integration of graphing calculators, for example, Kastberg and Leatham (2005) caution that mere access to technology without the necessary knowledge of related curriculum materials does not entice teachers to incorporate that technology into their classroom instruction. This evinces a disjuncture between curriculum materials and the goals of technology integration. With reference to digital technologies, Niess et al. (2009) decry the fact that teachers' pedagogical content lacks a solid and consistent integration of modern digital technologies in the mathematics curriculum and instruction to a degree that extremely useful technologies such as dynamic geometry software (e.g. GeoGebra, Geometer's Sketchpad, Cabri, Autograph, Desmos, etc.), or advanced graphing calculators with computer algebra systems (CAS) are primarily used for providing examples where students mimic the actions and use the technologies for verification, demonstration, drill and practice. This is as opposed to higher order uses of investigation, conjecture and discovery. They affirm that while digital tools have evolved, strategies for their effective integration into mathematics teaching have not kept pace. This disconnect affirms the slow pace of adaptation even in developed countries like the USA where these digital tools are omnipresent. In the South African context, even in schools

where computers, laptops and tablets are available to teachers, their main use remains anchored on administrative work and assessment mark processing routines.

Theoretical perspectives

As new digital tools became available the focus of educational research shifted towards how these tools, in an increasingly techno-savvy society, could be harnesed to enhance teaching and learning of subject matter content in the classroom in much the same way that Shulman (1986; 1987) grappled with pedagogical content knowledge (PCK) as a blending of content and pedagogy. The traditional didactic triangle of teacher-student-content was recast as a didactic quadrangle (e.g. Ndlovu, 2004) when prospects of computer mediated-learning loomed larger and larger.

In the sustained pursuit of theoretical frameworks to adequately explain the didactical relationships in a digitally enhanced classroom, Mishra and Koehler (2006) extended Shulman's concept of PCK and proposed the technological pedagogical content knowledge (TPCK) model of teacher knowledge. TPCK was later grammatically modified to technological, pedagogical and content knowledge (TPACK) (e.g. Koehler & Mishra, 2009). Notwithstanding that modification, both acronyms continue to be used interchangeably in the literature (e.g. Niess). Whereas PCK has predominantly been portrayed as an amalgam of pedagogical knowledge and content knowledge, TPACK has analogously been described as the blending of three distinctive bodies of teacher knowledge: technological knowledge, pedagogical knowledge and (subject) content knowledge. Mishra and Koehler (2006) posit that the relationships between content (the actual subject matter that is to be taught and learned), pedagogy (the process and practice or methods of teaching and learning), and technology (both commonplace, like chalkboards, and advanced, such as digital computers) are complex and nuanced. Figure 1 shows the connections, interactions, affordances and constraints among the three domains of content, pedagogy and technology.

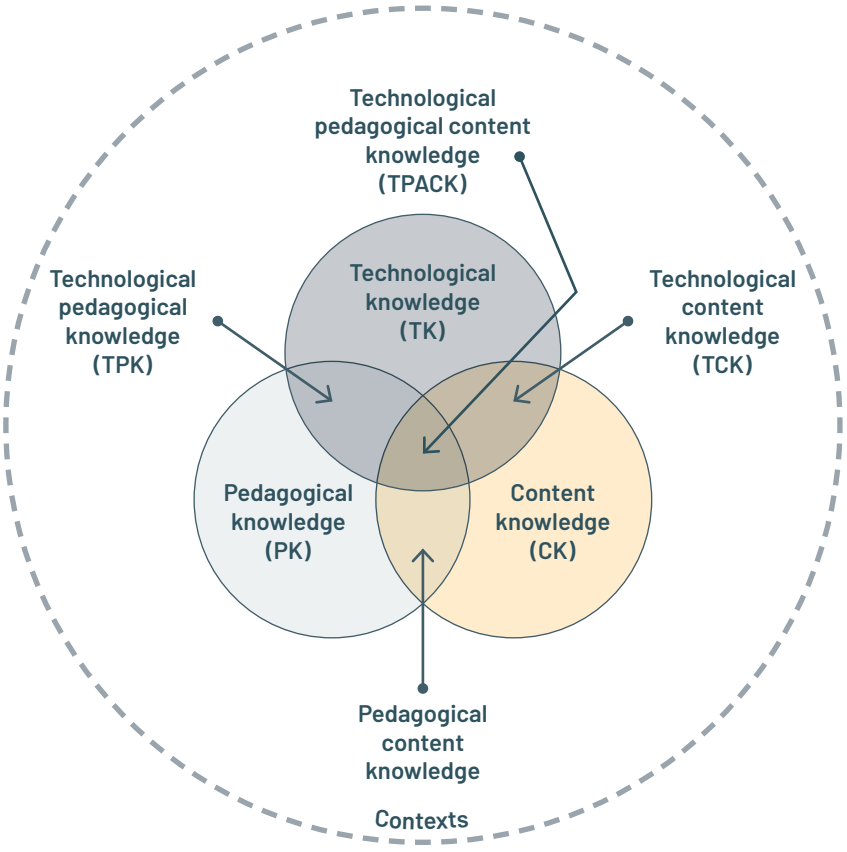

Figure 1: The TPACK framework and its knowledge components (adapted from Koehler & Mishra, 2009:3)

Technology knowledge (TK) is considered to be more dynamic than the other two core knowledge domains in TPACK, given the dynamic character of technology. Technology knowledge therefore goes beyond computer competency or literacy in the sense that persons must understand ICT broadly enough to apply it productively and fluently (Koehler & Mishra, 2009). In other words, it refers not just to digital literacy but to digital fluency. Koehler and Mishra (2009) further define technological content knowledge (TCK) to be an understanding in which technology and content influence and constrain each other when attempting to construct representations of concepts. Teachers thus need to understand which specific technologies are best suited for representing concepts in specific mathematics topics. This is comparable to TCK fluency. For example, dynamic mathematics technology may be excellent in representing functions and their graphs, calculus concepts such as the derivative (e.g. Ndlovu, 2008), geometric or function transfromations and circle theorems (e.g. Pfeiffer, 2017), but less suitable for representing sequencies and series. Technological pedagogical knowledge (TPK) on the other hand speaks to an understanding of how teaching and learning can change when particular technologies are used in particular ways (Koehler & Mishra, 2009). It includes knowing the pedagogical affordances and constraints of a mix of technological tools as they relate to representations of mathematics concepts and ways of arranging them in the classroom. This resonates with Trouche's (2004) theory of instrumental genesis (TIG). How teachers transition from PCK to TPACK, is the question that the next section attempts to answer.

Development of mathematics teachers' TPACK

In proposing TPACK standards for teachers in the US, Niess et al. (2009) refer to a five-stage model for an integrated development of teachers' TPACK as indicated in figure 2 below.

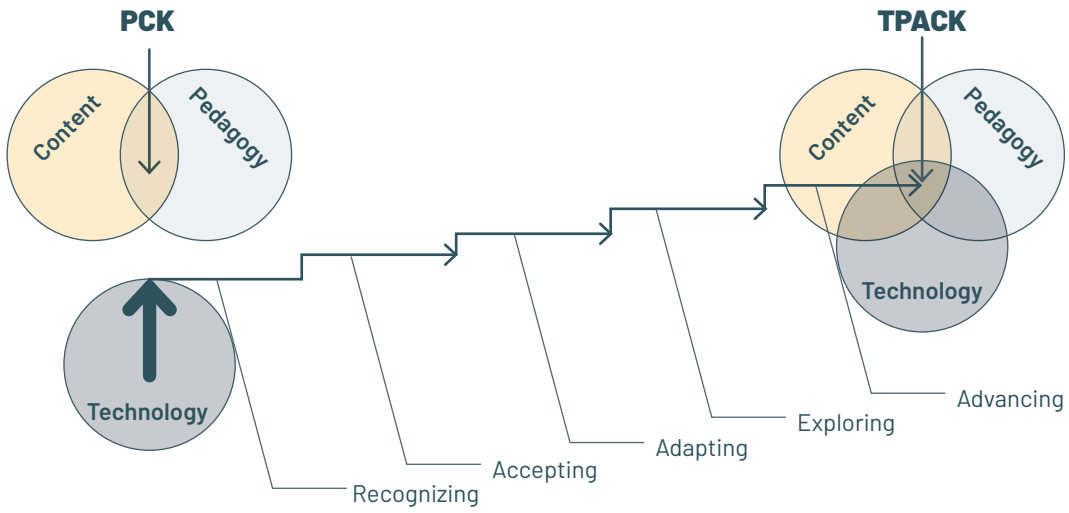

Figure 2: Teacher levels of development from PCK to TPACK (Niess et al., 2009)

The five stages identified when learning to integrate a particular technology for teaching and learning mathematics are as follows:

"1. Recognizing (knowledge), where teachers are able to use the technology and recognize the alignment of the technology with mathematics curriculum content yet do not integrate the technology in the teaching and learning of mathematics.
2. Accepting (persuasion), where teachers form a favorable or unfavorable attitude toward teaching and learning mathematics with an appropriate technology.
3. Adapting (decision), where teachers engage in activities that lead to a choice to adopt or reject teaching and learning mathematics with an appropriate technology.

4. Exploring (implementation), where teachers actively integrate teaching and learning of mathematics with an appropriate technology.
5. Advancing (confirmation), where teachers evaluate the results of the decision to integrate teaching and learning mathematics with an appropriate technology" (p. 9).

These developmental stages from PCK to TPACK, in combination with TIG provide us with conceptual tools with which to describe and characterise teacher readiness to integrate technology in the teaching and learning of mathematics in this study, whose research questions follow.

Research questions

The main purposes of the study was to establish the extent of teacher readiness to integrate appropriate ICT for the teaching and learning of mathematics, and to determine their TPACK needs for the effective integration of ICT in their mathematics classrooms. The main research question that guided the study was: What is the readiness of teachers at a well-resourced urban school in the Gauteng Province of South Africa regarding the integration of ICT into the teaching of mathematics?

The following sub-questions will contribute to answering the main question:

a) What ICT tools for teaching mathematics are available at the selected school?

b) What are teachers' orientations towards using ICT tools to teach mathematics?

c) To what extent are available digital technologies being integrated to teach mathematics?

d) What obstacles do teachers face when attempting to integrate technology?

Research methodology

In this study we adopted a qualitative intepretitive approach to understand the state of teacher readiness from the perspective of the participants. The Afrikaans-medium school was purposefully selected for being fairly well resourced, accessible and well known to the second author as a practitioner there. Four teachers took part in the study with the first of them participating in a one-on-one interview and the remaining three participating in a focus group interview. Qualitative data were collected in the form of descriptions of available technology at the school, self-reported teacher orientations/attitudes/beliefs towards ICT integration and the self-reported extent of integration into their mathematics classroom practices. Interview data were subjected to content analysis and emergent themes identified.

Results from in-depth interview with Teacher 1

Teacher 1 (T1) was a high school mathematics teacher aged 55 and with 25 years' teaching experience. She held a BEd degree (in media studies) as her highest teaching qualification. Below is a summary of how the interview unfolded with second author acting in the role of Interviewer (I).

Regarding her attitude towards technology Teacher 1 (T1) was very positive and keen to learn about and apply technology in her classroom as she saw many advantages in using technology (recognition & acceptance). She felt confident with technology in general (adapting) and rated her technological competence (TK) at 6 on a scale of 1 to 10. The teacher could hardly think of any disadvantages. Rather she listed some general advantages such as saving time, professional presentation and adapting and reusing previous work (generic use). She was of the view that it would be easy for her to learn a new mathematics teaching programme (positive self-efficacy belief) "... I don't think it would be too difficult, because ... I had to teach myself within two or three weeks to type a question paper ..." She justified her belief by adding that if someone could teach her how to use such a programme she would learn it quickly (adapting).

T1 explained that she used technology often for work, mostly for administration, communication and lesson preparation to type worksheets, notes and assessments. She was confident mostly with MS

Word, and some Excel, WhatsApp, emails and YouTube (c.f. Drijvers et al.'s 2013 general communication technologies). Although she saw the use of ICT in making her job easier, she did not really see much use for mathematics teaching specifically. She remarked that ICT doesn't really have as much a place in mathematics as in other subjects (pre-recongnition stage for mathematics teaching?). She, however, admitted that she would use technology in topics such as statistics and geometry for demonstration purposes (techno-demo & adapting stage?) and support in terms of drawing axes quickly and neatly (technical-demo/technical-support). She also described a video she showed grade 8 learners on how to draw a pie chart with a protractor (technical-demo).

Her teaching strategy (instrumental orchestration practice) was predominantly of showing the learners how to do something, and then letting them practice it (techno-demo, surface usage). She did not mention experiential learning (explorative use), individual assistance and real-life applications (problem solving) that can be accessed with the help of technology. Save for spreadsheets, her technological knowledge for mathematics teaching seemed to lag behind as she was unaware that there are programmes like dynamic geometry systems (DGSs) for mathematics teaching and learning. When asked if she knew about any programmes specifically designed for mathematics, she replied: "No, I have never really used such a programme even though I have once heard a colleague mention GeoGebra before". She was only able to describe an annual training day at her school during which there would be one or two applications demonstrated, such as making a form or quiz on Office. However, the suggestions seldom became a fixed feature because of lack of use, or as a result of struggling initially and then giving up.

According to T1, although her school encouraged/expected technology integration and provided the hardware and connectivity for it, there was nobody to provide technical support with mathematics applications specifically (TCK & TPK lacking). When asked the reasons why it was expected of teachers to use more technology in lesson presentation, she said it was to keep their attention, and could not think of any other reasons to use technology more. This demonstrated the lack of awareness of T1 (and perhaps many other teachers at the school as well), about the range of advantages (e.g. creating higher order thinking skills such as problem solving, modelling, reasoning and proving alluded to by Niess et al. 2009). T1 thought it would be more beneficial to have a support person, a user manual, training and perhaps a centre one can go to learn and become competent and proficient in ICT uses in mathematics. She also identified time as a major constraint and said that teachers don't have time to spend on learning and trying new things (resitance to change?). Another suggestion was that the Department of Basic Education (DBE) should develop and introduce programmes for schools to use.

Results from focus group interview with three teachers (T2-4)

I: How do you feel about technology use in the classroom generally?

T4: *I don't use it a lot*, I can project via my laptop, PowerPoints and such, but because I teach mathematics, *I prefer not to use a finished product* typed and finished to show on the screen, rather to half *expose it step by step*. … *I prefer to write on the board*. Or on a *webcam* where you *write on paper and it gets reflected* on the board.

T3: I received those solutions you sent (speaking to T4) and used them the first day or two then I stopped … always found that step by step works very well because *there is communication* the whole time as you reveal it … unfortunately it takes quite a lot more time … *the overhead projector* (OHP) was … very nice because it saves me from *writing myself to death* on the board … *I don't use it for maths*.

T2: I obviously use OHP a lot because I have a *webcam* to project the question on the board … then I do the sum on the board … which is nice. But … where one has less time … you show them step by step the finished solution quickly. … then one uses … Autograph, to explain graphs …

T3: But, with physical sciences, our textbook publisher sells … *PowerPoints* that duplicate of the solutions. If it was in reality PowerPoints in maths, it would have been more useful. It's about the conversation about *why does this term look like this?*

T4: And the *thinking process*.

T3: Sometimes I *solve it wrongly*, and they see it's wrong then a conversation follows.

I: Is it necessary to integrate technology into mathematics education? Why, or why not?

T3: My daughter is also a maths teacher, she broke her foot … and *taught with* her *iPad* that she … wrote with a special pen and projected on the board . You *aren't bound to a position*, in class but it also *restricts your space*. With the board you can have two boards next to each other (TK).

I: What do you think of ICT use?

T2: ICT is necessary, one can't just *chalk and talk* anymore … you need other things.

T4: The kids need exposure to different visual apparatus [like] … a video clip, even after presenting the lesson. You can use a *YouTube* video to practically demonstrate population growth, for example, it *intrigues* learners and makes them *more interested*.

P3: And it is another form of learning.

T4: The advantage is that you can save your lesson on the computer and if a learner is absent you can *email it* to her. But this technology is expensive, it costs the department R8000 but is not yet installed ..so we sit with the technology and we also have a *support system problem*.

T2: We aren't sweet 16s anymore, it's *easier for younger people* to engage with technology, while we *older people struggle* more …

T3: Yes, but it's not that one isn't willing, maybe we haven't been with it for long.

T4: Exactly, that's why I say we *need a good support system* … that we can rely on to *install new equipment* quickly.

T3: But it was so with the *Interactive Whiteboard* as well, *only one teacher used it*.

T4: There was also *only one bought*, … then they said we *go to that venue*…and packing our books and *moving to the venue wasted time so no one used it*.

T4: But I do see, when we mark at *other schools*, it is standard to have equipment such such as a projector, a computer, a printer… interactive whiteboard.

T2: Old software, yes, for example, I do have *Geometer's Sketchpad*, but I *don't use it* because I *don't really know how it works*.

T3: Nowadays you even get *calculators that can show you the graph*…

Discussion of results

Discussion of interview results

To answer the first research quesiton about available technology, it can be deduced from the interview excerpts that the following digital tools were available for teacher use: compter hardware with Microsoft Office packages (MSWord, Excel, etc.) as well as WiFi connectivity. To answer the second research question about teacher orientations of ICT use, it can be deduced that the teacher had a positive disposition towards technology. However, with regard to usage she attested to using computers mainly for word processing purposes and ocassional spreadsheet use for administration purposes. She was thus partially at the recognition stage of Niess et al.'s developmental continuum but could not align much of her mathematics teaching with the available technology. Although psychologically ready to use the available ICT, the teacher could be adjudged to be a long way towards ICT integration in her

mathematics classroom. Athough she knew some of the advantages (e.g. keeping learners engaged), she was not convinced about using it for teaching mathematics, nor confident in using ICT on her own. She testified to a need for additional technical support. Her own elementary uses were limited to teacher centred technical demonstrations. To answer the fourth research question about obstacles to ICT integration it can be deduced from T1's responses that a) there is is lack of technological knowledge (TK) about digital technologies that can be used for mathematics teaching and learning, b) there is lack of TPACK skills to integrate available technology to teach mathematics, due to lack of training and c) there is lack of technical support at her school.

Discussion of results from focus group interviews

In answer to the first research sub-question it can be deduced from the focus group interview transcript threads that the school has hardware such as laptops for teachers in sufficient numbers, overhead projectors (OHPs), webcams (still to be installed and in limited numbers) and interactive whiteboards (limited numbers). There is also WiFi connectivity (for YouTube videos) and *Sketchpad* software was installed in some computers. This corroborates findings from the interview but adds more to the list of digital tools available at the school. In answer to the second research sub-question about teacher orientations, there are mixed reactions from teachers. The participants acknowledge that ICT is necessary, the teacher can't just chalk and talk (line 26), and ICT motivates learners (line 29). However, in respect of the third research sub-question ICT is used mainly for communication purposes in the form of PowerPoint presentations, and not necessarily mathematics teaching. T4's response is an example of such use (line 2) which aligns with technical demonstration in a teacher-centred manner. T3 is forthright in her preference for the traditional step-by-step explanation on the chalkboard (line 4) but also accepts the use of a webcam where step-by-step explanations can be projected onto the board. This kind of use is also largely for general communication purposes alluded to by Drijvers et al. (2010) rather than specific to mathematics teaching and learning. Some more innovative teachers use downloadable software applications like Autograph (line 14) for graphing purposes, YouTube videos (line 28) to demonstrate exponential growth practially or interactive whiteboards (line 40). However, such teachers were few and far between. For example, only one teacher used the Interactive Whiteboard (line 40). In answer to the fourth research sub-question about obstacles, it can be deduced that a) older teachers struggle to integrate new technologies (e.g. in line 35 T2 complains that they are no longer sweet 16s, technology is better for younger people), b) the lack of technological knowledge to integrate ICT into mathematics teaching and learning (e.g. line 46), c) technology is expensive, so they can't have enough of webcams or interactive whiteboards in their classrooms (lines 32—33), they have to share, d) there was lack of TPACK, and e) there is no technical support provided (line 38).

Conclusion

From the data collected, it is clear that although the school was relatively well resourced, most of the teachers were not ready to use technology for the teaching of mathematics. From the indepth interview we see that although the teacher was willing to even teach herself how to use certain technology for teaching mathematics, she lacked the appropriate training/exposure to technology specific to the teaching of mathematics. Although she appreciated/accepted that technology could be used for the effective teaching of mathematics, she only used it for general communication as a demonstration tool. In other words, on the one hand she recognised the importance of ICT, but lacked the knowhow to use it for teaching mathematics. This compares with Drijvers et al.'s (2010) minimalist use of technology as a technical demonstration tool and compares favourably to Niess et al.'s (2009) developmental stages of a) recognition and b) accepting but did not reach the adoption stage (stage 3). From the focus group interview it was affirmed that only a few teachers could use mathematics specific technology such as

Geometer's Scketchpad, graphing calculators, etc. Most of the teachers in the focus group preferred the traditional step-by-step instruction to technology that shows complete (ready made) solutions to learners. The teachers also affirmed that they lacked the TPACK to use even downloadable technology such as GeoGebra and Autograph, or even already installed packages such as Excel and Geometer's Sketchpad, simply because they could not use them. The teachers reiterated the need for TPACK training that goes beyond workshops to hands on experience subsequently supported by onsite technical support. Some older teachers felt that they were not tech-savvy enough but believed that with some patience they still could learn. Time to utilise technology also appeared to be a challenge as curriculum coverage seemed to take priority in the light of high expectations of learners to perform well in the final examinations, with or without technology. Hence balancing the technology integration demands of the school with performance in high stakes examinations/assessments represented a conflict in priorities. In other words, teachers were stuck in the stages of recognising and accepting, and could not move to adapting, explorative, advanced level use of ICT in their mathematics classrooms.

References

Chang, H., Wang, C., Lee, M., Wu, H., Liang, J., Lee, W.Y., Chiou, G., Lo, H. Lin J., Hsu, C., Wu, Y., Chen S., Hwang, F. & Tsai, C. (2015). A review of features of technology-supported learning environments based on participants' perceptions. *Computers in Human Behavior*, 53, 223—237.

Department of Basic Education (DBE). (2011). *Curriculum and Assessment Policy Statements (CAPS) Further Education and Training Phase Mathematics*. Pretoria: Department of Basic Education.

DBE. (2013). The establishment of a Ministerial Committee to investigate the implementation of the mathematics, science and technology. *Government Gazette* Notice No. 36191.

DBE (2016). *Revised five-year strategic plan 2016—2020*. Pretoria: Department of Basic Education.

Drijvers, P., Doorman, M., Boon, P., Reed, H. & Gravemeijer, K. (2010). The teacher and the tool: instrumental orchestrations in the technology-rich mathematics classroom. *Educational Studies in Mathematics*, *75*(2), 213-234.

Drijvers, P., Sietske Tacoma, S., Besamusca, A., Doorman, M. & Boon, P. (2013). Digital resources inviting changes in mid-adopting teachers' practices and orchestrations. *ZDM The International Journal on Mathematics Education, 45*(7), 987—1001.

Drijvers, P., Ball, L., Barzel, B., Heid, M.K., Cao, Y., Maschietto, M. (2016). Uses of technology in lower secondary mathematics education: A concise topical survey. In *ICME-13 topical surveys* (pp. 1—34). New York, NY: Springer.

Freire (1970). *Pedagogy of the oppressed*. New York: Continuum.

Department of Education (2004). White Paper 7 on e-Education: Transforming Learning and Teaching through Information and CommunicationTechnologies (ICTs). *Government Gazettee*, Notice No. 26762.

Department of Basic Education (DBE) (2013) The Establishment of a Ministerial Committee to Investigate the Implementation of Mathhematics, Science and Technology. *Government Gazettee*, Notice No. 36191.

Department of Basic Education (DBE) (2013) *Investigation into the implementation of Maths, Science and Technology*. Pretoria: Ministerial Committee on the Implementation of Mathematics, Science and Technology.

Kastberg, S. & Leatham, K. (2005). Research on graphing calculators at the secondary level: Implications for mathematics teacher education. Contemporary Issues in Technology and Teacher Education, 5(1).

Koehler, M.J. & Mishra, P. (2009). What is technological pedagogical content knowledge? Contemporary Issues in Technology and Teacher Education, 9(1).

Mishra, P. & Koehler, M.J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record, 108(6), 1017—1054.

Ndlovu, M. (2004) An analysis of teacher competences in a problem-centred approach to dynamic geometry teaching. Unpublished MEd thesis. Pretoria: University of South Africa.

Ndlovu et al (2013) Ndlovu, M., Wessels, D. & De Villiers, M. (2013). Competencies in using Sketchpad in geometry teaching and learning: Experiences of preservice teachers. *African Journal of Research in Mathematics Science and Technology Education*. 17(3): 231—243.

Niess, M.L., Ronau, R.N., Shafer, K.G., Driskell, S.O., Harper, S.R., Johnston, C., Browning, C., Özgün-Koca, S.A. & Kersaint, G. (2009). Mathematics teacher TPACK standards and development model. *Contemp Issues Technol Teacher Educ*, 9(1):4—24.

Padayachee, K. (2017) A Snapshot Survey of ICT Integration in South African Schools, *South African Computer Journal*, 29, 2, 36—65.

Pfeiffer, C.R. (2017). A study of the development of mathematical knowledge in a geogebra-focused learning environment. Unpublishhed PhD dissertation. Stellenbosch: University of Stellenbosch.

Stols, G.H., Venter, S.J. & Louw, E.M. (2016). Faktore wat onderwysers se gebruik van GeoGebra vir Wiskundeonderrig beïnvloed. Suid-Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie, 35(1), a1366.

Trouche, L. (2004). Managing complexity of human/machine interactions in computerized learning environments: Guiding students' command process through instrumental orchestrations. *International Journal of Computers for Mathematical Learning*, 9, 281—307.

FOURTH INDUSTRIAL REVOLUTION: FEASIBLE FOR STUDENTS WITH DISABILITIES LEARNING IN HIGHER EDUCATION?

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Abstract: Students with disabilities in the South African higher education context have limited access to education broadly, and classroom learning, specifically. This is as a result of contextual and impairment-related disadvantages. Using specific tools drawn from Critical Disability Theory, the study analysed and synthesised the feasibility of the Fourth Industrial Revolution in empowering students with disabilities to engage in learning. Data were collected through scanning South African and international literature available on Google scholar, ProQuest, in books, journal articles, and online resources, on Fourth Industrial Revolution and how it can empower students with disabilities, to overcome obstacles they encounter to access learning. The finding is that the Fourth Industrial Revolution is feasible to positively influence students with disabilities' learning. However, ableism, disablism and body corporeality illuminate the invisible and hidden obstacles that could hinder the empowerment of students with disabilities to learn. So feasibility is dependent on the particular students with disabilities themselves appreciating it or not. The argument of the chapter is thus, Fourth Industrial Revolution is feasible for students with disabilities' when accepted by them, who have a lived experience of disability. The paper hopes to contribute to the on-going debate on the feasibility and practical implementation of Fourth Industrial Revolution in the South African context of higher education.

Key words: students with disabilities, higher education, Critical Disability Theory, Fourth Industrial Revolution, learning

Introduction

The age of Fourth Industrial Revolution has come and has already been embraced both in developed countries in the West and some developing countries in Africa. Akoojee and Nkomo (2008) argued that most African countries are still struggling with the technology of the Third Industrial Revolution. However, South Africa is said to be one of those countries who are starting to embrace the Fourth Industrial Revolution in Africa. It is against this background that the feasibility of Fourth Industrial Revolution, in terms of enabling students with disabilities to access learning in higher education, is of interest to this paper.

Before going straight to discussing the feasibility of the Fourth Industrial Revolution in enabling learners with disabilities to access learning, this chapter starts by discussing the industrial revolutions from the first to fourth, to make an understanding of what the Fourth Industrial Revolution is and how is it different from the third. This is important because there has been a mis-conceptualisation in which the trends in the two have been understood as the same. The paper goes further to discuss the opportunities the Fourth Industrial Revolution can provide for humanity globally. Next, the limitations confronting students with disabilities' learning in the South African context of higher education are discussed to set the stage in which the trends in the 4th Industrial Evolution could enable students with different categories of disabilities to access learning. Specific tools drawn from Critical Disability Theory, which are ableism, body corporeality and disablism, are used to explain the hidden unforeseen obstacles that might limit the Fourth Industrial Revolution, enabling students with disabilities to access learning. The

chapter concludes by reiterating on the argument that Fourth Industrial Revolution is feasible in terms of enabling students with disabilities' access to learning. However, ableism, body corporeality and disablism as invisible obstacles could work against the feasibility and defeat the purpose. So feasibility is to the extent to which the trends of the Fourth Industrial Revolution are appreciated by the students with disabilities. Also issues of context, individuality and intersectionality need not be glossed over when considering the feasibility of the Fourth Industrial Revolution for students with disabilities' learning in the context of South African higher education.

Conceptualisation of the Fourth Industrial Revolution

There are misconceptions in which the Fourth Industrial Revolution is conflated and not differentiated from the Third Industrial Revolution. This is because both are characterised by technological advancement. Scholars, among others, Stearns (1993) Mokyr (1998) Landes, (2003) Rifkin (2011) and Rosen (2012) have conducted studies on the first three revolutions and they all reflect a developmental progression from one revolution to the other. A pattern is reflected from the age of the steam engine, to the age of science and mass production, to the rise of digital technology. All the revolutions have resulted in the transformation of society as it continues to shift the focus from one way of economic production to the other. For better understanding of the Fourth Industrial Revolution as another developmental milestone and entity from the three, it is important that all the revolutions, from the first to the fourth are discussed in their sequence.

From the First to the Fourth Industrial Revolution

The first revolution spanned from around the end of the 18th century to the beginning of the 19th century. This revolution as described by Steams (1993) was a slow period of proto-industrialisation and it involved the advent and rise of industry; an event and an economic development which took over agriculture. In essence, the structure of the economy of the society evolved from being agrarian to be industrial, as society shifted the focus from one economic structure to the other. As the revolution took place, there was an invention of the steam engine which produced energy. As Stearns (1993) puts it, the new type of energy propelled various processes such as mass extraction of coal and the development of railroads.

There was also development of major inventions, as informed by new technological knowledge, which saw to major inventions, which included among others, metal shaping. The revolution led to the creation of the first factories and cities which led to great economic acceleration accompanied by human and material exchanges (Rosen, 2012).

The First Industrial Revolution is viewed as one that created disability as a social construct. It is argued that during the feudal system, societies' economies were based on primitive farming and though that required manual labour, it is stated that disability was not emphasised as people worked collectively as members of society (Oliver, 1990). When the economy shifted from agrarian to industrial, people with physical disabilities who were not able to participate in industrial activities were excluded from the labour force in factories and they stayed home. Those people were then viewed as "disabled" (Oliver, 1990), because there was demand for production as dictated by the market forces of the day, but them were not participating.

The Second Industrial Revolution occurred between the period 1870 and 1914. Mokyr (1998) refers to it as the "Technological Revolution" because of the growth and expansion of the pre-existing industries and development of new ones. Oil and steel industries expanded. The new technologies enabled the refining of internal combustion engines and petroleum, alloys and chemicals, new materials and substances, resulting in the new development from steam to electric power. This saw to a mass production through the use of electricity, which also culminated in communication technologies (Landes, 2003).

In terms of disability, the Second Industrial Revolution had both positive and negative implications. In the West, in Britain specifically, more disability emerged and was more visible because there were a lot of experiences of injuries, disease and ailments as resulting from equipment failure, use of coal, steam power, flammable gases, dust and rock falls in factories and mines (Turner & Blackie, 2018). Long hours of standing at workplaces resulted in "in-knee cripples in which the legs curved outside" (Dodd, 1841 cited in Turner & Blackie, 2018:7). It could be argued therefore that while it is presumed that advancement in technology brings with it improvement in terms of living standards and transformation of the society for the better, in the Second Industrial Revolution, more casualties were created and as a result disability was more pronounced. Thus as in the First Revolution, disability was further created in more practical ways in the Second Revolution. However, on a positive note, it is revealed that at that period physical disabilities came to be realised to be a problem that needed a solution. This implies intervention strategies were thought about and possibly implemented, to assist persons with physical disabilities,whose disablement resulted from injuries and disease that developed from working in industry. Thus, though that cannot be viewed as improving the standard of living, consideration for disability was made at the time.

The Third Industrial Revolution took place in the 20th century. Rifkin argues that the revolution revolved from renewable energy to conversion of buildings to power plants, to hydrogen and other energy storage technology, to smart grid technology, as well as plug in, electric, hybrid, and fuel cell based transportation (Rifkin, 2011). Butle (2018) adds up when he argues transcending from the 1960 onwards, the Third Industrial Revolution, included computing and communications technologies. This has helped to destroy distance and costs barriers. It could be argued that the Third Revolution was characterised by digital technology, which has continued to this day. It is this continuity of the digital technology to the present day that there is a blurred boundary between the Third and Fourth Industrial Revolution, which has made many people conflate the two. In relation to disability, it could be argued that those with disabilities were rather enabled to function as those without disabilities at that time during the Third Revolution. For example, when the technology of the age destroyed distances, it helped those with physical disabilities and visual limitations to find their way to their workplace much easier.

In this paper, this historical understanding of disability is important as the foundation on which to analyse how the Fourth Industrial Revolution in particular is impacting on students with disabilities' learning in the context of South African higher education.

The Fourth Industrial Revolution combines technologies and biological spheres. Schwab (2017) explains this as the infusion of technologies into people's lives as blurring the lines between the biological, digital and physical spheres. It implies that the Fourth Industrial Revolution has become part of people's everyday lives both in urban and rural settings, that it has changed how they live, what they do, how they interact, how they relate, how they acquire new knowledge, and how they apply it in their everyday lives. It is the age that is characterised by cyber-physical systems, intelligent robots, mobile supercomputing, self-driving cars, genetic editing and neuro-technological brain enhancements, argues Schwab (2017). Ab Rahman, Abdul Hamid and Ai Chin (2017) agree with Schwab (2017) that the Fourth Industrial Revolution is the present environment with disruptive technologies and trends such as the Internet of Things (IoT), robotics, virtual reality (VR) and artificial intelligence (AI). Robots and artificial intelligence as self-driving cars can thus do what can be done by human hands and mind. Abu Rahman et al. (2017) also reiterate that the trends of the Fourth Industrial Revolution ease many tasks that relate to human activity, as human activity is replaced by high technologies. It could be argued that the Fourth Industrial Revolution is conflated with the third by virtue of technological orientation. It must be understood however that other things such as robots and artificial intelligence stand out in this present revolution, to make it distinct.

The Fourth Industrial Revolution's distinguishing features are the sustainable (Ab Rahman, Abdul Hamid and Ai Chin, 2017) and disruptive (Christensen, Raynor & McDonald, 2015) innovations. Sustainable innovation improves on the existing ways of production, technology, market, network, societal values and products. Disruptive innovation involves new initiatives and the formation of new economic and business production and market. Mariaye and Samuel (2008) purport that it influences various sectors and spheres of human endeavours. In simple terms, the Fourth Industrial Revolution involves integrating technology into people's lives, resulting in them doing things differently from the way they did previously. It could then be reiterated that the Fourth Industrial Revolution broadly, and its specific trends, continue to change the way humans act, their relations among one another, and their everyday lives.

Fourth Industrial Revolution and the opportunities it can provide

That the Fourth Industrial Revolution could have opportunities for all people globally is on one hand indisputable and on the other, contestable. Schwab (2017) argues that there has never been a time of promise on one hand and of peril on the other than the present time of the Fourth Industrial Revolution. As the forces of disruption and innovation are shaping every context, there are opportunities of improved quality of life through access to the digital world and technology, making it possible to access efficient services and knowledge (Schwab, 2017). For example, making transport bookings, buying products and making payments online can easily be done with technology. Persons with disabilities particularly who have impairment-related disadvantages, who have been limited in many areas of life and in different ways, could benefit more from the Fourth Industrial Revolution. An interesting example of one of the benefits of the Fourth Industrial Revolution to persons with disabilities is advanced technology, in which at one institution of higher learning in South Africa, there is an assistive device that enables a severely physically disabled student, who cannot use his or her limbs, to control the mouse of the computer with the eyes (Ndlovu, 2017). It can therefore be assumed that with such advanced technology infused into people's lives, those with disabilities can also function in the same way as do those without, to access knowledge and learning.

While the Fourth Industrial Revolution seems to have possibilities for a better life in general, there are fears that it is going to render many individuals unemployed as robots and artificial intelligence are likely to take over what human beings do. This has led to different countries, more specifically the developed ones, to start preparing its citizens for such a time. Countries such as America (USA) and China are said to be well prepared for the Fourth Industrial Revolution, reports the World Economic Forum (2018). These are countries with high levels of technological facilities, technological orientation and technological competence, implying that the embrace of Fourth Industrial Revolution starts from being technical advanced, which as already highlighted, many countries are Africa are still struggling with (Akoojee & Nkomo, 2008). It is against this background that the feasibility of the Fourth Industrial Revolution to enhance learning for students with disabilities in South African higher education is of interest to tease out in this paper.

Limitations to learning by students with disabilities

In the South African context of higher education, students with disabilities are limited in their learning, not only within the four walls of the classrooms but also by barriers which are contextual. There are barriers which limit all students with disabilities and those which limit students with a specific category of disabilities. In the classroom context, literature has revealed that students with disabilities are generally excluded in the South African context of higher education (Crous, 2004; Mutanga, 2017; Mutanga & Walker, 2017). This is because academics are not willing to include them in their teaching. The unwillingness is as a result of lack of knowledge about disabilities (Matshedisho, 2010; Haywood, 2014), and viewing of students with disabilities as a burden (Van Jaarsvel & Ndeya-Ndereya, 2015). It is

further argued that they are limited to access learning because they get their work and feedback late (Naidoo, 2010; Tugli et al. 2013). Their work is sometimes distorted when it is converted by those who are not experts in the programmes they are studying. Students with disabilities are also limited in their learning because of use of inaccessible, irrelevant technology and teaching formats, more especially for those with visual impairments (Kajee, 2010; Mokiwa & Phasha, 2012). Students with hearing impairments specifically are limited in terms of sign language interpretation which is a very expensive service in South Africa (Zulu, 2014). As a result of this, there is little provision and support for students with hearing impairments in South African higher education (Matshedisho, 2007). A study by Ndlovu (2017) reveals lot of barriers experienced in the process of interpretation by human interpreters. The barriers have included among others, the interpreter being not available because he or she is sick or has taken leave, and another to take his place is not found in time. In such a time students with hearing impairments who need such a service to learn miss lectures and consequently learning. Besides such kind of barriers, sign language interpreters mis-interpret what they are interpreting to the students when they are not experts and lack knowledge and the discourse in the field of study (Ndlovu, 2017).

In the social environment, outside the classroom, students with disabilities are also limited, and this negatively influences their learning. It is reported that they confront negative attitudes from the staff and other students without disabilities in South African higher education institutions (Howell, 2005). Students with physical disabilities, and those with total visual limitations in particular, are limited by inaccessible physical structures such as buildings in institutions of higher education (Engelbrecht & De Beer, 2014) and in society at large (Swartz & Schneider, 2006). Efforts to overcome these barriers have been done in different contexts with some institutions of higher education doing renovations of retrofitting of original buildings (Fitchett, 2015), but many institutions have remained inaccessible infrastructurally. They are also limited by barriers of public transport which limit their mobility (Khuzwayo, 2011; Parliamentary Monitoring Group South Africa, 2013).

Besides the contextual barriers limiting students with disabilities' learning, they also confront impairment-specific limitations. Corker and Shakespeare (2002) argue that not all of the oppression of persons with disabilities is a result of the environment, but also from their impairments in themselves. In a study carried out by Ndlovu (2017), in one institution of higher education in South Africa, students with disabilities were also acknowledging that their limitations to learn resulted from their impairments more than from the environment. For example, a medical student was cited as saying, "I cannot operate on a patient with this vision. I cannot do procedures that really need good sight". Odendaal-Magwaza and Farman (1997) also argue that some students with disabilities have been denied to enter specific programmes at institutions of higher education because they are believed to be unable to meet their course demands due to their impairments. They have been excluded in programmes that have courses that involve field practice off-campus, or where they will be required to use particular types of equipment, or require extensive interaction with the public. Oliver (1990) argues that this kind of acknowledgement of impairment-related limitations leads to diverting attention away from making the social environment accessible and inclusive. Important as this might be, however, impairment-related limitations, their severity and category, are real and must not be glossed over because they indeed limit learning of students with disabilities in higher education.

Feasibility of the 4IR on South African realities and its unique constraints

Learning through use of programmed robots

Specific trends, including the Internet of Things (IoT), robotics, virtual reality (VR) and artificial intelligence (AI) can enable students with specific categories of disabilities access to learning. Within the classroom, robots could be programmed by an expert in the specific discipline, and used as an accurate

way of conversion, and students with disabilities have access to learning material that is not distorted. Programmed robots can also be used to enhance learning of students with hearing impairments, who are completely deaf, in terms of interpretation. They can be used in place of the human interpreters and the experiences of absence of a human interpreters, expenses involved and mis-interpretation can be avoided.

Possibility for mobility and overcoming inaccessibility

Artificial intelligence as a trend of the Fourth Industrial Revolution can be used to enable learning of students with disabilities. Programmed self-driving cars specifically can be used by students with profound physical disabilities and vision, who are limited by their impairments, to drive. As Shakespeare (2006) stated that she cannot drive because she is totally blind, students like her could be enabled through artificial intelligence. A programmed self-driving car can help them access places where they could have been limited by an inaccessible transport system. In programmes where they are required to do fieldwork off-campus, self-driving cars can take them there, without them experiencing hassles of inaccessible public transport.

Further to artificial intelligence, the internet of things, in which all things and objects are automated, could enable students who have physical and visual limitations access to things they want to use in their learning environment with ease. When this specific 4IR trend is used in the South African higher education context, no longer will students with disabilities move to things and objects in the classrooms or libraries, but things as books and any other learning equipment will move to the students who have mobility problems. In support of robotics, internet of things, artificial intelligence and the Fourth Industrial Revolution in general, Samochowiec and Schmidt (2017:9) argued that "Survival no longer require a high level of fitness". This implies the Fourth Industrial Revolution broadly can enable students with disabilities to be able to do learning activities they would have difficulty doing before. It could be argued therefore that specific trends of the Fourth Industrial Revolution are feasible and can improve students with disabilities' learning, despite the unique constraints and realities of South African higher education.

Invisible barriers seen through Critical Disability Theory

Ableism, disablism and body corporeality have been drawn from Critical Disability Theory as theoretical concepts that could help explain how the specific trends of the Fourth Industrial Revolution could be explained, and how they can, in an unforeseen and invisible way, hinder rather than promote learning of students with disabilities in higher education.

Ableism

Programmed robots and self-driving cars can be understood in terms of ableism and consequently normalisation. Ableism is essentially a preference of ability over disability. Hehir (2002) states that it involves a devaluation of disability and a preference for ability, and this results in a generally espoused notion that able-bodiedness or "normalcy" is better than disability. It results in society believing, for example, that it is better for a child to walk than to roll, to read print than to read Braille, or to speak than to sign (Hehir, 2002). Goodley (2014) concurs that ableism favours able-bodiedness. Within an environment in which ableism is entrenched, those without disabilities view themselves as having the responsibility to restore persons with disabilities back to a "normal" state. It can be argued that ableism informs normalisation, rehabilitation and a medical view of disability, because those with disabilities are seen by society as having been victims of a tragedy and in need of "fixing". Students with disabilities do not need to be "fixed" so that they can access learning and the specific trends of the Fourth Industrial Revolution has that "fixing" kind of a solution. Such a response by society is vehemently

critiqued by Critical Disability scholars because ableism assumes that those with disabilities want to be what societies have determined as "normal". An ableist mind-set is that those with disabilities do not belong in the mainstream, and they can only be absorbed into it when they have been normalised. Students with disabilities might view that "fixing" and normalisation as taking away their humanity and become resistant, and hence the whole purpose of using the specific trends of the Fourth Industrial Revolution is defeated. Eldridge (1997) has argued that there should be a barrier-free society, in which all people belong. This implies that it is the environment that should be "fixed" and made barrier free and not students with disabilities. Critical Disability theorists such as Goodley are seeking new ways of understanding normalisation of the body, with the view of bringing back all bodies and casting them as valuable (Goodley, 2013), but not in the way of using robots and artificial intelligence within the context of the Fourth Industrial Revolution.

Corporeality

Robots and self-driving cars could be also understood in the light of denying students with disabilities body corporeality. Corporeality refers to the role of the physical body in society in a way that all human beings inhabit a body, live in it and it is a prism to reach out to the world (Campbell, 1999). Grosz (1994) argues that experience is always embodied, corporeally constituted and located in one's incarnation; hence it's linked with knowledge production. It implies that even those who inhabit a "disabled" body should be allowed opportunity of a lived experience of disability, to help them produce knowledge. It is an embodied experience that should be respected because it can help their learning better than when it is replaced by robots and artificial intelligence. In essence, when robots and self-driving cars take over body corporeality, it implies that students with disabilities are subjugated and oppressed because they are locked in objectified bodies (Young, 1990). So when robots and self-driving cars take over and reach out to the world on behalf of the bodies of students with disabilities, it implies that the "disabled body" has been represented as sub-human and positioned as the "Other". The subordination of body can limit rather than promote learning. Thus, while on the surface robots and artificial intelligence in the form of self-driving cars can be viewed as being able to promote learning for students with disabilities, at the deeper levels they can be self-defeating in the process of learning.

Disablism

Students with disabilities could be disabled rather than abled through specific trends of the Fourth Industrial Revolution. Barnes and Mercer (2003) argue that disablism is a mode of specific oppression that subordinates persons with disabilities and manifests in exclusionary practices at various interpersonal, institutional and societal levels. Disablism emerges when those without disabilities wield relative authority and power, and impose restrictions on the activities and psycho-emotional wellbeing of those with disabilities (Thomas, 2010). One of the disablist ways in which students with disabilities could be limited in learning through robots and self-driving cars is when technology fails. A student with total loss of vision could experience disablism emotionally and psychology when a self-driving car is mis-programmed and it takes her or him to a place which is not her or his intended destination. Technical failures can also develop before the destination and the student with total visual impairments is alone in a self-driving car. While technology failure can also affect other students without disabilities, it could be exacerbated for those with disabilities because they would have totally relied on the particular mode. As a result they could be affected in a way that would affect their learning negatively rather than promote it, because the breakdown of a particular mode would also render them grounded and "disabled". Thus, while specific trends of the Fourth Industrial Revolution such as robots and artificial intelligence in the form of self-driving cars can help students with specific categories of disabilities to access learning, in situations where they could have been limited, there are unforeseen barriers that could self-defeat the whole process.

Feasibility of the Fourth Industrial Revolution to students with disabilities' learning

It is feasible that the Fourth Industrial Revolution broadly and specific trends such as programmed self-driving cars and robots can enable students with disabilities in general, and those with specific categories of disabilities, to access learning in the South African context of higher education. There has been a shift from understanding of the body as simply biological (Meekosha, 1998), to view all bodies as valuable, even those with impairments. There has been again a move from essentialist understanding that an impaired body is deficient. All bodies, including those with impairments, should be recast in terms of value to overcome feelings of inadequacy (Meekosha & Shuttleworth, 2009). That implies need for the inclusivity for all bodies in all their uniqueness in education broadly and in learning specifically. Starting from this understanding as a foundation and background, technologies, mechanical devices and artificial intelligence that could enhance, and even constitute parts of bodies with impairments, so that they are also enabled to access learning, as other students without disabilities, are feasible for enabling the learning of students with disabilities. They are an extension of the body, to enable it to do what it couldn't do, without that particular kind of mode. They are a kind of support and special provision, which students with disabilities always need for their learning. However, as already highlighted, the feasibility could be accomplished if students with disabilities themselves could be receptive to specific trends and take it that they are meant to assist them learn rather than to be ableist, to influence body corporeality negatively and disable them, as revealed in the specific theoretical concepts drawn from Critical Disability Theory.

Conclusion

The argument for the chapter is that the Fourth Industrial Revolution, more specifically the programmed robots and artificial intelligence such as self-driving cars, can enable students with hearing impairments, physical disabilities and those with total visual impairments, to access learning in South African higher education. Ableism, corporeality and disablism reveal the invisible limitations that could hinder the specific trends influencing the students with disabilities' learning. However, if the particular students themselves could view the specific trends in a positive way and appreciate them, they can be enabled to learn.

When addressing the issue of feasibility of the Fourth Industrial Revolution to the students with disabilities' learning, context, individuality and intersectionality need not be glossed over, but considered important. Different contexts may influence different responses to the specific aspects of the Fourth Industrial Revolution by students with disabilities. Students with disabilities are also not homogeneous. Different experiences, agency and exposure need not be overlooked because they can interplay in the process of learning through the particular tools of the Fourth Industrial Revolution.

Categories of disabilities also need not be overlooked when addressing the issue of feasibility of the Fourth Industrial Revolution, to students with disabilities' learning. Different categories of disabilities and even those with the same categories of disabilities might still not require the same trends because they have different and unique learning needs. Programmed robots may interpret for and assist one student with hearing impairments to access learning and might not be useful to another student with the same impairments. In the same way, self-driving cars may assist one student with physical or total visual limitations to get to a learning place. It might not be the same way for other students with the same impairments. Also severity of impairments, and intersectionality due to class, gender, race, and different educational backgrounds, might have a bearing on how students respond to learning through the specific tools in the Fourth Industrial Revolution. Some students might benefit and others not. It is thus important that when the question of feasibility of the Fourth Industrial Revolution to students with disabilities' learning is tackled, context, individuality and intersectionality are not glossed over.

References

Ab Rahman, A., Abdul Hamid, U.Z. & Ai Chin, T. 2017. Emerging technologies withdisruptive effects: A Review. *Perintie eJournal*. 7 (2); 111—128.

Butle, M. (2018). The implications of having an industrial revolution in one generation. Available at:https://www.fin24.com/Finweek/Featured/the-implications-of-having-an-industrial-revolution-in-one-generation-20180409.

Akoojee, S. & Nkomo, M. 2008. Access and quality in South African higher education: the twin challenges of transformation. *South African Journal of Higher Education,* 21(3), 385—399.

Barnes, C. & Mercer, G. 2003. *Disability: Key concepts*. Cambridge: Polity Press.

Campbell, F. A. 1999. 'Refleshingly disabled': Interrogations into the corporeality of 'disablised' bodies. *Australian Feminist Law Journal,* 12(1), 57—80.

Christensen, C.M., Raynor, M.E. & McDonald, R. 2015. What is disruptive innovation? *Harvard Business Review*, 44—53.

Corker, M. & Shakespeare, T. 2002. *Embodying disability theory: Disability postmodernism*. London, NY: Continuum.

Crous, S.F. 2004. The academic support needs of students with impairments at three higher education institutions. *South African Journal of Higher Education,* 18(1), 228—251.

Eldridge, A.G. 1997. *British Columbia*. 3. SCR.62.

Engelbrecht, L & De Beer, J.J. 2014. Access constraints Experienced by physically disabled students at a South African higher learning institution. *Africa Education Review,* 11(4), 544—562.

Fitchett, A. 2015. Exploring adaptive co-management as a means to improving accessibility for people with reduced mobility at the University of Witwatersrand. In E. Walton and S. Moonsamy (Eds.), *Making Education Inclusive*. Cambridge Scholars Publishing.

Goodley, D. 2013. Dis/entangling critical disability studies. *Disability & Society,* 28(5), 631—644.

Goodley, D. 2014. *Dis/ability studies: Theorising disablism and ableism*. London: Routledge.

Grosz, E. 1994. *Volatile Bodies: Towards a corporeal feminism*. St Leonard: Allen & Unwin.

Haywood, C. 2014. *The opinions of lecturers at a University of Technology regarding their role in supporting students experiencing barriers to learning*. Masters Dissertation. North West University, South Africa.

Hehir, T. 2002. Eliminating ableism in education. *Harvard Educational Review,* 72(1), 1—33.

Kajee, L. 2010. Disability, social inclusion and technological positioning in a South African higher education institution: Carmen's Story. *The Language Learning Journal,* 38(3), 379—392.

Khuzwayo, Z. 2011. Providing accessible transport for people with disabilities in the EThekwini Municipality area: Unpacking the options. *Paper presented at the Southern African Transport Conference*, 11—14 July 2011. Pretoria: South Africa.

Landes, D. 2003. *The unbound prometheus: Technical change and industrial development in Western Europe from 1750 to the present* (2nd ed.). New York: Cambridge University Press.

Mariaye, H. & Samuel, M. 2018. Education hubs and private higher education expansion in small island developing states contexts: The case of Mauritius, *Transformation in Higher Educatio*n. Vol. 3(0), 46—55.

Matshedisho, K.J. 2007. Access to higher education for disabled students in South Africa: A contradictory conjuncture of benevolence, rights and the social model of disability. *Disability and Society, 22*(7), 685—699.

Matshedisho, K. 2010. Experiences of disabled students in South Africa: Extending the thinking behind disability support. *South African Journal of Higher Education, 24*(5), 730—744.

Meekosha, H. 1998. Body battles: bodies, gender and disability. In T. Shakespeare (Ed.). *The Disability Reader: The social science perspective*. London: Cassell.

Meekosha, H. & Shuttleworth, R. 2009. What's so critical about critical disability studies? *Australian Journal of Human Rights*, 15(1), 47—76.

Mokiwa, S.A. & Phasha, T.N. 2012. Using ICT at Open Distance Learning (ODL) institution in South Africa: The learning of students with visual impairments. *Africa Education Review*, 9(1), 136—151.

Mokyr, J. 1998. The Second Industrial Revolution, 1870—1914. New York: Cambridge University Press.

Mutanga, O. 2017. Students with disabilities' experience in South African education: A synthesis of literature. *South African Journal of Higher Education*, 31(1), 135—155.

Mutanga, O. & Walker, M. 2017. Exploration of the academic lives of students with disabilities at South African Universities: Lecturers' Perspectives. *African Journal of Disabilities*, 6(0), a316.

Naidoo, A. 2010. *Students with disabilities' perceptions and experiences of the disability unit at the University of Kwazulu Natal: Howard College Campus*. Masters Dissertation, University of KwaZulu-Natal: South Africa.

Ndlovu, S. 2017. *Obstacles and opportunities for students with disabilities in entering and in preparation to graduate into professions in higher learning: The case of a university in South Africa*. Unpublished Thesis: University of Witwatersrand: Johannesburg.

Odendaal-Magwaza, M. & Farman, R. 1997. Unpublished submission by the University of Natal to education portfolio committee at the public hearing on Draft White Paper 3. *A programme for higher education transformation at the national assembly*. Parliament, Cape Town.

Oliver, M. 1990. *The politics of disablement: Critical texts in Social Work and the Social Work and the welfare state*. Basingstoke: Macmillan.

Oliver, M. 1996. *Understanding disability: From theory to practice*. New York: Palgrave Macmillan.

Parliamentary Monitoring Group. 2013. *Disabled people in South Africa: Briefing on education, employment and accessibility challenges*, Available at: http://www.pmg.org.za. Accessed on the 17 May 2018.

Rifkin, J. 2011. *The Third Industrial Revolution: How lateral power is transforming energy, the economy, and the world*. Palgrave Macmillan; New York.

Rosen, W. 2012. *The most powerful idea in the world: A story of steam, industry, and invention*. Simon and Schuster: New York.

Samochowiec, J. & Schmidt, A. 2017. *Robotics and disability: How assistive devices will improve life*. Zurich: GDI Gottlieb Duttweiler Institute.

Schwab, K. 2017. *The Fourth Industrial Revolution*. Crown Business.

Shakespeare, T. 2006. *Disability rights and wrongs*. London: Routledge.

Stearns, P.N. 1993. *The Industrial Revolution in world history*. New York: Springer.

Swartz, L. & Schneider, M. 2006. Tough choices: Disability and social security in South Africa. In B. Watermeyer, L. Swartz, T. Lorenzo, M. Schneider & M. Priestley (Eds.). *Disability and social change: A South African agenda* (pp. 234—243), Cape Town: HSRC.

Thomas, C. 2010. Medical sociology and disability theory. In G. Scambler & S. Scambler (Eds.). *New directions in the Sociology of chronic and disabling conditions: Assaults on the lifeworld*. Basingstoke, UK: Palgrave Macmillan.

Thomson, R.G. 1986. *Freakery: Cultural spectacles of the extraordinary body*. New York: New York University.

Tugli, A.K., Zungu, D.T., Goon, D.T. & Anyanwu, F.C. 2013. Perceptions of Students with Disabilities Concerning Access and Support in Learning Environment of a Rural-Based University. *African Journal of Health Education, Recreation and Dance*, 356—364.

Turner, D.M. & Blackie, D. 2018. *Disability in the Industrial Revolution: Physical impairment in British coalmining, 1780–1880*. Manchester: Manchester University Press.

Young, I.M. 1990. *Justice and the Politics of Differences*. Princeton: Princeton University Press.

Van Jaarsveldt, D. & Ndeya-Ndereya, C. N. 2015. "It's Not My Problem": Exploring Lecturers' Distancing Behaviour towards Students with Disabilities. *Disability & Society*, 30(2), 199—212.

World Economic Forum (WEF). 2018. Preparing for the Fourth Industrial Revolution.

Zulu, T. 2014. The Socio-economic status, Sign Language Utilisation and the *Cost of Providing Sign Language Interpreter Services in the Cape Metropole District Services*. Unpublished Thesis: University of Cape Town: Cape Town.

THE NATURE OF CONFLICT: PRE-SERVICE MATHEMATICS TEACHERS' EXPERIENCES OF SCHOOL AND UNIVERSITY MENTORS

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Abstract: The practicum experiences of pre-service teachers (PSTs) take place under the supervision of school and university mentors. School mentors monitor the development of the PSTs in real-world conditions, all the while learning to teach in context; while university mentors clinically supervise and assess the extent to which the students are mastering their professional practice according the measures promoted in the university setting (Nyaumwe & Mavhunga, 2005). Crucially, the university and school mentors operate in different institutional spaces where educational ideologies and beliefs may differ: the university is usually a more progressive space, while the schools often prefer traditionalism (Hudson, 2007). This disjuncture has the potential to lead to conflicting messages conveyed in the mentors' feedback to the pre-service teachers (Nyaumwe & Mavhunga, 2005).

In this study, four PSTs were tracked during their practicums. Each PST was interviewed via semi-structured interviews and asked about their mentoring experiences. In addition, the mentors' feedback sessions with the students were recorded. One PST in particular received patently contradictory messages from his school and university mentors, regarding his practice during an observed lesson, suggesting that the mentorship space is a site of conflict between the school and university mentors, in terms of the ideologies they promote and the demands they make on PSTs. This conflicting feedback could impact negatively on the emerging practice of the pre-service teacher.

Keywords: pre-service teachers; mentors; conflict; differing contexts

Introduction

The practicum experiences of pre-service teachers (PSTs) take place under the supervision of experienced school and university mentors. These mentors are responsible for monitoring the development of the student teacher in real-world conditions: to support, encourage, coach, give feedback and initiate student teachers "to teach in the context of teaching" (Cavanagh & Prescott, 2007; Zuzovsky, Feiman-Nemser & Kremer-Hayson, 1998; Nyaumwe & Mavhunga, 2005).

The differing contexts of school and university mean that the mentors view the PSTs from dissimilar perspectives, and as such may differ in terms of what is taken as evidence and how the assessment criteria are applied. In addition, the expertise of mentors varies greatly and this too can have differential impacts on the pre-service teachers (Hudson, 2007). These differences have implications for what the mentors view as important in the developing practice of the PSTs. While the university mentors may look for progressive and reform pedagogies — such as discovery learning and group work — the school mentors are usually satisfied with traditional "chalk-and-talk" practice in a well-disciplined classroom (Mapolelo, 2003). The school mentors may believe they are in a better position to evaluate the student teachers, given the greater contact time they have with these students during their practicum; the university mentors see only snapshots of their students in practice (Cavanagh & Prescott, 2007).

University and school mentors rarely agree on a particular student's assessment, due to the subjectivity inherent in such practice, even though both university and school mentors are usually provided with the same assessment instruments to standardise the evaluation process and to ensure consistency (Nyaumwe & Mavhunga, 2005:137).

In order for the PSTs to extract the most out of their practicum experiences, there needs to be close alignment in the supervisory behaviours (i.e. supporting actions, ideas and discussion) of the different mentors (Mena, Hennissen & Loughran, 2017). But what happens when there are conflicting messages conveyed in the mentors' feedback to the PSTs? This paper will show how some PSTs receive patently conflicting feedback from their school and university mentors and discuss some implications for the professional development of the emerging teachers.

Literature review

Mentors

Mentor teachers play a crucial role in shaping the professional practices of pre-service teachers. Their feedback, support and guidance can inform the PSTs' development by either instilling in them a sense of confidence, power or agency (Williams, 2010) or, conversely, inhibiting their development by silencing of their voices (Patrick, 2013).

Historically, university mentors provide the link between university-based teacher education programmes and the schools in which the PSTs do their practice teaching. These university mentors typically represent the university and their roles include transmitting expectations for certification, communicating expectations for pre-service and mentor teachers, and evaluating PSTs in the final stages of their educational programmes (Martin et al. 2011).

School mentors generally position themselves as "expert" and the PSTs as "novice", and this can create a power relationship in which the PSTs begin to feel disempowered. While PSTs are often encouraged by their university mentors to introduce new ideas as presented to them in the university context, school mentors are known to favour the old ways of doing things and can show antagonism towards alternative views brought in by pre-service teachers (Phelan et al, 2008). This type of mentor-mentee relationship creates tension which can negatively influence the PSTs, who often choose to compromise their university-influenced beliefs and practices and give in to the demands of their school mentors in order to attain respectable assessments (Hoffman et al., 2015; Patrick, 2013). In the long term, this "silencing" of PSTs' voices can be counterproductive to their professional development, as they tend not to take ownership of their practice.

University mentors are often the teacher educators for specific subjects that the PSTs are critiqued on. These mentors visit the PSTs to assess them clinically, a few times during the practicum, but usually do not go beyond the lesson observation and feedback elements of their roles (Burton, 1998). The university mentors should ideally perform complementary roles to the school mentors, by encouraging the PSTs "towards a critical examination of how aspects of the subject should be taught" (Burton, 1998:130).

Professional development

Most teacher education programmes in the 21st century endeavour to support pre-service teachers to be able to handle the complexities of teaching and to create positive learning environments for diverse children. This proves difficult at times because many pre-service teachers enter the teacher education programmes with many years of personal experience but lack theoretical and pedagogical knowledge. They hope to gain pedagogic skills and find themselves frustrated when all they get is educational research and theoretical knowledge. This is where the pre-service teachers "need to be assisted

in reflecting on how craft/practical knowledge may be acquired and how propositional/theoretical knowledge may be used" (Mewborn, 1999).

This professional development is necessary to prevent pre-service teachers from entertaining the notion of teaching as a common-sense practice, but rather something that is theoretically informed (Doyle, 1990). Usually, practicum sessions provide an important opportunity for PSTs to practice what theory has been discussed in the university methods courses and to "test their perceptions and beliefs and the efficacy of instructional theories as a guide to their practices" (Cavanagh & Prescott, 2007; Nyaumwe, 2004; Tabachnick & Zeichner, 1999). The PSTs also learn to cope with the demands of teaching, which include classroom management, administration and becoming a member of a community of practice of teachers.

Teacher learning is believed to be a social activity. The work of Lave and Wenger (1991) has proved useful in understanding how pre-service teachers know and learn about the practice of teaching (Cavanagh & Prescott, 2007). For Lave and Wenger, learning is a social activity that is derived from the pre-service teachers' active engagement in the world in a *community of practice*. The pre-service teachers, as novices, engage with the experienced teachers in the social contexts of schools during their TPs and, in doing so, they observe what is required to become part of that community.

Mentor feedback

The feedback provided by mentors to PSTs during their practicum experiences is usually directive, and may include praise, criticism, advice, telling PSTs what they should do, and correction (Hoffman et al., 2015). Often, school and university mentors assume traditional authority positions, in which they attempt to transmit their views of successful teaching to the novice PSTs. Directive feedback by school mentors typically leaves little opportunity for PSTs to reflect on their own beliefs and the possibilities afforded by the (usually reform) practices they have been presented with at university. Evaluative comments are also commonly used by mentors with the intention of changing the pre-service teachers' future instruction. This limits opportunities for PSTs to benefit from reflecting on, and interpreting, their lessons. Content-specific feedback is not often provided (Hoffman et al., 2015; Patrick, 2013), which is a matter of concern especially in the South African terrain, given "ongoing evidence of largely authoritative pedagogies and of gaps in teachers' mathematical content knowledge" (Ramdhany, Venkat & Christiansen, 2018:194).

There is some evidence of conflict or "seemingly oppositional points of view" (Martin, Snow & Franklin Torrez, 2011:3) between academic (i.e. university) and practitioner (i.e. school) knowledge, as manifested through the feedback provided to PSTs. This suggests that conversations between university and school mentors are necessary in order to gain better understandings of teaching practices and challenges of learning to teach, with the broader aim of supporting the PSTs in their professional development. Attention to conflicts within this triadic relationship (university mentor-preservice teacher-school mentor) has led to an increased awareness of the need for collaborative interactions of supervisors, student teachers, and mentor teachers and the ways preservice teachers are supported in their development.

Conceptual framework

Hudson (2007) designed a five-factor model to analyse and describe the work of mentors. He believed that effective mentoring of PSTs is vital for their professional development and "cannot be left to chance" (Hudson, 2007). The five factors in his model include: personal attributes (the mentor shows support, pays attention and assists the student in reflection); system requirements (the mentor discusses the aims of teaching mathematics as contained in curricular and policy documents); pedagogical knowledge (the mentor assists in lesson planning and implementation, teaching and assessment); modelling (the mentor

models a lesson to demonstrate effective class management and mathematical discourse); and feedback (the mentor provides oral and/or written feedback on observed lessons). This model demands social interaction and conversation between the mentor and the student (Hudson, 2007; Cavanagh & Prescott, 2007). These mentoring conversations are a special kind of professional conversation regarded as a core activity in knowledge construction. Talking about teaching allows PSTs to recognise and name the knowledge of practice; the PSTs' knowledge construction can improve through this sort of participation.

Methodology

This paper draws on the author's PhD study which centred on investigating pre-service mathematics teachers' experiences as they negotiated the university–school divide. While a range of data was collected for the broader study, in this paper I draw on the feedback provided by the university and school mentors to the pre-service teachers (PSTs). This feedback took the form of handwritten notes and audio-recorded mentoring conversations between the mentors and the PSTs, which were analysed in a way to understand the messages conveyed in these interactions. Thus, the research presented here was qualitative in nature.

Sampling

Four mathematics PSTs (of a class of 26) completing their Postgraduate Certificate in Education (PGCE), a one-year exit certification qualifying them as professional teachers, were selected for further scrutiny. These four students (3 males and 1 female) were the only ones who volunteered to be part of my study. No additional students were asked or coerced to participate.

Data collection

Over the course of the year, many types of data were collected. These included video-recorded lessons presented by the PSTs, school and university mentors' written and verbal feedback to the PSTs, and semi-structured, face-to-face student interviews at the end of the year.

Data analysis

Each feedback conversation between the mentor and the student was transcribed verbatim, and the written feedback and the mentoring conversations were analysed by the following two approaches: (1) conversational analysis (CA) and (2) interpretative analysis.

Social scientists have for some time studied conversations and what is achieved through them using the methodology of conversation analysis (CA) (Atkinson & Heritage 1984). Conversational analysis is usually limited to the analysis of the sequences of utterances, propositions or cycles in a search for meaning or speech agreements out of the conversation without paying attention to personal attributes, contextual factors or personal identities (Gordon, Ellis-Hill & Ashburn, 2009). In educational research, transcribed conversations have been analysed to look for indicators of styles of mentoring (i.e. directive or elicitive approach) (Hawkey, 1998), or to describe how mentors' questioning influences PSTs' responses (Harrison, Lawson & Wortley, 2005).

In interpretative analysis, the focus is on the parts of the speech that reflect ideologies, personal beliefs or values, because it is argued that they may influence teachers' representation of practice (Schiffrin, 1994). This was especially pertinent to analysis of the school mentor's written feedback, as she made notes while observing the PST conducting a lesson.

Ethics

All ethical considerations, as per my institution's rules, were adhered to in this study. During analysis of the transcripts of the lessons observed, the student interviews and the student-mentor feedback, the

students were referred to as Student 1, 2, 3 or 4. However, for the purpose of this paper, a pseudonym has been used to refer to the PST reported on. The schools at which the students taught during their TPs were also coded School 1, 2 and so on. Some of the PSTs mentioned the names of schools in their interviews, and these school names (in the transcripts) were also changed to School A, B, C and so on. The ethical protocol reference number for the study is: HSS/0081/013D.

Findings

All the school mentors provided general feedback, which focused on classroom management and student expectations. Some mentors were reported to have provided lesson plans and assisted with resources and class discipline when required. None of the school mentors were reported or recorded to have discussed the aims of teaching mathematics as per curricular or policy documents, nor to have mentors modelled exemplary lessons for the benefit of the PSTs. There were also many examples of pedagogic advice, such as the following offered to William (not his real name):

> *How about marking section A in class after the learners have done it? Instead of taking it in good faith that the learners understand it, mark section A and look for (learners') errors. Discuss the section in class; it is easier to root out individual problems, (because) sometimes learners' voices get lost in chorus answering. This also gives the teacher a sense of learners' problems, how much has been taken in.*

This is sound advice to pre-service teachers, who may not realise that chorus-answering does not necessarily mean that ALL learners have the same understanding. This mentor's advice also includes some pointers on how William could maintain more control over his assessment of the learners. Vuyo's (not his real name) mathematics specialist university mentor also highlighted the need to consolidation: *"You've got to make sure before you move on that you've consolidated, both in terms of conceptual understanding and procedural fluency"*, but she mentions this in terms of Kilpatrick et al.'s (2001). Strands of Mathematical Proficiency with her reference to "procedural fluency".

Only Vuyo had a mathematics specialist university mentor to evaluate his mathematics lessons, while the other three university mentors were not mathematics specialists. Thus, while all the university mentors echoed the school mentors' generic pedagogical feedback, only one could (and did) provide feedback on the actual mathematical content and pedagogy.

I will use a further example of Vuyo's experience to demonstrate one instance of apparent conflict between school and university mentors. Vuyo had a very conscientious school mentor who sat in on all Vuyo's lessons and provided daily oral and written feedback to him. As much as this mentor appreciated Vuyo's strong content knowledge, she was unhappy with his conversational style towards the learners and his apparent lack of focus (her words: *"he's always jumping from one thing to the next"*). After one particular lesson on exponents, her written feedback to him included the following (in capital letters and exclamation mark): 'ALGEBRAIC AND GRAPHIC ARE TOO HARD!' His university mentor (the mathematics specialist) encouraged Vuyo to use his strong content knowledge to extend the learners where possible and, during the same lesson, applauded his use of algebraic and graphic representations when dealing with exponents. This was the most obvious example of contradictory messages conveyed to the student by his mentors, which could have a disruptive effect on the student's developing practice. However, the university mentor ended her feedback on a conciliatory note, by reminding Vuyo of the need to balance his own pedagogical choices with the school's requirements.

Conclusion

The aim of this paper was to show that, while most school and university mentors may agree on the general pedagogic feedback they provide to pre-service mathematics teachers, the mentorship space can be a site of conflict between these mentors, in terms of the ideologies they promote and the demands they make on PSTs. All mentors drew the PSTs' attentions to issues such as learner discipline, the importance of providing clear explanations and consolidating after each section. Only the specialist mathematics university mentor provided specific feedback on the mathematics content and pedagogy, but this feedback contained at least one instance of clearly contradictory advice to the school mentor's feedback. There was also cause for concern for the three students who did not receive feedback on the mathematics content and who could be led to believe that they handled the mathematical content effectively, which may not always have been true.

The mentorship space is an uneven terrain across many South African universities and schools. Given the importance of the practicum on the PSTs' professional development, this could have detrimental effects on the quality of our next generation mathematics teachers.

References

Burton, D. (1998). The changing role of the university tutor within school-based initial teacher education: issues of role contingency and complementarity within a secondary partnership scheme. *Journal of Education for Teaching,* 24(2), 129—146.

Cavanagh, M. & Prescott, A. (2007). Professional Experience in Learning to Teach Secondary Mathematics: Incorporating Pre-service Teachers into a Community of Practice. In J. Watson & K. Beswick. (Eds.). *Proceedings of the 30th annual conference of the Mathematics Education Research Group of Australasia*.

Doyle, W. (1990). Themes in teacher education research. In W. R. Houston (Ed.), *Handbook of research on teacher education*, 3—24. New York: Macmillan.

Gordon, C., Ellis-Hill, C. & Ashburn, A. (2009). The use of conversational analysis: nurse-patient interaction in communication disability after stroke. *Journal of advanced nursing,* 65(3), 544—553.

Harrison, J.K., Lawson, T. & Wortley, A. (2005). Mentoring the beginning teacher: Developing professional autonomy through critical reflection on practice. *Reflective practice,* 6(3), 419—441.

Hawkey, K. (1998). Consultative supervision and mentor development: An initial exploration and case study. *Teachers and teaching,* 4(2), 331—348.

Heritage, J. & Atkinson, J.M. (1984). Structures of social action. *Studies in Conversation Analysis*, 346—369.

Hoffman, J.V., Wetzel, M.M., Maloch, B., Greeter, E., Taylor, L., DeJulio, S. & Vlach, S.K. (2015). What can we learn from studying the coaching interactions between cooperating teachers and preservice teachers? A literature review. *Teaching and Teacher Education*, 52, 99—112. http://dx.doi.org/10.1016/j.tate. 2015.09.004.

Hudson, P. (2007). Examining mentors' practices for enhancing preservice teachers' pedagogical development in mathematics and science. *Mentoring & Tutoring: Partnership in Learning, 15*(2), 201—217.

Kilpatrick, J., Swafford, J. & and Findell, B. (Eds.). (2001). *Adding it up: Helping children learn mathematics*. Washington DC: National Academy Press.

Lave, J. & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

Mapolelo, D. (2003). Case studies of changes of beliefs of two in-service primary school teachers. *South African Journal of Education,* 23(1), 71—77.

Martin, S., Snow, J. & Franklin Torrez, C.A. (2011).Navigating the terrain of third space: Tensions with/in relationships in school-university partnerships. *Journal of Teacher Education,* 62(3), 293—311. http://dx.doi.org/10.1177/0022487110396096.

Mena, J., Hennissen, P. & Loughran, J. (2017). Developing pre-service teachers' professional knowledge of teaching: The influence of mentoring. *Teaching and Teacher Education, 66*, 47-59. http://dx.doi.org/10.1016/j.tate.2017.03.024.

Mewborn, D.S. (1999). Reflective Thinking among Preservice Elementary Mathematics Teachers. *Journal for Research in Mathematics Education,* 30(3), 316—341.

Nyaumwe, L. & Mavhunga, F.Z. (2005). Why do mentors and lecturers assess Mathematics and Science student teachers on teaching practice differently? *African Journal of Research in SMT Education,* 9(2), 135—146.

Nyaumwe, L. (2004). The impact of full time student teaching on preservice teachers' conceptions of mathematics teaching and learning. *Mathematics Teacher Education and Development*, 6, 23—36

Patrick, R. (2013). "Don't rock the boat": Conflicting mentor and pre-service teacher narratives of professional experience. *The Australian educational researcher,* 40(2), 207—226. DOI: 10.1007/s13384-013-0086-z.

Phelan, A., Sawa, R., Barlow, C., Hurlock, D., Irvine, K., Rogers, G., et al. (2008). Violence and subjectivity in teacher education. *Asia-Pacific Journal of Teacher Education,* 34(2), 161—179.

Ramdhany, V. Venkat, H. & Christiansen, I.M. (2018). Dissonance and Continuity in the Mathematical Education and Training Experiences of Pre-service Secondary Mathematics Teachers. *African Journal of Research in Mathematics, Science and Technology Education,* 22(2), 186—195, DOI: 10.1080/18117295.2018.1474843.

Schiffrin, D. (1994). *Approaches to Discourse: Blackwell textbooks in linguistics*. Blackwell Publishers Ltd, Oxford.

Tabachnick, B.R. & Zeichner, K.M. (1999). An idea of action: Action Research and the development of conceptual changing teaching of Science. *Science Education,* 83(3), 309—323.

Williams, J. (2010). Constructing a new professional identity: career change into teaching. *Teaching and Teacher Education,* 26(3), 639—647.

Zuzovsky, R., Feiman-Nemser, S. & Kremer-Hayon, L. (1988). Introduction. *European Journal of Teacher Education,* 21(1), 7—10.

THE EDUCATOR'S ECOSYSTEM: LIFELONG LEARNING IN A DIGITAL AGE

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Abstract: Teachers College (TC) of Western Governors University (WGU) prepares educators in an online, competency-based approach that is student-centered, accessible, and affordable. TC is driven to serve educators throughout their careers from the moment of curiosity to becoming a teacher to beyond graduation where professional skills and knowledge are honed. This paper focuses on the theoretical underpinnings and design of an educators' ecosystem: preparation for licensure, induction support, and professional development micro-credential offerings that are stackable into TC's higher degrees for certified teachers.

Theme Integration: One of ICET's 2019 conference themes is *Teachers' Professional Learning for an Integrated Curriculum*. This paper will discuss the theoretical influences upon Teachers College's approach to designing a professional learning ecosystem for educators to span the lifecycle of a professional career. Curriculum integration is at the heart of the design through:

- responsiveness to emerging trends in the profession,
- agility in meeting the needs of school districts and states across the United States, and
- flexibility in personalizing learning to the unique and changing demands of millennial teachers and educational leaders.

The elements of modern learning design are also applicable to integration into the P-12 curriculum.

Introduction

To confront the need to educate an ever-increasing population with limited, and often shrinking, education budgets, 19 governors from the Western Governors Association founded WGU in 1996. WICHE (Western Interstate Commission on Higher Education) and NCHEMS (National Center for Higher Education Management Systems) were integrally involved in the development and early implementation of the university and its five central themes: (1) responsiveness to employment and societal needs; (2) a focus on competency-based education that demonstrates mastery rather than seat-time; (3) expanding access to higher education for populations traditionally under-served; (4) cost-effectiveness to mitigate the debt associated with a college education in the United States; and (5) development of a technology infrastructure so that degrees could be earned independent of place and time.

Today, as then, Western Governors University (WGU) is a non-profit, online, competency-based institution of higher education headquartered in Salt Lake City, Utah. WGU's four colleges (Business, Health Professions, Information Technology, and Teachers College) offer bachelor's and master's degrees to students in all 50 United States and four US Territories. Western Governors University is accredited by the Northwest Commission on Colleges and Universities (NWCCU), a regional accreditation body of colleges and universities in a seven-state region that includes WGU's headquarters of Utah.

WGU's competency-based approach is unique:

What is competency-based education? Simply put, it measures learning rather than time. Students progress through courses as soon as they can prove they've mastered the material, rather than

advancing only when the semester or term ends. If a student can learn faster, spend more time on schoolwork, or lean on knowledge they already have from previous work or school experience, they can accelerate. With 24/7 access to online learning resources to engage with on their schedule, students embark on a learning journey tailored exactly to where their knowledge currently is—and where it needs to be. In addition, faculty members are on hand to provide personalized, one-on-one learning support when it's needed (WGU website, downloaded on April 15, 2019 at 1:56 pm).

As defined by WGU, "competency-based education determines educational goals in terms of demonstrable, measurable descriptions of the knowledge, skills/abilities, and behaviors students should possess at the end of a program … that are essential for beginning the unsupervised practice of a career" (Mendenhall, 2017:383).

WGU's Teachers College was founded in 2001 with funding from the federal government to prepare teachers for looming national shortages (King, 2017:51). With fewer than 400 students in 2003, Teachers College has grown to boast enrollments exceeding 25,000 students in 2019 with 32 distinct programmes for initial licensure as well as advanced programmes for already certified teachers. In addition, WGU's Teachers College is the first in the United States to have earned full seven-year accreditation without any areas of concern from both the Council for the Accreditation of Educator Preparation (CAEP) and the Association for Advancing Quality in Educator Preparation (AAQEP).

Theoretical foundations

The vision for an educator's ecosystem is grounded in the professional literature and research related to teacher development across an educator's career, emerging understandings of the way that millennial teachers and leaders approach learning, and recent calls for the "disruption" of higher education with implications for educator preparation.

Teacher development

As early as the late 60s, Katz and Weir (1969) proposed that teachers might have developmental stages in their professional growth patterns. Asserting that no professional began their career as a "veteran", Katz (1972) proposed four stages from Survival to Maturity and suggested that the tasks and training needs differed at each stage. In the Survival stage, pre-service and up through year two, a beginning teacher needs onsite support and basic "how to" assistance in meeting the needs of students as well as the school and district in which the beginning teacher is employed. At the Consolidation stage which may emerge as early as year 1 and continue through year 3, the beginning teacher is still in need of "how to" assistance but is more likely to know what they need and ask for advice from a variety of individuals with areas of expertise aligning with the teacher's needs. At the third stage of Renewal, emerging as early as the second year of teaching and continuing into the fourth year, the beginning teacher is feeling more grounded in knowledge of the classroom and seeks out new information to improve their practice through conferences and engaging in professional development activities. By the stage of Maturity, evident as early as the third year of teaching and extending into year five and beyond, the no-longer-beginning teacher seeks individualised growth through engagement in seminars and institutes with specialized focus to meet the teacher's interests and needs.

Table 1: Training needs for Teacher Developmental Stages

Training Needs	Developmental Stages			
	Stage I: Survival	**Stage II: Consolidation**	**Stage III: Renewal**	**Stage IV: Maturity**
Pre-service	On-site support and technical assistance			
Year 1		On-site assistance, access to specialists, colleague advice, consultants		
Year 2			Conferences, professional associations, journals, magazines, films, visits to demonstration projects	
Year 3				Seminars, institutes, courses, degree programmes, books, journals, conferences
Year 4				
Year 5+				

Fieman-Nemser (2001) furthered the discussion of teacher development by proposing the components of a professional learning continuum from initial teacher preparation through the early years of professional practice. Fieman-Nemser identified five central tasks of initial teacher preparation as: (1) analyzing beliefs and forming new visions of what they thought teaching was and what it could be, (2) developing subject matter knowledge for teaching in their discipline or cross-disciplinary knowledge for multi-subject classrooms, (3) developing understandings of learners and learning that will impact the instructional decision-making, (4) developing a beginning repertoire of instructional strategies and assessment tools, and (5) developing the tools to study teaching through reflection and data gathering.

In contrast, she characterised the central tasks of induction, or the first three years of a beginning teacher's practice, as multi-faceted and multi-dimensional. For example, beginning teachers, graduates of preparation programmes are now focused on gaining local knowledge of their own students, the curriculum they are expected to teach, and the unique context of the school in which they are teaching. Additionally, they are now applying their preparation to meet the needs of their students by designing responsive curriculum and instruction and enacting their beginning repertoire of instructional strategies in purposeful ways. Embedded in this work of getting to know the students and applying what they have learned, beginning teachers are also working on creating a classroom learning community of their own, as opposed to fitting in to the classroom community they experienced as student teachers. Overall beginning teachers are developing a professional identity and learning in and from their daily practice.

These transitions from learning about to learning in the classroom during the first three years of teachers is the fertile ground of induction. However, in discussing the state of induction programmes for beginning teachers, Feiman-Nemser identified three critical areas of concern beginning with a narrow vision of induction as short-term support, rather than the multi-year developmental guidance that Katz envisioned. In addition, induction programmes are often limited by their definitions of the role of a mentor as a formal observer of the teacher rather than as a facilitator, critical friend, or guide on the side. Lastly, induction programmes often confuse or conflate high-stakes assessment of a teacher's practice (used for re-hiring or defining an improvement plan) with the daily technical assistance and support needed in those early years as outlined by Katz.

In summary, there is a continuum of learning for educators that extends beyond pre-service preparation into their first few years of teaching. This continuum can be characterised developmentally, but more

importantly it can lead to a nuanced agenda for supporting the professional development of teaching professionals in new and interesting ways.

Characteristics of millennial teachers

Generations are described in many ways: years of birth, defining characteristics, as well as common habits and behaviors. The generational group that is most representative of beginning teachers are characterised as Millennials: Born 1981—1996 (22—37 years old) (Serafino, 2018).

Millennial teachers are those most likely to be the beginning teachers of today with approaches to learning that are dramatically different from their more mature educator colleagues. Compared to earlier generations Millennials have been characterised as valuing collaboration, seeking work life balance, and desiring meaningful work. However, King (2019) notes that numerous studies demonstrated that millennials are not unlike previous generations in these preferences. Although King accepts that today's learners are different from the past, she sets out a formula for "modern learning" that is in contrast to the work-separated, event-centric learning experiences of the past.

King suggests that the following six elements are essential to "embracing learning's informal and 'always-on' nature by creating an ecosystem that offers diverse learning modalities that appeal to the modern learner" (2019:11): learner centered, chunked into smaller units of learning, presenting content in varied formats as opposed to strictly reading and writing, underscored by a focus on application of learning in order to retain the learner, and presenting opportunities to learn through embedding instructional across multiple learning systems and highlighting accessibility.

Table 2: Elements of design for modern learning

Learning elements	Design Components
Learner-centric	• Just-in-time, just-for-me options • Personalized learning experiences
Micro-modular	• Short 2 to 5 minute bursts of learning and reference • Combine into larger programmes
Varied treatments	• Purposeful application of video treatments • Scenarios, experts, animation, "how to"
Retention driven	• Reinforce, practice, assess • Ensure application of learning
Embedded	• Accessible within learning systems, company portals • Push content recommendations to learners
Mobile	• Anytime access via tablet and smartphone • Read, listen, and watch preference and choice

The elements of design for the modern learner push against the traditional boundaries of time and space, on curriculum delivery and assessment as reading and writing; and on learning segments as seat-time hours. If we combine the insights of Feiman-Nemser and Katz with the elements of modern learning, there are multiple opportunities for engaging beginning teachers, Millennials, in a new kind of induction that reaches beyond the first few years of teaching and extends into the professional development of a teacher throughout their professional career with an educator ecosystem of support and learning.

Disruption in educator preparation

Calls to disrupt educator preparation in the higher education arena are gaining traction due to the high cost of a degree in the United States making a university-based degree for initial licensure increasingly prohibitive. When US teacher salaries are among the lowest of all professional degrees, a traditional teaching degree earned at a brick-and-mortar institution is far from appealing when the average cost of a bachelor's degree from the United States is $20,770 per year.

Western Governors University has been singled out as a disruptive innovator in higher education (Christiansen, et al. 2011) noting that college disruption was not possible without an upwardly scalable technology driver, now present and accepted with online delivery systems. Distinguished for its online delivery and competency-based approach, the WGU model is also disruptive in its low cost for degree and competitive graduate outcomes (Liu, 2013). Additionally, Christiansen, et al. challenged the value-added and solution shop business models of traditional higher education, suggesting a facilitated user network instead.

In summary, the disruptive components of teacher preparation add value to an educator's professional development journey. Reducing cost, expanding access through online delivery, and demonstrating existing competencies without fulfilling seat time requirements opens up higher education to embrace the elements of modern learning across the professional continuum of learning.

The educator's ecosystem

Prior to 2019, TC offered only degree-bearing or endorsement programmes at the Master's level for already certified teachers. The portfolio of programmes included: Master's of Arts programmes for English Language Learning, Mathematics Education, or Science Education; Master's of Science programmes in Educational Leadership, Special Education, or Curriculum and Instruction; and Masters of Education programmes in Learning and Technology or Instructional Design. Drawing upon the literature as a foundation, Western Governors University's Teachers College leadership began to re-envision the future of its degree-constrained, program-based portfolio for the more advanced, just-in-time learning for certified teachers throughout their professional careers.

The WGU educator's ecosystem begins with an understanding that an educator's learning continuum extends into and beyond the first years of a beginning practitioner. As a teacher gains expertise, seeks information to help solve the challenges of a complex teaching and learning environment, and moves into leadership roles, an ecosystem with non-degree bearing content can support this lifelong learning journey of a professional educator.

In the WGU ecosystem, stackable content in the form of micro-credentials (certificates or badges) can be consumed independently or in a grouping of four or five micro-credentials to earn a certificate and four or five certificates to comprise a micro-masters. The micro-masters, in turn, can be leveraged and credited to a degree-bearing program, if desired. As an example, WGU in partnership with Digital Promise (a tech company that provides online competency-based micro-credentials for educators) is developing a set of micro-credentials in social-emotional learning (SEL) that will result in micro-masters in SEL that can be applied toward the WGU Master's of Science degree in Curriculum and Instruction.

These types of stackable micro-offerings form the core of formalized on and off ramps both into and out of degree programmes. An educational administrator, for example, who may have completed a master's degree in educational administration to be licensable as a building principal in the United States, could add the SEL micro-masters to their transcript in anticipation of applying for a position as a leader of a public school in which SEL is a focus of school improvement and instruction. In this way, an educator can explore and complete quality content to meet their professional and career needs just-

in-time. The completed content, then, is not limited to skill enhancement. Rather the content appears on a professional's graduate work transcript and can be leveraged as evidence of ongoing professional development at a graduate level of quality and currency.

This is just one of the ways that WGU is envisioning, planning, and implementing an educator ecosystem. The ecosystem addresses the needs of the professional continuum for an educator, employs the design elements of modern learning, and enhances the disruption of a traditional system of degree-bearing content that is a barrier to meeting the needs of modern learners in an educational context that is constantly changing and challenging.

Practical significance and implications

The question remains, "What does this educator ecosystem have to do with teacher professional development (PD) for curriculum integration, one of ICET's core themes or the Fourth Industrial Revolution?" Although the implications for teacher professional development are apparent and important, one of the failings of professional development for teachers in the United States is that the content of PD is rarely responsive to teachers' needs. Often PD is developed by the school districts or each state in alignment with state- or school-specific goals for student outcomes. However, research shows that in PD of this kind teacher engagement is low and one-shot PD workshops or stand-and-deliver lectures have little impact on a teacher's classroom practice.

Conversely, when adult learners are self-guided and accountable for their own learning, as suggested by the modern learning elements, then greater and more long-lasting outcomes are attained. The elements of modern learning are more responsive to the reality of learning needs in the modern age. Change is constant, flexibility is essential, and consumable learning segments allow for greater choice and higher engagement. Thus, professional development is disrupted from its workshop-constrained, personal needs-agnostic delivery, and is transformed into on-demand, value-added, personalized experience engaging with high quality content that educators can apply toward their own career goals.

The implications for an integrated curriculum may not be as apparent as with teacher professional development, however it is just as important. To begin, the students of today are not the students of yesterday, particularly if those students are challenged and challenging learners. In a recent blog post, The Underground Parent noted that K-12 education is rapidly changing and predicted, as an outcome of the Fourth Industrial Revolution, that learning and teaching in the future will shift to a more personalized, on-demand, and facilitated experience (2019). For example, learning playlists will take the place of curriculum and attainments will be chronicled as certificates and credentials for life-long learning.

Beginning to think of students as engaged in a life-long journey as citizens and learners is not a new notion. Neither is the power of the idea that student choice and holding students accountable for their own learning results in better student outcomes. However, often teachers think of themselves as the person accountable for student learning. They also often think of learning as episodic and binary; students learn or don't learn this particular lesson on this specific topic on this unique day. The idea of a continuum of learning and of learning needs evolving over time as students mature is often neglected in learning design and delivery in the P-12 classroom. The United States P-12 curriculum is primarily textbook-centered and standards-based, and many publishers sell their products for adoption by school districts because they are teacher-proof. Teacher-proof means that anyone can teach the content using the textbook, teacher's guide, and supplemental materials. There is little opportunity for teacher adaptation of textbook or curriculum materials to fit modern learning design elements. In fact, teacher adaptation may be actively discouraged.

Nonetheless, the elements of modern learning design could be foundational to curriculum integration. For example, personalising learning to become more learner-centric means allowing more student

choice and interest to guide curriculum than textbooks. Developing micro-bursts for teaching and learning within the context of a larger unit of curriculum can allow students to focus on earning "badges" that build needed skills. The table below provides additional suggestions about how four of the modern learning design elements could provide opportunities to integrate curriculum.

Table 3: Integrating elements of modern learning into K-12 curriculum

Elements of Modern Learning	Design Components	Curricular Integration Examples
Learner-centric	• Just-in-time, just-for-me options • Personalized learning experiences	• Students identify cross-curricular areas that they would like to explore, such as math and social studies, and propose a project to do so.
Micro-modular	• Short 2 to 5 minutes bursts of learning and reference • Combine into larger programmes	• Short bursts of cross-curricular connections are identified and highlighted within larger lessons.
Varied treatments	• Purposeful application of video treatments • Scenarios, experts, animation, "how to"	• Varied treatments are presented from which students make the cross-curricular connections embedded in the video/scenario/expert interview.
Retention driven	• Reinforce, practice, assess • Ensure application of learning	• Extend varied treatments to have students create (alone or together) a curricular integration to teach to other students.

In summary, the Fourth Industrial Revolution's impact on education is not simply a matter of technology integration. It is a way of thinking about teaching and learning that is fundamentally different from what it is now. An educator's ecosystem has the potential to be a model for a student-centered ecosystem. Modern learning design and curricular integration that spans grade levels can be a disrupter of P-12 education, leading the way to innovation in how we educate and for what purposes. Just like an educator's ecosystem that has the power to disrupt how we prepare teachers for a lifetime of learning, not just a license to teach.

References

Christensen, C.M., Horn, M.B., Caldera, L. & Soares, L. (2011). Disrupting College: How Disruptive Innovation Can Deliver Quality and Affordability to Postsecondary Education. *Innosight Institute*.

Feiman-Nemser, S. (2001). From Preparation to Practice: Designing a Continuum to Strengthen and Sustain Teaching. *Teachers College Record* 103:6, 1013—1055.

Katz, L.G. (1972). Developmental Stages of Preschool Teachers. *The Elementary School Journal* 73:1, 50—54.

Katz, L.G., & Weir, M.K. (1969). *Help for preschool teachers: A proposal*. Urbana, IL: ERIC Clearinghouse on Early Childhood Education. ED 031 308.

King, H.T. (2017) Teachers College (Chapter 9), pp. 379—400). In *Reinventing higher education, changing lives: The Story of Western Governors University*. WGU: Salt Lake City, UT.

King, K. (2019). Millennial learning myths and misconceptions: Prescriptions for a modern learning strategy. Skillsoft, White paper. Downloaded on April 27, 2019 at 12:52 pm from https://www.skillsoft.com/wp-content/uploads/2018/11/SKL-WP-Millennial-Learning-Myths-and-Misconceptions.pdf.

Liu, M. (2013). Disrupting teacher education. Education Next 13(3). Downloaded on April 28, 2019 at 5:27 pm MT from https://www.educationnext.org/disrupting-teacher-education.

Mendenhall, R. (2017). Western Governors University: CBE Innovator and National Model. In *Handbook of Research on Competency-Based Education in University Settings*, Rasmussen, K., Pamela Northrup, and Robin Colson (editors).

Serafino, J. (March 1, 2018). *New guidelines redefine birth years for millennials, Gen-X, and 'Post-Millennials'*. Downloaded on April 28, 2019 at 12:16 pm MT from http://mentalfloss.com/article/533632/new-guidelines-redefine-birth-years-millennials-gen-x-and-post-millennials.

The Underground Parent. (2019). Downloaded on July 2, 2019 at https://undergroundparent.wordpress.com/ed-reform-2-0/teaching-profession-future.

DEVELOPING SECOND LANGUAGE COMPREHENSION THROUGH TECHNOLOGY: A CASE OF LEARNERS WITH A HEARING IMPAIRMENT IN A BOTSWANA VILLAGE SECONDARY SCHOOL

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Abstract: This paper reports on a study that was conducted in Botswana to explore the use of technology to enhance the comprehension of English as a second language for lower secondary school learners with a hearing impairment. The learners enter school with limited language compared to their hearing peers, yet they are expected to access the same curriculum, enroll in all the mainstream subjects using the English language for teaching and learning in addition to examinations. Technology was used to develop their language literacy and highlight the importance of flexible representation, engagement and expression. To collect data, classroom observations, document analysis and open-ended interviews with the teachers were used. The findings indicate that a classroom environment that employs the use of technology allowed the learners to connect better with the curriculum content. Technology provided opportunities for cooperative learning. Furthermore, since the learners were skilled in operating the technology used, this accorded them the self-confidence to try out new tasks that were designed to enhance their language skills and comprehension and, subsequently, academic success. The conclusion is that the use of technology promoted individually and culturally relevant pedagogy that assisted these learners to access the curriculum and enhance their general academic development and progress. Without technology being an integral part of teaching and learning, education provision could have been compromised especially because, within the Fourth Industrial Revolution context, the learners also needed exposure to a variety of resources to develop other competences they required to learn effectively.

Key words: Botswana, hearing impairment, technology, literacy, teaching strategies

Introduction: background to the study

In the paper we report on seven 14-year-old learners with a hearing impairment attached to a Special Education Unit in a school in a village in the south eastern region of Botswana. In this school, the learners with a hearing impairment are taught primarily in small segregated classes, but partake in the general school extra-mural activities. In some instances, they are integrated into classes with their hearing peers, for example, during computer studies lessons wherein they are able to follow the guidance provided and collaborate with their hearing peers when performing tasks.

To facilitate the language development of these learners, computers, iPads, interactive whiteboards in the form of Smartboards, Mimio and Parrot, laptops and tablets were used during lessons mainly for teaching vocabulary and to model language structures and utterances/expressions. In addition, collective learning experiences were encouraged by using the devices that stimulated active communication among learners. They explored and acquired targeted linguistic features together as communication partners.

Acquiring language is an intricate undertaking that involves vocabulary development, grammar and social language skills. The use of technology, including augmentative and alternative communication (AAC) interventions, is thus seen as valuable to enhance functional communication skills, language comprehension speech and expressive language (Schlosser & Wendt, 2008).

Schwab (2015) has argued that the Fourth Industrial Revolution (4IR) requires a fusion of advanced technologies. In education, technology provides a way of representing information both visually and interactively. The enhanced communication and connectivity that results, enable teachers to share information and learners to interact with each another; thus Schwab's (2015) suggestion that technology has the potential to reduce the anxiety and complexity of abstract concepts that both teachers and learners may come across.

Furthermore, since schools are required to digitise classwork (Schwab, 2015) in the 4IR context, computer-based technology and programmed learning tools have placed the learner at the centre of the educational process (Fawson & Smellie, 1990). Learners gain access to new systems of learning through the integration of, for example, computer guided teaching methods. Using internet tools such as Skype also makes teaching and learning global. In short, technology in the classroom connects learners with the world. Both teachers and learners can and are also able to learn independently depending mainly on their own level of competence in using technology. In particular, Roberson (2001) argues that technology facilitates visual presentation of information that learners with a hearing impairment need for successful communication and instruction in the classroom.

Since literacy involves coding of culturally and socially relevant signs and symbols, the use of gargets connects the readers and texts (Rosenblatt, 2004). Specifically, text-based technologies, as studied by Stewart (2009), have been found to support literacy development for learners. Lewis and Fabos (2005) studied instant messaging (IM) and found that with its attractiveness among youth, it forms a central part to reading and writing practice. Its use stimulates learners to participate in text deciphering, encoding, interpretation, and analysis, among other literacy processes, thus enhancing comprehension. Perhaps it is for these reasons that Manovich (2001) argues that digital literacies are directly linked to print literacies because the motivation to read and write, and the development of fundamental social rules, can all be facilitated by the use of information and communications technologies (ICTs). Their use also enables learners to co-construct knowledge (Sutherland, et al.,2004) and they are useful for teachers when they have to integrate literacy activities for language development for learners, including those with hearing impairment (Williams, et al. 2000).

When only the spoken word is used in communication and instruction, individuals who have, for example, a hearing impairment are not able to participate fully in the learning process (Roberson 2001). For example, the findings in studies that were conducted to establish how computers were used in programmes for learners with a hearing impairment, among others, (Harkins, Koch & Michel, 1994; Deninger, 1985; Harding & Tidball, 1982; Rose & Waldron, 1984), indicate that the expansion of computer technology use for instructional purposes in classes changed the world for these learners by making communication more visual, through, for example, the use of pagers, electronic mail and online services. Such visual telecommunications was, according to Harkins, Koch and Michel (1994), important to these learners because "it can empower them to take initiative at earlier ages than has previously been possible" (pp. 195-196). Highnote-Allgood et al. (2009) also examined the use of computer picture dictionaries to improve expressive communication for learners with a hearing impairment and the results indicated an increase in the number of words learnt after the intervention. As put by Lane, Hoffmeister and Bahan (1996:408), "vision and its associated activities, such as visual/manual language and attentiveness to the visual environment are highly valued" when technology is used. In short, technology in the classroom, including the use of information and communication technology (ICTs) enhances the quality and accessibility of the curriculum, content comprehension and the development of technological skills.

Using technology for teaching language to learners with a hearing impairment

Integrating technology in the classroom of learners with a hearing impairment allows for equal participation that promotes equal opportunities for all learners to achieve their potential. Technology assists learners to be co-creators of their learning environment to make most of their innate capacity to learn (Woods, 2017). According to Cameron (2016), the use of gadgets such as computers and tablets in the education systems to facilitate access to the curriculum has a significant impact on how teachers and learners relate to one another. In Standen, Brown and Cromby's (2001) view, such virtual environments appear to be successful contexts for devising teaching strategies for learners with disabilities, including those with a hearing impairment. Computer based instruction allows learners to take charge of their learning and become less dependent on the teachers (Standen, Brown and Cromby, 2001).

In the mid and late 1980s, research was conducted to establish how computers were used in programmes for learners with a hearing impairment (Deninger, 1985; Harding & Tidball, 1982; Rose & Waldron, 1984) and the findings indicate that the expansion of computer technology use for instructional purposes in classes changed the world for these learners by making communication more visual, through for example, the use of pagers, electronic mail, and online services. Visual telecommunication is, according to Harkins, Koch and Michel (1994), important to these learners because "it can empower them to take initiative at earlier ages than has previously been possible" (pp. 195—196).

Another simulative and attractive thinking tool for learners with a hearing impairment is virtual reality (VR) technology (Passig & Eden, 2000). Pantelidis (1995) describes VR as a multi-media collaborative setting that is computer guided. It provides opportunities for the operator to participate actively in the virtual world. The user becomes an active part of the environment and gains from the interaction without the use of words. The internet, display of video segments and new methods of connecting with others, for example, use of electronic mail and real-time chat, allow learners with a hearing impairment to be set free from "the limited and sheltered interpretation of the world that heretofore had restricted learning and participation" (Propp:647) because of the emphasis on audible-based communication.

Technology as enhancer of comprehension

Acquiring language is an intricate undertaking that involves vocabulary development and comprehension. For example, augmentative and alternative communication (AAC) is an evidence-based approach that addresses fundamental communication shortfalls in children with multifaceted communication requirements, including learners with a hearing impairment (Meinzen-Derr, et al., 2017). AAC techniques provide dynamic visual supports for language development and offer grammatically suitable options to support linguistic expansion. Thus, AAC systems offer a variety of comprehensive language systems to support ongoing language growth. The systems also promote opportunities to access language conceptions and characteristics. This enables learners to use higher level language concepts, important to effectively develop the language skills that are necessary for communicative interactions. It is for these reasons that this study was conducted to examine how the teachers assisted the learners, in particular, those with a hearing impairment to use technology(ies) as tool(s) for learning English.

Mthethwa-Sommers (2012) has pointed out that alternative ways of teaching are crucial for equal participation in lessons especially if they engage lived experiences and categories of understanding based on what Muthukrishna (2008) calls social identity. Recognising different social identities and allowing them full and equal participation to meet their needs (Francis & Le Roux, 2011) is important for promoting socially just education.

A socially just education empowers and challenges inequitable social environments. It recognises diversity and encourages teachers to create empowering, democratic educational environments (Hackman, 2005). It is therefore culturally responsive by encouraging learners to take an active role in their learning. For these reasons, Hytten and Bettez (2011) argue that in a socially just environment teachers need to possess tools for personal reflection and to build relationships that are necessary for effective communication and collaboration. It is in this sense that Hytten and Bettez (2011) view socially just education as inherently part of a democratic way of life.

This notion of democracy underscores Young's (1996) views on the importance of equalising forms of communicative interactions. Her notion of communicative democracy argues for opportunities that emphasise the acknowledgement of different views in an argument and negotiation. For example, Hicks (2002) claims that the process and outcomes of this notion are inclusive, just and reasonable. Advocates of communicative democracy hold that an adequate ideal of inclusion has to acknowledge that all individuals are capable of making informed and insightful judgements and decisions. The ideal explains the principle of equal respect in communicative democracy.

It is for these reasons that Young's communicative democracy was considered valuable to examine how teachers engaged the different technological competences of learners with hearing impairments when teaching them English. Their strategies were of particular interest in the study. For example, how they used teaching strategies to facilitate and develop equalising forms of participation, communication and mutual respect within the learning process (Reich 2007) was crucial to probe to understand how they encouraged learners to develop their English language vocabulary, sentence construction and other competences.

By examining the strategies used to raise learners' awareness about how they could use technology to learn the different ways in which the English language is used in everyday life, in particular, how sentence construction was taught through, for example, varying means of accessing content, including technological devices such as IPads, computers (Diaz-Rico 2013) was of interest. The assumption was that technology had to scaffold content instruction. Multimedia and visuals cues had to help to solve language development and acquisition problems.

In the study we wished to answer the question: how effective is technology in teaching English as a second language to learners with a hearing impairment? The following sub-questions helped in obtaining responses to the question.

- What forms of technology were used for teaching English as a second language?
- How were the teachers using the technology as a teaching resource?
- How were the learners interacting with the technology?
- How effective was the technology for both the teaching and learning processes?

The Study

Context

Botswana's education system is governed by the Ministry of Education, Skills and Development.

The education policy in Botswana

The first National Policy on Education (NPE) of 1977 was formulated to do away with the British model of education and provide a more inclusive education system (Makwinja 2017). The second policy known as the Revised National Policy on Education (RNPE) was meant to prepare Batswana for the transition from a traditional agro-based economy to an industrial one. It also addressed issues of access, equity and the

general improvement of the quality of education (RNPE, 1994). For example, the RNPE (1994) indicated the goal of the junior certificate curriculum (form 1 to 3) as fostering children's proficiency in the use of Setswana and English language for effective communication. The curriculum was to enable the learners to understand their society, culture and be patriotic. Learners are also expected to be knowledgeable in mathematics, science and social studies in addition to learning how to utilise the computer, appreciate technology, understand scientific concepts, and become analytical and critical thinkers.

The education system has seven years of primary education, three years of junior secondary education, and two years of senior secondary education. Each year at the primary level is referred to as a standard while secondary levels are referred to as forms. Ten years of basic education, leading to a junior certificate qualification are compulsory and approximately half of the school population attends a further two years of secondary schooling leading to the award of the Botswana General Certificate of Education (BGCSE). After leaving school, learners can attend one of the seven technical colleges in the country, or take vocational training courses in teaching or nursing. The best learners enter the University of Botswana.

Primary education and secondary education in Botswana

The RNPE admitted that the poor quality of education is due to inadequate facilities (RNPE, 1994). Despite all the attempts to provide learning facilities classrooms in Botswana still carry more than the capacity although it was recommended that a class must hold between 30—35 learners. For example, it is not uncommon to find a primary classroom filled with 40—45 learners.

The schooling system in Botswana is divided into public and private schools. In the primary school, from standard one to seven, progression is currently automatic to ensure that all learners are exposed to ten years of basic education. At this level learners are assigned one teacher for a single standard. One teacher is responsible for all the subjects up to standard seven. From the primary school learners progress to a three year junior certificate programme that goes up to form three. Completion of the junior certificate programme may lead to admission to the senior secondary school programme. Only those pupils whose grades are high enough in the Junior Certificate Examination are admitted to the senior secondary programme.

At the senior secondary school, the learners would take a maximum of 10 subjects. The curriculum includes six core subjects (English, Setswana, social studies, mathematics, integrated science, design and technology and a basic computer awareness course). The learners select a maximum of four optional subjects from the following list: home economics, agriculture, commerce, principles of accounts/bookkeeping and office skills (Makwinja 2017).

Primary schools are usually feeder schools for secondary schools that are relatively a short distance from the schools. Therefore, the feeder school is Y primary school, which is about a hundred metres away. Y primary school has a unit for learners with a hearing impairment and has boarding facilities to accommodate learners from other areas of the country. In fact, there are two junior secondary schools in Botswana, that cater for learners with a hearing impairment, W is in the north and serves the northern and north-western region and X junior secondary school servers the southern and western regions. Both schools have boarding facilities to accommodate the learners with a hearing impairment from across the country.

The sample

X secondary school is located in a village in the South East of the country and is approximately 30 kilometres to the south of the capital city Gaborone. It is an 18 stream school, which means it has six form one classes, six form two and six form three classes. The student population is approximately 500 learners and includes 40 with a hearing impairment. Out of the 40, 24 are boys and 16 are girls.

The majority came from poor backgrounds and the government was responsible for their well-being, for example, supplying them with school uniforms. The learners did the same subjects as their hearing peers, for example, English language as a second language.

Two classes of form 3 participants were chosen for a baseline assessment. One class (class O) consisted of seven learners and the other (class P) had nine learners. The learners were chosen because of their familiarity with digital devices in the school. They were admitted to the school in 2017 and had adequate exposure to the technology used but mostly used sign language. They were taught in a special education unit. Those who used devices such as hearing aids had residual hearing and were thus able to communicate orally. In addition, the school availed documents about the learners' background, their degrees of hearing impairment and their general academic performances over the years. Each class had about 10 learners but the one chosen for the study had seven learners. According to the school records, the degree of their hearing impairment falls within the range of deaf to hard of hearing. Two learners with residual hearing use hearing aids.

A baseline assessment for the two classes was administered to determine their level of English language comprehension. Computers were used for the test in which they had a bank of words to choose from to construct simple sentences. All the learners in one class O were able to construct the sentences, but the other group from the class P faced difficulties in completing the task. The class that demonstrated some understanding of how English language sentences are constructed was selected for the study. In this case it was class O. The sample for this study was thus one form 3 class with seven learners.

The learners' age ranged from 14 to 16 years. They came from various parts of the country and all resided in the school hostel.

The learners could write intelligible sentences, express their needs and respond appropriately when spoken to. However, although not adequately competent in comprehension of English language due to limited exposure, in general, they could recognise some English words but a few understood their meaning. They participated in extra curricula activities such as sports with their hearing counterparts.

Two teachers for the English language shared the six classes of learners with a hearing impairment. They had qualifications in special education obtained from the University of Botswana. They were also English language teachers and both had more than five years of teaching learners with a hearing impairment and were confident in using technology in their teaching. Table 1 below provides the full profiles of these teachers.

Table 1: Profile of English language teachers

Teacher	Gender	Qualification	Institution	Years of experience
Teacher 1	Female	BEd (Special Education major)	University of Botswana	10+
Teacher 2	Female	BEd (Special Education major)	University of Botswana	10+

Ethical clearance to gain access to the school and invite the participants to get involved in the study was obtained by asking for consent, respecting participants' choices and making them aware that their participation is voluntary (Ramos, 1989). To promote quality interaction between the researchers and them and facilitate the collection of reliable data, trust had to be built by allowing them to raise and discuss their concerns regarding participation. When assured that their participation was voluntary, that their privacy will be respected at all times and that the information they shared was for the purpose

of the study only they agreed to get involved in the study. Their confidentiality and anonymity was also ensured by using pseudonyms for them and the school.

Data collection tools and research process

For ensuring the trustworthiness and credibility of the data, it was important to triangulate its collection (Thurmond, 2001). The research tools and process that were employed to ensure this are discussed below.

Document Analysis

Document analysis involves analysis of learners and learning, teachers and teaching knowledge based on the official documents (Posner, 1992). It should look at the goals as well as the content in relation to the learners and context. This method was used to examine the purposes and objectives of teaching, learning and knowledge to establish how they fit together with the technology that was to be used.

Classroom materials that indicated how teachers integrated technology in their lessons were studied. The teachers provided their term plans as well as their daily lesson plans to be scanned before the lesson was conducted. Files of classroom exercises and activities were examined for language functions. The RNPE (1994) and school policy documents on the use of technology provided cues about what to look for as regards focus and coherence. In this sense, the purpose of document analysis was to assess the material taught and if the goals that were set (Jansen, 2009) were supported by the technology the teachers planned to use.

Observations

The study employed observation as a method of data collection to capture how the teaching practices, planned activities and learning materials were used to create an environment and interactions with participants (Potter, 1996) that facilitated language development for learners with a hearing impairment. They observed lessons thus provided contextual information to frame the analysis and make sense of the data collected, that is, develop insights into the context of teaching and sensitive issues that the participants may be unwilling to discuss.

This study adopted direct observation of the strategies employed by teachers in teaching language to learners with hearing impairment using technology. The observations provided opportunities to capture the teaching in its natural setting and assesses it (Grove & Fisk 1992). A single subject research approach, which according to Horner, et al. (2005) is experimental rather than descriptive was used.

For twoweeks, learners were taught sentence construction using a variety of words. Traditional methods such as pairing the learners to support each other in organising tasks and doing the write-ups and/or presentations were used. In addition, they were allowed various opportunities to practise repeating words, appropriate word use and sentence construction.

To aid their memory, the material taught had to be copied and thereafter the learners were asked to gap fill the answers. In some instances, to check comprehension, learners were given matching activities. Total communication was used to teach sentence construction and allow the learners to speech read to improve their language skills and overall communication efficiencies. In the subsequent week, technology-based teaching methods were employed to teach sentence construction. Each participant was allowed access to a tablet in addition to other devices such as computers. For 10 minutes prior to a 30-minute lesson, learners were allowed to engage actively with the device without guidance. They randomly constructed sentences from a bank of words available in their tablets and, for each correct sentence, they were awarded a point. The sentences were projected on the interactive board for other learners to view.

In the five days, words in their order of complexity were introduced to learners from either the computers or their tablets. In between the activity, video clips were downloaded and projected to learners for them to see how sentences are constructed and develop skills, for instance, in projecting pictures. They were then instructed to provide names for the pictures and use them in a sentence. In the last day of the intervention the teacher chose the appropriate language page-set from the computers that allowed room for growth but also exploited the learners' existing communication skills. The chosen page set had age-appropriate vocabulary grounded on the child's overall accomplishment on the baseline language testing and information drawn from the primary language sample. Room for language progress was also important, for instance, a child with marked language skills may require access to a wide-ranging vocabulary base. Tablets were used to promote guided discovery learning where they were asked, for instance, to send each other emails with properly constructed sentences in an effort to foster written English language development. The learners repeated the tasks to foster competence and enhance the validity of the results (Martella, Nelson & Marchand-Martella, 1999).

Interviews

Two teachers were interviewed for the study. The semi-structured interviews lasted for 30 minutes. The interview questions were meant to encourage them to explain how effective the use of technology was in developing the language competence of learners with a hearing impairment who had to learn English as a second language.

Data management and analysis

The study used thick description (Holloway & Todres, 2003) to make explicit the patterns of social interactions observed, explain them and put them into codes by assigning a word or phrase to each coding category for easy sorting and organising. Interview transcripts and observation notes were perused in systematic way and ideas chunked and co-related to find differences and similarities and then assign codes. Transcribing the spoken word to the written word to facilitate the identification of codes from the transcripts (that is, observation notes and recordings from the interviews) helped in categorising the data. Once the ideas were identified/coded, they were categorised to uncover trends from which themes for analysis emerged (Miles, Huberman & Saldana, 2013). Finally, the analysis was given to the teachers to check its authenticity. Their input and comments helped to validate interpretation of the researchers (Shenton, 2004).

Data presentation and discussion

The data in the study show that the achievement levels of learners with a hearing impairment in the English language skills were improved when using technology.

Improved language skills

An analysis of lesson plans revealed that the two teachers in the study planned to integrate technology in their pedagogy. There was a clear shift from print-dominated literacy practices to multilayered forms of ICTs. Interviews with them also uncovered interesting views regarding the use of technology in their pedagogy. They indicated that technology had significantly added value to their teaching practice, learner interest was stimulated by the use of gadgets and they had noted an improvement in the development of some language skills of the learners.

In the lessons observed, the learners used language purposefully and creatively with technology to initiate and present intelligible sentences. As they were engaged in an activity where they chose words from their devices to construct sentences, the attention was focused on the screens as words popped up in different colours. One student was approached by the teacher to observe his progress.

The student raised his hand and said to the teacher: "The way these words are popping up is interesting and makes the activity easy, please give us some time to work on it on our own?" The teacher responded by saying "Ok". However, before using the internet, one learner tried to construct a sentence as follows, "home I go", however, after surfing the net, he corrected the sentence as "I go home" and confidently told the teacher that the sentence was now correct. In general, technology also generated enthusiasm and undisrupted attention on the tasks. As the evidence indicates, when class exercises done without using technology were compared to exercises done with the help of technology, there was a marked difference in terms of learner performance.

Before the study, the learners had to do a language assessment exercise to determine a language competence baseline score. Based on the initial scores of the learners, the mean number of different words used were significantly lower at the commencement of the study. However, when using technology, the learners performed better. The results noted from class exercises and assignments revealed a significant improvement for learners when gadgets were used.

The teachers paired the learners and each pair worked on a single computer or tablet. By collaborating they discovered new words which they used to construct sentences on their own. For example, during the five days of using technology, the learners could download from the internet words that had the same meaning as a word provided by the teacher and use them to complete sentences. Many could link the words. Also, as they interacted using the computer, they were able to confidently position themselves in lessons as they argued for the words chosen. The internet provided or associated these words with pictures to clarify their meanings. As a result, the learners could improve their vocabulary as they identified two more words that meant happy. For example, when the learners were given the following words: excited, happy and joyful; to use to complete sentences by inserting the correct one in the gaps, they first surfed the internet for the meaning of the other two and thereafter were able to use them correctly. The sentences they had to complete were the following;

- My mother was ———— when she saw me.
- It is ———— to have a birthday party'.
- I was ————- when I travelled to the city'.

When the activity was completed, it became clear that they understood the meanings of the three words. They were also asked to construct their own sentences using their devices and with the help of the teacher managed to do so. At the beginning of the lesson, although at secondary school level, it appeared as if the learners were only aware of the word happy as they could not provide synonyms for it. However, with the help of technology, they could, as a first step identify words that meant happy and learn to build their own sentences with others as the teacher guided them on how to do so.

In addition to vocabulary, as regards word choice and familiarity, language style also played a key role.

For example, the teachers noticed that when using technology, the learners chose different language styles. Their approach to language use was more reflective than anticipated. This was demonstrated by, for instance, when learners engaged one another in using words for different contexts. When requested to sit opposite each another around a table and given another word, namely "bank" to use in sentences referring to different contexts, the following sentences were given as examples:

- People use the bank to keep their money safely.
- I saw a crocodile on the river bank.
- I try to do things myself and do not bank on my parents for everything.

During this sentence construction activity, one learner called the teacher over to ask about how he could use different words in a sentence, that is, word arrangement. He had a brief discussion with the teacher and self-corrected. The discussion was follows;

Student: "How does one arrange the words colour and different in the following sentences? "My tablet has different colours" and "My tablet has colours different"

Teacher: "What do you think?"

Student: "I think the first sentence is correct and the second one can only be correct if you add "that are" between the words "colours" and "different"

Teacher: "Well done, I am proud of you"

Leu, Kinzer, Coiro & Cammack (2004) assert that technology avails new opportunities for communication and information. As the evidence indicates, using a digital device with the learners in X junior secondary school encouraged them to develop their vocabulary. The development of comprehension through using the computer, regardless of cognitive abilities, was possible among these learners. As Roberson (2001) also argued, the use of educational technology allowed them to be involved in the educational process. When technology was used, the learners, despite their impairment, felt empowered to be active participants in the learning process. Equalising forms of communication and participation by using technology as another means to teach English, not only exposed the learners to a different strategy, but as Young (1996) would argue, it democratised communication between the teacher and learners and among the learners themselves. Since the learners had some skill for using the internet, they did not depend solely on the teacher in seeking information that they needed. Their involvement motivated and evoked their interests in the lessons, as they received affirmation from the teachers and their peers. As Mthethwa-Sommers (2012) also argued, the alternative approach to teaching was important for equal engagement in lessons. It is therefore reasonable to conclude, based on the evidence provided, that language intervention approaches employing technology are valuable for language comprehension and expressive skills (Schlosser & Wendt, 2008). Romski, et al. (2015) demonstrated with his systematic analysis that early technology intervention augments communication and language development for learners. The teachers in this study confirmed this and felt strongly that technology assisted the language development of their learners. The use of peer-to-peer tutoring when using the internet appeared, in their view, more effective than depending solely on their teacher directed methods.

Peer-to-peer tutoring

When a pair of learners were provided with one word and asked to construct a sentence using the same word but in different contexts, they would have a brief conversation. The following is an example of their conversation about the word "bank":

Student 1: "Have you ever seen a bank on a river?"

Student 2: "No". The wall on the side of a river is called a bank".

Student 1: "I never knew that".

Student 2: "There is a bank where we keep our money and the wall on the side of a river is called a bank".

Student 1: "Thank you" but how can she (pointing at a fellow learner) bank on herself?

Student 2: She means doing things for herself and not asking her parents.

An important visual cue which, curiously, mattered significantly to the learners" language comprehension, was concrete representations. Punctuation seemed less important, except for one learner who felt

confident that she had used the correct punctuation and capital letters in the correct places to convey meaning. The learner was able to recognise punctuation symbols on her device and what they would be used for. She was able to explain that the symbol (.) is used at the end of a sentence and (,) is used between words in a sentence and (?) is used in a sentence that asks a question. Thereafter, when the class was asked to look for the meaning of punctuation symbols and assist each other to clarify what the symbols meant, during their discussions they also could correctly point to a symbol such as a full stop (.), comma (,), question mark (?) and their meaning when used in a sentence. However, when given the following and asked to insert appropriate punctuation symbols, a few of them confused a comma and a full stop and made mistakes that needed to be corrected.

- What is the name of your school (.)(,)(?)
- My friends hep me with my school work (?)(.)(,)
- Our teacher likes sports (,)(.)(?) clothes (.)(?)(,) children and her friends.

A number of studies have demonstrated that children using technology are inspired by it and are confident to learn more by using it (Talkmitt, 1996). However, as suggested by Kress (2003), the kind of reading and writing offered by multimodal digital technologies need not replace more systematic and reflective forms of literacy as technology use can build on these analytic forms. These forms of technologies, as Cummins, Brown and Sayers (2007) suggest, enhance the development of literacy skills needed to function academically but Passig (1996) argues that technology only forms a "presymbolic" communication where the user can interrelate with the imaginary world. Therefore, given the language competence of the learners in this study, it is reasonable to assume that their digitally negotiated abilities could provide scaffolding for foundations of literacy that they found difficult to master on their own. Since they struggled to use language in a more composite way to traverse meaningful sentence construction, technology mainly enabled them to be actively involved in the learning environment (Pantelidis, 1995). They benefitted and actively participated in the learning process, found the technology amusing and appealing, some even indicated to the teacher that they required less interference during the activities, but still faced difficulties when they were required to use words to create complex sentences with the aid of their gadgets. For example, they were asked to create the following sentence using words such as 'come, the, after, to, finish, room, task, with, your, their, completing, advise, activities' for the sentence would appear as follows: "*come to the room after competing your task and advise others to finish their activities*", this proved difficult. Many were only able to construct three-letter words sentences. Using the same three-word sentence they constructed as example, to construct a more complex one that included more words presented some challenges. The words were different but had the same meaning, for example, beautiful: attractive, pretty, lovely and stunning. The following are some of the example sentences they were asked to construct using the words:

The ..... girl I saw at my school had a ..... picture that she drew.

His little sister put on a _____ dress and, when she visited my aunt, she was admiring the _____ landscape.

Some learners indicated that they were seeing some words for the first time and struggled to appropriately use them in a sentence. The following is an example of how one of them presented his sentence; "... she was admiring the *pretty* landscape when I visited my aunt".

Although technology played a crucial role in teaching learners with a hearing impairment, in the interviews the teachers were concerned with the lack of support from the school administration. They highlighted the need for regular training to successfully embed technology in lessons. They would like to see more digital devices introduced to complement their teaching approaches. Upon further

enquiry, one teacher indicated that, "as much as it took us a while to get accustomed to technology use, after embracing it, we are far in terms of academic outcomes compared to colleagues who are still reluctant to use it". Another lamented, "we need to get our school administration on board, they still lack enthusiasm and it affects progress". They requested the administration to provide experts to help them explore further how to use the gadgets but their request was never acceded to. A letter of request was shown to the researchers as evidence. Even though their learners, more than their hearing peers, needed various means of teaching them a second language, the education authorities were unresponsive. Despite national government policy, one of the school administrators emphasised that they themselves were still not confident with using technology hence the challenge to extend support to the teaching staff.

Concluding remark

The evidence in this study indicates that, generally, digital devices can be therapeutic tools for learners with communication challenges. Their use improved second language skills by closing the gap in their language development through expanding vocabulary, cooperative learning and expressive communication. These are skills the learners need to succeed in the 4IR environment. Technology has proven crucial for respecting and recognising the attributes that learners with a hearing impairment possess to assume responsibility for their own language development. In particular, the study has demonstrated how such recognition is motivating and affirming their identities as adequate resource for meaningful learning.

References

Akamatsu, C.T., Mayer, C. & Farrelly, S. (2005). An investigation of two-way text messaging use with deaf learners at the secondary level. Journal of Deaf Studies and Deaf Education, 11(1), 120–131. doi:10.1093/deafed/enj013

Andrews, R. (Ed.). (2004). *The impact of ICT on literacy education*. Psychology Press.

Au, K.H. (1998). Social constructivism and the school literacy learning of learners of diverse backgrounds. *Journal of literacy research,* 30(2), 297–319.

Barker, R.M., Akaba, S., Brady, N.C. & Thiemann-Bourque, K. (2013). Support for AAC use in preschool, and growth in language skills, for young children with developmental disabilities. *Augmentative and Alternative Communication,* 29(4), 334–346.

Beach, R. & Lundell, D. (1998). Early adolescents' use of computer-mediated communication in writing and reading. *Handbook of literacy and technology: Transformations in a post-typographic world, 379,* 93–112.

Brady, N.C., Thiemann-Bourque, K., Fleming, K. & Matthews, K. (2013). Predicting language outcomes for children learning augmentative and alternative communication: Child and environmental factors. *Journal of speech, language, and hearing research*.

Brandt, D. & Clinton, K. (2002). Limits of the local: Expanding perspectives on literacy as a social practice. *Journal of literacy research,* 34(3), 337–356.

Breivik, J.K. (2005). Deaf identities in the making: Local lives, transnational connections. Washington, DC: Gallaudet University Press.

Bryman, A. & Burgess, B. (Eds.). (2002). *Analyzing qualitative data*. Routledge

Bryman, A. & Burgess, R. G. (1994). Reflections on qualitative data analysis. *Analyzing qualitative data*, 216–226.

Bowe, F.G. (2002). Deaf and hard of hearing Americans' instant messaging and e-mail use: A national survey. *American Annals of the Deaf*, 6—10.

Cameron, J. (2016). *The artist's way*. Penguin.

Cummins, J., Brown, K. & Sayers, D. (2007). *Literacy, technology, and diversity: Teaching for success in changing times* (pp. 91—111). Boston, MA: Pearson.

Cummins, J. (1994). From coercive to collaborative relations of power in the teaching of literacy. *Literacy across languages and cultures*, 295—331.

Deninger, M.L. (1985). Plenary Address: Is It Still an Apple for the Teacher?. *American annals of the deaf*, 130(5), 332—339.

Diaz-Rico, L.T. (2013). *The cross-cultural, language, and academic development handbook: A complete K-12 reference guide*. New York, Pearson Higher Ed.

Fawson, E.C. & Smellie, D.C. (1990). Technology transfer: A model for public education. *Educational Technology*, 30(4), 19—25.

Flower, L. (1994). *The construction of negotiated meaning: A social cognitive theory of writing*. SIU Press.

Ford, R.C. & Richardson, W.D. (1994). Ethical decision making: A review of the empirical literature. *Journal of business ethics*, 13(3), 205—221

Francis, D. & Le Roux, A. (2011). Teaching for social justice education: the intersection between identity, critical agency, and social justice education. *South African Journal of Education*, 31(3), 299—311.

Frank, C. (1999). *Ethnographic Eyes: A Teacher's Guide to Classroom Observation*. Portsmouth, Heinemann .

Grove, S.J. & Fisk, R.P. (1992). Observational data collection methods for services marketing: an overview. *Journal of the Academy of Marketing Science*, 20(3), 217—224.

Guthrie, J.T., Wigfield, A., Barbosa, P., Perencevich, K.C., Taboada, A., Davis, M.H. & Tonks, S. (2004). Increasing reading comprehension and engagement through concept-oriented reading instruction. *Journal of educational psychology*, 96(3), 403.

Hackman, H.W. (2005). Five essential components for social justice education. *Equity and Excellence in Education*, 38(2), 103—109.

Harding, R.E. & Tidball, L.K. (1982). A national microcomputer-software survey of current microcomputer usage in schools for the hearing impaired. *American Annals of the Deaf*, 127(5), 673—683.

Harkins, D.A., Koch, P.E. & Michel, G.F. (1994). Listening to maternal story telling affects narrative skill of 5-year-old children. *The Journal of Genetic Psychology*, 155(2), 247—257.

Henderson, V., Grinter, R.E. & Starner, T. (2005). Electronic communication by deaf teenagers (Informally published manuscript). Georgia Institute of Technology, Atlanta, GA. Available at: https://smartech.gatech.edu/ handle/1853/8451.

Henderson-Summet, V., Grinter, R.E., Carroll, J. & Starner, T. (2007, September). Electronic communication: Themes from a case study of the deaf community. In *IFIP Conference on Human-Computer Interaction* (pp. 347—360). Springer, Berlin, Heidelberg.

Hicks, D. (2002). The promise (s) of deliberative democracy. *Rhetoric and Public Affairs*, 5(2), 223—260.

Highnote-Allgood, M., Heller, K.W., Easterbrooks, S.R. & Fredrick, L.D. (2009). Use of picture dictionaries to promote functional communication in learners with deafness and intellectual disabilities. *Communication Disorders Quarterly*, 31(1), 53—64.

Hillegeist, E. & Epstein, K. (1991). Interactions between language and mathematics with deaf learners: Defining the "language-mathematics" equation. *Advances in cognition, education and deafness*, 302—307.

Holloway, I. & Todres, L. (2003). The status of method: flexibility, consistency and coherence. *Qualitative research*, 3(3), 345—357.

Horner, R.H., Carr, E.G., Halle, J., McGee, G., Odom, S. & Wolery, M. (2005). The use of single-subject research to identify evidence-based practice in special education. *Exceptional children*, 71(2), 165—179

Hytten, K. & Bettez, S.C. (2011). Understanding education for social justice. *The Journal of Educational Foundations*, 25(1/2), 7.

Janks, H. (2000). Domination, access, diversity and design: A synthesis for critical literacy education. *Educational review*, 52(2), 175—186.

Jansen, J. (1991). The state and curriculum in the transition to socialism: The Zimbabwean experience. *Comparative Education Review*, 35(1), 76—91.

Kress, G. (2003). *Literacy in the new media age*. Routledge.

Lacina, J. & Watson, P. A. (2008). New from ACEI Publications: Focus on Literacy: Effective Content Teachers for the Middle Grades. *Childhood Education*, 84(3), 159—162.

Lane, H.L., Hoffmeister, R. & Bahan, B.J. (1996). *A journey into the DEAF-WORLD*. Dawn Sign Press.

Lee, Y., Jeong, S.W. & Kim, L.S. (2013). AAC intervention using a VOCA for deaf children with multiple disabilities who received cochlear implantation. *International journal of pediatric otorhinolaryngology*, 77(12), 2008—2013.

Leu, D.J., Kinzer, C.K., Coiro, J.L. & Cammack, D. W. (2004). Toward a theory of new literacies emerging from the Internet and other information and communication technologies. *Theoretical models and processes of reading*, 5(1), 1570—1613.

Lewis, C. & Fabos, B. (2005). Instant messaging, literacies, and social identities. *Reading research quarterly*, 40(4), 470—501

Light, J. & Drager, K. (2007). AAC technologies for young children with complex communication needs: State of the science and future research directions. *Augmentative and alternative communication*, 23(3), 204—216.

Liggett, T. (2014). Deliberative democracy in English-language education: Cultural and linguistic inclusion in the school community. *Democracy and Education*, 22(2), 4.

Luke, A. (2000). Critical literacy in Australia. *Journal of adolescent and adult literacy*, 43(5), 448—461.

Makwinja, V.M. (2017). Rethinking Education in Botswana: A Need to Overhaul the Botswana Education System. *Journal of International Education Research*, 13(2), 45—58.

Maiorana-Basas, M. & Pagliaro, C.M. (2014). Technology use among adults who are deaf and hard of hearing: A national survey. *Journal of deaf studies and deaf education*, 19(3), 400—410.

Manovich, L. (2001). What is new media. *The language of new media*, 18—41.

Martella, R., Nelson, J.R. & Marchand-Martella, N. (1999). Research methods: Learning to become a critical research consumer. Boston: Allyn & Bacon.

Mein, E. (2009). Literacy, knowledge production, and grassroots civil society: Constructing critical responses to neoliberal dominance. *Anthropology & Education Quarterly*, 40(4), 350—368.

Meinzen-Derr, J., Wiley, S., McAuley, R., Smith, L. & Grether, S. (2017). Technology-assisted language intervention for children who are deaf or hard-of-hearing; a pilot study of augmentative and alternative communication for enhancing language development. *Disability and Rehabilitation: Assistive Technology,* 12(8), 808—815.

Miles, M. B., Huberman, A.M., & Saldana, J. (2013). *Qualitative data analysis: A methods sourcebook*. Sage.

Millar, D.C., Light, J.C. & Schlosser, R.W. (2006). The impact of augmentative and alternative communication intervention on the speech production of individuals with developmental disabilities: A research review. *Journal of Speech, Language, and Hearing Research*.

Morrell, E. (2002). Toward a critical pedagogy of popular culture: Literacy development among urban youth. *Journal of Adolescent & Adult Literacy,* 46(1), 72—77.

Mthethwa-Sommers, S. (2012). Pedagogical possibilities: Lessons from social justice educators. *Journal of Transformative Education,* 10(4), 219—235.

Muthukrishna, N. (2008). *Educating for social justice and inclusion in an African context: Pathways and transitions*. South Africa, Nova Science Pub Incorporated.

Nittrouer, S., Sansom, E., Low, K., Rice, C. & Caldwell-Tarr, A. (2014). Language structures used by kindergartners with cochlear implants: Relationship to phonological awareness, lexical knowledge and hearing loss. *Ear and Hearing,* 35(5), 506.

O'Brien, T. (2004). Writing in a foreign language: Teaching and learning. *Language teaching,* 37(1), 1—28.

Okuyama, Y. & Iwai, M. (2011). Use of text messaging by deaf adolescents in Japan. *Sign Language Studies*, 11(3), 375—407.

Osler, A. & Starkey, H. (Eds.). (2005). Citizenship and language learning: International perspectives. Trentham Books.

Pantelidis, V. (1995). Reasons to use VR in education. VR In The Schools, 1(1), 9. Available at: http://www.soe.ccu.edu/vr/vrits/1-1pante.htm.

Passig, D. (1996). *Virtual reality in education*. Ramat-Gan, Israel: School of Education, Bar-Ilan University

Passig, D. & Eden, S. (2000). Enhancing the induction skill of deaf and hard-of-hearing children with virtual reality technology. *Journal of Deaf Studies and Deaf Education,* 5(3), 277—285.

Pilling, D. & Barrett, P. (2007). Text communication preferences of deaf people in the United Kingdom. Journal of Deaf Studies and Deaf Education, 13(1), 92—103. doi:10.1093/ deafed/enm034.

Posner, G.J. (1995). *Analyzing the curriculum*. McGraw-Hill Humanities Social.

Potter, W.J. (2013). *An analysis of thinking and research about qualitative methods*. Routledge.

Power, M.R., Power, D. & Horstmanshof, L. (2006). Deaf people communicating via SMS, TTY, relay service, fax, and computers in Australia. *Journal of deaf studies and deaf education,* 12(1), 80—92.

Propp, G. (1978). An overview of progress in utilization of educational technology for educating the hearing impaired. *American annals of the deaf,* 123(6), 646—652.

Ramos, M.C. (1989). Some ethical implications of qualitative research. *Research in Nursing and Health,* 12(1), 57—63.

Roberson, L. (2001). Integration of computers and related technologies in deaf education teacher preparation programmes. American Annals of the Deaf, 146(1), 60—66

Reich, W. (2007). Deliberative democracy in the classroom: A sociological view. *Educational Theory,* 57(2), 187—197

Republic of Botswana. (1994). The Revised National Policy on Education April 1994. Gaborone: Government Printer

Romski, M., Sevcik, R.A., Barton-Hulsey, A. & Whitmore, A.S. (2015). Early intervention and AAC: What a difference 30 years makes. *Augmentative and Alternative Communication,* 31(3), 181—202.

Rose, S. & Waldron, M. (1984). Microcomputer use in programmes for hearing-impaired children: A national survey. *American Annals of the Deaf,* 129(3), 338—342.

Rosenblatt, L.M. (1994). The transactional theory of reading and writing.

Rosenblatt, L.M. (1985). Viewpoints: Trans- action versus interaction—A terminological rescue operation. Research in the Teaching of English, 19, 96—107.

Schlosser, R.W. & Wendt, O. (2008). Effects of augmentative and alternative communication intervention on speech production in children with autism: A systematic review. *American journal of speech-language pathology.*

Schwab, K. (2015). World economic forum. Global Competitiveness Report (2014-2015) *Retrieved 24 April 2019 from http://www3. weforum. org/docs/WE Global Competitiveness Report_2014-15.pdf*.

Sevcik, R.A. & Romski, M. (2000). AAC: More than three decades of growth and development. *Asha leader,* 5(19), 5—6.

Shenton, A.K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for information,* 22(2), 63—75.

Spencer, L. & Ritchie, J. (2002). Qualitative data analysis for applied policy research. In *Analyzing qualitative data* (pp. 187—208). Routledge.

Standen, P.J., Brown, D.J. & Cromby, J.J. (2001). The effective use of virtual environments in the education and rehabilitation of learners with intellectual disabilities. *British Journal of Educational Technology,* 32(3), 289—299.

Stewart, P. (2009). Facebook and virtual literature circle partnership in building a community of readers. Knowledge Quest, 37, 28—33.

Strauss, A. & Corbin, J.M. (1997). *Grounded theory in practice*. Sage.

Street, B. (2003). What's "new" in New Literacy Studies? Critical approaches to literacy in theory and practice. *Current issues in comparative education,* 5(2), 77—91.

Sutherland, R., Armstrong, V., Barnes, S., Brawn, R., Breeze, N., Gall, M. & Wishart, J. (2004). Transforming teaching and learning: embedding ICT into everyday classroom practices. *Journal of Computer Assisted Learning,* 20(6), 413—425.

Talkmitt, M. (1996). VESAMOTEX-Virtual Education Science and Math of Texas. *VR in The Schools,* 1(4), 5—7.

Thurmond, V.A. (2001). The point of triangulation. *Journal of nursing scholarship,* 33(3), 253—258.

Williams, D., Coles, L., Richardson, A., Wilson, K. & Tuson, J. (2000). Integrating Information and Communications Technology in Professional Practice: an analysis of teachers' needs based on a survey of primary and secondary teachers in Scottish schools. *Journal of Information Techology for Teacher Education,* 9(2), 167—182.

Willis, A.I. (2003). Parallax: Addressing race in preservice literacy education. *Making race visible: Literacy research for cultural understanding*, 51—70.

Woods, P. (2017). Researching holistic democracy in schools. *Democracy & Education*.

Yoshinaga-Itano, C., Sedey, A.L., Coulter, D.K. & Mehl, A.L. (1998). Language of early-and later-identified children with hearing loss. *Pediatrics-English Edition,* 102(5), 1161—1171.

Young, I.M. (1996). Communication and the other: Beyond deliberative democracy. *Democracy and difference: Contesting the boundaries of the political,* 31, 120—135.

INVESTIGATING THE FLIPSIDE OF E-LEARNING IN MALAWI UNIVERSITIES

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Abtract: Malawi adopted distance learning as early as 1965 and converted it to e-learning around 2011. Since then, spaces of higher learning have been mandated through Acts of Parliament to make e-learning a component of knowledge delivery and engagement in higher education. This mode of learning is centred on the use of technology. It is argued that the predominance of the face-to-face (F2F) delivery mode excludes deserving students from accessing higher education.

This paper argues that although e-learning has the potential to provide ubiquitous access to education, it has the potential to exclude the disadvantaged rural masses in Malawi. In other words, the claims that e-learning is ubiquitously accessible; fits well into the knowledge economy grid; is cost effective and cost saving; and that the technology used therein drives socio-economic and education changes might be falsified assumptions that can potentially altogether ruin the education landscape. This paper asserts that although the proponents of e-learning justify it as invincible, they subtly ignore complex historical, socio-economic and cultural realities inherent in the miscellaneous knowledge forms of the users.

This is a conceptual paper which utilises critical theory (CT) as the main paradigm. In using this, we intend to challenge the self-evident claims that e-learning would produce similar benefits in all contexts. In this regard, we employ the notion of "ideology critique" to understand e-learning and the extent to which these would militate against rural conditions.

Key words: E-learning, ODeL, critical theory, ideology critique

Introduction

"I just prefer the course materials to be printed as I want to revisit it, be able to highlight crucial sections, write down some notes on it, and take it with me. This way, I can make the most of my time whenever needed" (Zozie, 2017).

Comments like these have become common among ODeL students in Malawi and elsewhere (McNally & Rutland, 2009; Zozie, 2017). These are the comments that made us undertake this study. As a conceptual study, it will use existing literature on this topic and analyse it using critical theory to understand power-relations and the role of ideology within e-learning contexts.

In Malawi, it is often difficult for ODeL students to have their voices heard as they do not have representation in the Mzuzu University (Mzuni) student union. Moreover, the statutes establishing the students' union did not provide for ODeL executive members. Furthermore, ODeL students spend most of their time home, and have additional obligations that prevent them from collective bargaining processes. Accordingly, such voices may be lost when policies are being designed. To bolster these voices, this study highlights key issues that confront ODeL students in Malawi most of which come from poor rural families. The paper further reconceptualises a framework upon which policies e-and practices in ODeL or e-learning context can be based. We contend that when framing policies on instructional media, students' voices must be prioritised.

ODL in Malawi in a glance

Access to education in Malawi is historically based on the premise of equity and equality (Chimpololo, 2010; Zozie, 2017). The egalitarian values upon which this premise is founded originated in the 19th century European colonisation. It is this emphasis on egalitarianism that has increased student populations in many countries including Malawi (Lamond & White, 2008). Increased access similarly led to the desire for more inclusive student population in HE institutions.

Following this, Malawi established the Malawi College of Distance education (MCDE) in 1965 to provide primary and secondary education. In 1999, the Domasi College of Education and Mzuni (1997) were established to contain the growing numbers of students wanting HE as the University of Malawi (Unima) could only manage to enrol 0.3% of the qualified students (Zozie, 2017). ODeL was then envisaged to have the potential to remove the barriers of time, space, age and distance (Chimpololo, 2010). Since then Malawi began to invest in a perceived "quality ODeL" model. Within these contexts, print-based instruction supported by some basic technologies have been utilised until 2018. However, from 2019 onwards, Mzuni opted to use e-learning as a dominant mode of delivering instruction. This comes at the time when 80 per cent of Malawi's population are living below the poverty line of $1.96/day (Zozie, 2017). Besides this, most of these people live in the rural areas where technologies are problematic. Nationally, only 13 per cent has access to technologies (Freedom-house, 2018). Accordingly, making e-learning the primary mode in ODeL raises more questions than answers given these realities.

While e-learning has presented us with many opportunities, it has not been short of hitches. With techno-developments, institutions have been required to invest heavily in IT infrastructure, training and content which have created a lot of cultural, socio-economic dilemmas (McNally & Rutland, 2009). It is further argued that educators now need to do more research in e-learning to create holistic knowledge practicelys that can foreground best practices in ODeL (Murphy, et al, 2012; McKellar & Warburton, 2013). According, this paper is a response to these calls, and answers the question:

How far is Malawi justified to use e-learning as a primary mode for delivering education in ODeL contexts?

Previous studies in this area

Lack of studies in ODeL have been blamed on the confusion that exists between the terms ODeL and e-learning, something seen even at state policy levels (McNally & Rutland, 2009). Following this, the New Zealand Qualifications Authority sought guidance on how best they could change the qualification standards from ODL to *"e-learning"*. Similarly, in 2017 Mzuni management asked the University Council to change the name Centre for Open and Distance Learning to the Centre for Open, Distance and e-Learning to give prominence to e-learning.

While these terminologies do overlap, ODeL is defined as planned teaching and learning activities at a distance though use of instruction media such as print and technologies (Perraton, 2002). E-learning, conversely, refers to learning supported by digital tools (Zozie, 2017). For Mzuni, the difference between the two is obscured and absent. Moreover, in typical e-learning learner/teacher interaction and collaboration are encouraged through the internet and social media tools (McKellar &Warburton, 2013). E-learning proponents assume that technologies can solely increase access to education at a cost-effective price (Kim & Chong, 2010). They further argue that e-learning is ubiquitous (anywhere, anyone, anytime); fits well into the knowledge economy grid; and fosters interaction, academic performance and critical thinking. Accordingly, government has prioritised investment e-learning infrastructure arguing that this is the only means to increase access to education and efficiency (Friesen, 2008).

While some of these claims can be contested, Jaffe (1998) admonishes educators to view e-learning as a window of opportunities for the source of hitches now facing HE. He further cautions that adopting

e-learning based on mere generalisation may become costly for the entire HE system. Similarly, Zozie (2017) notes that in Malawi few studies have been done upon which e-learning policies could be based on. Agreeing with Jaffe, McNally and Rutland (2009) and Grimwood (2006) argue that if e-learning can increase access to education equitably, then it must ensure that there is equality and justice. The challenge for Malawi now is to ensure that injustices do not arise due to the adoption of one delivery mode that may compromise students' learning choices and socio-economic conditions.

Methodology

For us to effectively critique e-learning claims, we used critical theory and ideology critique. Within critical theory, we used critical knowledge typology as used by Friesen (2008); Habermas, (1990) and McLaren (2009 who used it in similar contexts. Essentially, we examined existing literature and policy documents in this field and analysed them using critical theory to locate the claims, myths and practices that perpetuate injustices in ODeL.

Critical knowledge typology

McLaren (2009) and Habermas (1971/1990) identify technical (performative/productive), practical/experimental, and emancipatory knowledge as typologies for critiquing ODeL. They consider technical and experimental knowledge as ideological, and emancipatory knowledge as empowering and liberating. They also believe that all knowledge is political, subjective, multiple and influenced by human interests.

When knowledge is manipulated, it becomes an ideology for oppressing the powerless and the poor. Education must therefore help co-create emancipatory knowledge for empowering all learners. McLaren also condemns the standardised modules as ideological, hegemonic, elitist and biased against the poor students. Likewise, the socio-mobility goal of education is faulted for preferring productive knowledge over other knowledge forms hence leading to knowledge commodification, annihilation and capitalism. The tenets of knowledge typology, commodification, annihilation and capitalism help us understand the conditions and practices within e-learning contexts in Malawi, and how these militate against students' access and participation in education.

Ideology/immanent critique will in this context involve questioning ideas that are considered self-evident and can subjugate the powerless learners. It asks questions like: Why is it being portrayed like this? In whose interest is it being made to look so? What is its relationship to other marginal knowledge forms? How might it have been naturalised? How can this "naturalisation" be undone? Thus, Ideology critique identifies ideologies in dominant knowledge forms; analyse it against other marginal forms; shows that behind these claims live some politics and contradictions, and uses these contradictions to generate action for change.

We now critically analyse the four key themes based on the literature review above using critical theory and ideology critique.

The knowledge economy claims

It is mostly claimed that "knowledge," "information", "the networked" or "the post-industrial," are indispensable in our life today (see Bell, 1999; Kim & Chong, 2010). These claims imply that all levels of education need to undergo tremendous modifications to support the different forms of learning systems. Accordingly, we meet claims such as: "In what is coming to be called the 'knowledge age' the challenge is to take the children along ... a developmental path from natural curiosity to a disciplined, creative and mature knowledge producer" (Scardamalia & Bereiter, 2003:1370). Better still, "the new economy has placed the acquisition of knowledge and the role of education at the center of national development" (NEPAD, 2013). And "in this knowledge-driven era ... education is a lifelong endeavour and

may no longer need traditional artefacts such as teachers, classrooms, blackboards, degrees, printed-books of our historical learning eras" (Gandel, Katz & Metros, 2004:73). Claims like these have social, political and moral implications.

While technology does not come out clearly in this claim, it is possible to imply that such statements do point to the rising need for increasing access to education which has been deemed to be achievable through e-learning. Probably this could be the reason traditional educational artefacts are now being viewed as obsolete amidst the proliferation of advanced technologies and e-learning platforms. (Scardamalia & Bereiter, 2003, & Polsani, 2003). Historically, the idea of a new cultural, socio-economic era anchored in information has a politically charged background. By historicising the idea of the knowledge economy and information age, we want to demonstrate its ongoing construction, actual and probable debates that have existed.

It all began with a paradigm shift from an industrial-based economy to a knowledge-based economy around 1973 (Friesen, 2008; Gandel, Katz & Metros, 2004). Furthermore, Bell (1999) titled his book "the Coming ... post-industrial society" in which he foregrounded the emergency of a new socio-economic era of the 21st century. Bell presents the characteristics of this era and how it would unfold. He observes that there will be a shift from manufacturing to service the economy and that manufacturing workers would significantly fall while professional, social and technical jobs would increase. A decade later, in the US and Africa this prophecy came to pass (Friesen, 2008; Gandel et.al., 2004).

Bell also added another characteristic of the era which would be an enormous increase in the significance of education which would then lead to massification, commodification and marketisation. Peters and Roberts (2008) observe that today education has indeed become the basis for social mobility due to an increase in professional, social and technical jobs as foretold in the first feature. Similarly, due to this increased importance for education based on the assumptions of social mobility, universities have now abandoned their roles as service providers to that of business or profit-making enterprises. As businesses which seek to increase marginal returns and profits, they now emphasise massification of education, commodification of knowledge and marketisation of knowledge. And when social mobility takes the centre stage (Friesen, 2008) technical knowledge gets prioritised to attract more clients most of whom lie at the margins between poverty and prosperity. Thus commodification, marketisation and preference of technical knowledge constitute what has come to be termed as epistemic injustices in which students are epistemically and economically exploited (Peters & Roberts, 2008).

Using social mobility as a means to hoodwink poor learners through promised job opportunities is immoral in itself as these learners will at some point have to grapple with realities between unemployment and poverty and/or employment and poverty. Simply put education does not in any way guarantee employment and prosperity nor is it the sure way to getting rich given the many cases out there that are in various socio-economic positions with or without education. These are the very notion critical theorists have vehemently challenged (see McLaren, 2009; Habermas, 1971).

Another characteristic Bell (1999:xvii) advanced was the increased importance of technology, which was referred to as "intellectual technology". In this Bell predicted that technologies will form a complex but adaptive system which will benchmark the electronically mediated global economy. This is exactly what we are into as everything is encapsulated in e-this, e-that and e-everything. It will not be surprising to see congregants using computers in their sermons within the church although we cannot tell when and how. Bell later abridged these characteristics into one he called the "Knowledge Theory of Value (KTV) in which knowledge was viewed as the source of creativity and innovation that could add value and increase returns on investment ..." (Bell, 1999:xvii). Today, this view is common among business communities when they talk of novelty-centred business models. In the KTV, socio-economic value of

knowledge is critical for describing the "Knowledge Economy" notion. Bell used KTV to mimic Karl Marx's, "Labour Theory of Value" (LTV). The LTV viewed labour as a unique force that could add value to goods and improve profits. Thus the KTV presented knowledge as being the major driver for innovation, value-addition and profits. Assumptions like these have also created serious problems in the production, delivery and consumption of knowledge in HE. These have further complicated the maxim of knowledge forms and nature as theorised by philosophers (Habermas, 1990; McLaren, 2009).

Because of the KTV, the "knowledge work" by HE institutions has become a lucrative enterprise. Since schools are perceived as vehicles for delivering productive knowledge and scientific knowledge, they have now become "knowledge society or knowledge economy" (Drucker, 1994; Peters & Roberts, 2008). This means they now emphasise economic and social values more than service provision and creation of autonomous and responsible individuals (see Freire, 2005; Habermas 1990; McLaren, 2009). Essentially, schools have now become machines for reproducing knowledge to the masses. Bell concedes that this force is usually mobilised in natural sciences and or applied social sciences:

> *The major problem for the post-industrial society will be the training of adequate numbers of professional and technical staff ... Thus the expansion of science-based industries will require more engineers, chemists ... The need for social planning ... will require large numbers of persons trained in the social and biological sciences (Bell, 1999:232).*

On this, Newman & Couturier (2001) warn educators not to be overtaken by these claims as they argue that the schools and the post-industrial agendas do not match. They observed that the school in its current form seems to be incapable, unprepared and antiquated as it still operates with resources of the First or Second Industrial Revolution. Similarly Smith (2005) and Lucas (2003) concede that schools are indeed stuck in the past and just do not have the muscles to meet their post-industrial era ambitions. This implies that the schools do not know where to go and do not have necessary tools to move with their technologically driven agendas. It is not strange now that many countries in Africa despite being stuck in the mud conceptually and infrastructure-wise are still dreaming in colour about e-learning and the Fourth Industrial Revolution (4IR) at the expense of their cultural, socio-economic realities (McNally & Rutland, 2009; McLaren, 2009).

Like we saw above, the KTV prefers certain forms of knowledge over others. For instance, when we consider knowledge as a performative/productive force, it is not the same as emancipatory knowledge (Habermas, 1990; McLaren, 2009). Within the knowledge economy discourse or the KTV itself emancipatory knowledge and indigenous knowledge seem to be absent giving the assumption that such knowledge is irrelevant in the 21st century or is indeed inferior to other knowledge forms. This assumption leads to epistemi-cide or knowledge annihilation which constitutes epistemic injustices (Peters & Roberts, 2008). Similarly, Mason (2003) describes knowledge within e-learning contexts as a thing that can be atomised, repurposed, updated, recombined, metered, exchanged, advertised and sold at a much higher price than the physical book or labour. This is a practice (McLaren, 2009; Peters and Roberts, 2008) described as knowledge commodification which leads to knowledge capitalism and exploitation of the poor learners.

Masson, et al. further argues that when such knowledge is modularised, and you add industry-fit terminologies such as "learning objectives", it becomes "learning objects" or "knowledge objects."" They are these "objects" which are highly valued as machines for generating income for institutions. They are also these digital objects that get more attention in e-learning than anything else hence leading to the objectification of the learners and teachers. By theorising knowledge as a commodity or digital objects, knowledge becomes monolithic, fixed and neutral; an assumption Habermas (1990) and McLaren (2009) rejected. Instead, knowledge is judged based on a single criterion such as its performance (Polsani,

2003). Polsani further argues that performative knowledge is valued more than any other knowledge forms contrary to critical theorist assumptions (Habermas, 1971/90; McLaren et al., 2009). Moreover, the neutral knowledge as proclaimed by scientists enables what is called "technical decision-making" (Bell, 1999: 34). And technological management within knowledge discourse is as good as diametric opposites of ideology. Thus technological management is usually "calculated" and instrumental while ideology is emotional and expressive. By showing how these ideas originated, and how they continue to evolve hopefully destabilises the claims that have been advanced as absolute truths. From the way the knowledge economy has been described, one would think that technology or 4IR jobs would hold the number one spot. Nevertheless, if we use national statistics, the first three leading jobs in America, Africa and Malawi in particular are hospitality, healthcare, education and retail among others but not technology. The leading jobs imply that getting a job will mature knowledge producer or critical thinkers who can make sound decisions and have narrative imagination and empathy with some 4IR skills (Nussbaum, 2012). Thus Bell (1999) labelled the 21st century as "knowledge and service economy" as it represents a shift from the manufacturing era.

The implication with the above view is that service jobs are less paying and have low status. These jobs also require short-to medium-term on-the-job training which mostly may not count for future opportunities. This creates social and economic polarisation as the rich get richer while the poor get poorer. This is so because the rich tend to take advantage of the economic, knowledge and technology changes to increase their wealth while the poor are subjected to these technologies.

Precisely, beneath the simplicity of the buzz words, "knowledge economy" waits some socio-economic developments that are full of contentions and contractions. These claims obscure this clash by generalising the situation of one group of people (knowledge workers) to the population as a whole. To simply state that learners need to be put on the path leading to knowledge work is to ignore the reality that the ostracised forms of work "social work" equally count. To acknowledge this is also to acknowledge that education must actively nurture a range of skills that are relevant to different cultural, socio-economic environments and the 21st century in general. Since technologies seem inescapable in education, e-learning has to go beyond mere reproduction, understanding and construction of knowledge as being a mere disinterested and productive force valued in terms of performance. On e-learning, critical theory has urged us to move beyond mere conceptualisation of black boxes of knowledge, separated from the contexts and interests of the producers and users. Thus educators must be able to open up these black boxes and locate the owners; their motivations, implications and the contexts this knowledge fits.

The ubiquity factor or anyone, anywhere, anytime claims

Higgins (2006) observes that the proponents of m/e-learning claim that anyone can learn anytime anywhere while in buses or flights, etc. From a psychological perspective, this claim may be faulty given that learning needs concentration and brainwork. Now, how many of us would really want to learn while in transit, instead of relaxing in the comfort of that coach, or indeed in that frightening flight? Accordingly, Razak (2004) argues that since the principles of education cannot just be changed to suit e-learning; e-learning may only become a complementary delivery mode of education. This is also true considering that in developed countries, the majority of the youth also referred to as "digital natives", rarely use m-devices for crude learning purposes as they lack motivation for doing so (Foss, et al., 2012). Similarly, Zozie (2017) and Higgins (2006) observe that when a new learning option is developed, users' habits will usually take a long time to change. In China and Japan, for example, students still preferred buying printed-books and attending face-to-face campuses but not free e-learning; a situation that is common in Africa and Malawi in particular (Higgins, 2006; Zozie, 2017).

While e-learning proponents ignore these realities and instead cite trivial problems such as electricity, connectivity, etc. well knowing that such problems do not only affect education but life in general; we argue that the issue is not all about trivial obstacles but habits, pedagogical, technical and medical. Medically, studies show that there is a strong correlation between e-learning and brain tumours, audio-visual impairments and blood pressure (Sievert, et al., 2005 & Braune, et al., 1998).

Pedagogically, since e-learning takes place anywhere anytime, it raises questions on how educators follow up on achievements for students who are geographically isolated and interspersed. And, if individuals take full responsibility of their own learning (Higgins, 2006) how do institutions monitor who is doing what and how as is the case with face-to-face traditional education? Likewise, lack of "always on connectivity" makes tracking a difficult task, expensive and complicated given the huge geographical dispensation. In fact one does not always get immediate feedback but simply catches the data on the device and uploads it when internet connectivity is available (Higgins, 2006). Generically, both common sense and good pedagogical practices have taught us that learning and teaching need quick interactions, dialogue and collaboration for it to be most effective (Freire, 2005; McLaren, 2009). Additionally, without on-site supervision during examinations, lecturers have no reason to trust that the answers they get online are coming from legitimate students, and this is a weakness with e-learning.

Another problem with e-learning is student attrition. Studies show that 20-30 per cent of e-learners do not finish their programmes (Rovai, 2002; & Zozie, 2017). This is because lack of fixed study schedules which tend to encourage laxity and indiscipline among adolescent learners. There is also an absence of a "learning atmosphere" (Friesen, 2008) as students report that e-learning is time consuming and inefficient. Since e-learning means "learning on the move", the surrounding environment may interrupt the process. When such distractions occur frequently, students may become resistant (Higgins, 2006).

Just like the "knowledge economy" claims, "ubiquity" claims suggest a similarly reductive conception of identity, location and education. Instead of christening one group as representative of the entire population, it is particular people, times and places that may be seen as representative of others. Historically, when the internet was seen as the "next killer app" that threatened to erase traditional campuses, educators thought that they had find answers to problems of discrimination in education (Cairncross, 1997; Ried, 1998). These sentiments were given authority as captured in "ubiquitous" phrases and "access to learning". Nevertheless, since the irritations and usefulness of the internet became common, people began to realise that these two worlds were the same. This means that there is a binary opposition between the internet and "the actual world", and that it is not holy as claimed.

Even then, claims of having "anyone" online and ably create on-line identity are still common in e-learning studies although such studies cursorily justify their claims (Friesen, 2008; Zozie, 2017). Others glorify m-devices, and social media on how these platforms help users construct online identities but nominally justify their claims (Cameron & Anderson, 2006). The freedoms of ""nowhere-ness and facelessness"" presumed by e-learning scholars, do not exist in isolation of the limitations of the "actual" and "physical" world. Factually, individuals may not freely create online identities that can simply erase the physical markers of race, culture and gender (McNally & Rutland, 2009). Online forums have demonstrated that gender is often visible based on discourse styles and features individuals may not know or easily change. Female communication is manifested in an aligned orientation towards its interlocutors, while men present an aggressive orientation (Nakamura, 2002). Nakamura argued that the same tools that were believed to eliminate culture, gender and racial biases were the tools that promoted "cyber-type" stereotypes. He concludes that cyberspace propagates, disseminates and amplifies discrimination. These demonstrate that it is impossible to simply construct an online identity or persona ex nihilo from scratch.

Another limitation to the ubiquitous claim is the "digital divide" notion. It is argued that the ubiquity claims collapses at the borders of the developed nations (Peters & Roberts, 2008). These include Europe, North America, Japan, and South Korea minus South America, Asia, Africa and the rest. Even within the OECD, a digital divide exists based on socio-economic classes. The digital divide between the rich and the poorer has been critical for demystifying the ubiquity claims and socio-economic conditions. Presumably, the digital divide widens when the lowest income deciles are compared with the highest income deciles both in Malawi and elsewhere (McNally & Rutland, 2009).

Briefly the ubiquity notion is misleading when subtly understood, and its shortfalls become visible when issues of identity, place and time are understood abstractly. The reality is that when we go online, we are not simply ubiquitous but rather, we are positioned figuratively in terms of identity, place and time by the messages that bombard us. By positioning we mean the complex interrelationship between agency and objectification (Friesen, 2008). For example, to play the role of a teacher online or in a physical classroom is to be an individual into pre-determined structures reinforced through actions. Once positioned, an individual's identity is somehow determined by such actions, the way you are addressed and your responses. Positioning or "formation" of character occurs in the context of prescribed roles and expectations, stereotypes and responses to discriminatory terms. Since the hegemonic may be in the majority, it is them whose ideas or labelling leaves a mark on the powerless and the minority. Since online-content developers seek demographic segments that have disposable income, it should not be strange that the kind of identity that the Internet or e-learning addresses by default is white, male and the rich but not "other" (Nakamura, 2002:58). This way, the experiences of a small privileged group is generalised to mean "all". Thus diversities, tensions between multiple subjects "position" inherent in class, race and gender are again sugar-coated. With e-learning, it implies that learners are by default consumers who are assumed to be able to consume and learn in a default space dominated by economic contradictions. We have argued that instead of sugar-coating these claims, scholars may need to emphasise the elimination of inequalities within e-learning contexts; expose how such myths become normalised and demonstrate how such claims militate against students' learning choices and participation in education.

Technology drives educational change

This claim appears in the context of the impact of technology and how it influences change in education and life in general. This claim is also bloated by the "laws" of technically driven change found in pro-technology studies. For example, Moore's Law of the regular doubling of computer processor speeds; Kurzweil's Law of accelerating return positing the exponential nature of technical innovation among others (Friesen, 2008).

This claim assumes that technological progress is independent of social conditions as it can make things or unmake them. By using the word "impact" technology is assumed to possess traumatic repercussions on individuals. Technology is also subsumed to offer society and education a destiny. On this, Bull, et al. (2002) forecasted that it is just a matter of progress, design and price that technology would rule the educational world. They cautioned schools to get prepared for this revolution or remain behind as victims. They also cautioned educators to act before the tipping point since it would occur only once. This implies that educators are not seen as agents but rather objects whose future is in the hands of technologies. In fact the wording of this warning resembles the biblical way of Jesus' second coming and the judgement day in which humans are presented as powerless and cursed objects ready to be judged.

Besides this, Roger's (2003) Technology Acceptance Model (TAM) (Mahony and Wozniak, 2006) examines how people adopt technologies as ready-made artefacts. Rogers categorises tech-adopters as early adopters, late adopters and laggards. These labels signal how various responses are viewed in the TAM just as teachers and students are categorised in e-learning (Zozie, 2017)

To critique this claim, we need to look at alternative sources of data just like we did before. Moreover, studies that affirm that technological determinism or the belief that technologies drive are many and mostly misleading. According to Smith and Marks (1994) "hard" determinism seeks to argue that technology has the power to change things hence must be a necessity. What makes this determinism hard or optimistic is that the "positive" aspects of this change are over emphasised unlike the negatives. For example, staff members who do not embrace change are bluntly called "laggards" rather than being called the "wise few" eager to resist the consequences of technologies.

Recently, e-learning has demonstrated counter examples that challenges "hard" determinism assumptions. For example, the emergence of learning management systems in education since the 1990"s (Foss, et al., 2009; Bull, 2002; Chandler, 1995) has failed to erase traditional educational artefacts as predicted by many scholars discussed above. Instead, through series of negotiations, technology has been re-shaped, adapted and appropriated in education through the development of Web 2.0. McKellar and Warburton, (2013) adds that even those technologies that emerged within university walls only managed to reinforce institutional identity and functions but not disrupting the original artefacts as people claim. By juxtaposing the terms "adaptation", "negotiation" alongside "impact", "laws" and "indispensable"; the relationship between technology and education gets complicated. The former suggest that technology is neither antagonistic nor an inimitable force that can define the future like the latter seems to suggest. This could be the reason Feenberg (2002) describes technology as an ambivalent process of development suspended between different possibilities. We can therefore argue that technology is not a destiny in self but rather a scene of struggles and contradictions.

Technology interactivity, critical thinking driver and cost-effectiveness claims

The usual claims scholars make are that technologies can change the way society accesses knowledge and offer it at a cheaper cost (Wani, 2013). He argues that e-learning has enabled universities to expand their current geographical reach and establish themselves as global leaders. While scholars who holds this view are many (Hawkes & Cambre, 2000; Zozie, 2017; Foss, et al., 2012, etc.) they subtly ignore context realities and the heterogeneity of learners.

Wani and others note that there are many contradictions that occur within e-learning contexts. He argues that the desire for interactionism, originality and feedback challenges e-learners and teachers. Likewise repetitive postings, clashes on discussion topics, and cyber-bullying are recorded obstacles. Accordingly, many students report that face-to-face mode is indispensable as they can get immediate feedback at no cost and instantaneously. Like Wani, Zozie (2017) notes that in Malawi, students often complained of plagiarism which is perceived as irritating, incomprehensible and unethical. The authors note that this usually happens because of cultural differences as it were the case between Canadian and Russian students. Russians like Malawians culturally present their ideas formally making them resemble plagiarised content while Canadians use an online tradition of messaging. Contradictions like these extend to use of terms that may be culturally sensitive as they cannot be censored by the internet. Furthermore, the multi-tasking feature of technologies allows for popups which distract students' concentration and pace of learning. These are recorded as obstructions and contradictions to e-learning success and they do constitute epistemic injustices inherent in e-learning.

Summarily, meaningful interaction depends on the availability of network, data bundles, IT infrastructure, attitude and disposable income otherwise these claims remain cosmetic. Like Freire (2005) argues, interaction, problem-posing and problem-solving are pillars to critical thinking. This means to liken online interaction with human interaction is absolutely missing the context. The delay in feedback, net-obstructions and cultural clashes testify that e-learning has issues worth attending to first. Those that question the ability of e-learning to promote quality education and critical thinking might be justified.

Conclusion

We do accept that emerging technologies have brought radical changes in the HE landscape although adopting and using them are different matters. The question of legitimacy to make e-learning the primary delivery mode for education in Malawi is yet another.

These findings have provided answers to this complex question through the lenses of critical theory and ideology critique. We thus managed to demonstrate that some claims that pamper e-learning may be ill-founded and myths. We did not only desire to condemn these claims but also offer alternative conception of the same, and demonstrate complex issues need to be re-interpreted to understanding e-learning. Importantly, future research may get compromised if its discourses are rooted on myths. Thus understanding technology as a contradiction but not a destiny (fait accompli) helped demystify the myths unlike simply locating techno-impacts and contributions within institutional practices.

There is need for in-depth studies into the tensions created by the introduction of e-learning tools, subjects, objects and rules. While technology is premised on its assumed claims (Zozie, 2017; Daniels, 200), others have argued that e-learning is constrained by IT infrastructure, poor interactionism, cultural wars, isolationism, voice suppression, knowledge commodification, annihilation and capitalism, and other inequalities (Lamond & White, 2008; Peters & Roberts, 2008).

We recommend that educational transactions be viewed as "cycles of interactionism" among the stakeholders. Within communication lives noise that pervert-coding, decoding and encoding processes and may render communication impotent. This means when designing policies, learners' voices on access to and use of technologies are vital and these can be regained through an independent ODeL union. Importantly, the type of knowledge and media needs to be multiple and suited to learners' contexts to complete this cycle. For Malawi, e-learning must be considered as complementary to minimise digital divide, economic and ethical dilemmas among other issues. Only when such issues are reviewed will e-learning play much less an indispensable role. You can argue that e-learning does not only mean m-devices, the question changes, "what proportion of poor rural learners can afford a small but inexpensive computer equipped with the internet kit?" Your answers are as good as ours.

References

Bell, D. (1999). *The coming of post-Industrial society: A Venture in Social Forecasting*. (Special Anniversary Edition). New York: Basic Books.

Braune S., Wrocklage C., Raczek, J., Gailus, T. & Lüching, C.H. (1998). Resting blood pressure increase during exposure to radio-frequency electromagnetic field. Lancet, (351):1857—1858.

Bull, G., Garofalo, J. & Harris, J. (2002). Grand Challenges: Preparing for the technological tipping point. *Learning & Leading with Technology* 29 May 2002.

Cairncross, F. (1997). *The death of distance: How the communications revolution will change our lives*. Boston: Harvard Business School Press.

Cameron, D. & Anderson, T. (2006). Comparing weblogs to threaded discussion tools in online educational context, 2(11).

Chandler, D. (1995). Technological determinism. Accessed 27/04/2019, from: http://www.aber.ac.uk/media/Documents/tecdet/tecdet.html.

Chimpololo, A. (2010). The prospects and challenges of open learning and distance education in Malawi. *International Journal of Educational and Pedagogical Sciences*, 4(6), 618—623.

Cooper-Taylor, C. (2007). Proposed change to domain name "Open and Distance Learning". Unpublished Response to the New Zealand Qualifications Authority. *The Distance Education Association of New Zealand*.

Drucker, P.T. (1994). The age of social transformation. *The Atlantic Monthly*. November, 53—79. Feenberg, A. (2002). *Transforming technology: A critical theory revisited*. OUP.

Foss, B., Oftedal, B.F. & Løkken, A. (2009). *Rich media e-Compendiums: A new tool for enhanced higher education*. Kjell Arholms hus: University of Stavenger. Retrieved on 20/3/2019 from https://www.uis.no.

Freire, P. (2005). *Pedagogy of the oppressed*. New York: Continuum.

Friesen, N. (2008) Critical Theory: Ideology Critique and the myths of e-learning. Ubiquity, ACM Digital Library. 2008(6). Accessed from https://ubiquity.acm.org/article.cfm?id=1386860 on 23 March, 2019.

Gandel, P.B., Katz, R.N. & Metros, S.E. (1004). 'The weariness of the flesh': Reflections of the mind in an era of abundance.' Journal of Asynchronous Learning Networks. 8(1): 70-79. Accessed April 27, 2008, from: http://www.sloan-c.org/publications/jaln/.

Grimwood, P.R. (2006). *Distance learning and e-learning in New Zealand's ITP sector. Options and opportunities — Keynote address*. Paper presented at the Distance Education Association Conference, Auckland.

Habermas, J. (1971). *Knowledge and human interests*. Boston: Beacon Press.

Habermas, J. (1990). *Moral consciousness and communicative action*. Cambridge, MIT Press.

Hawkes, M. & Cambre, M. (2000). "The Cost Factor" in *Technological Horizons in Education*, 28(1): 26—36.

Higgins, M. (2006). Weaknesses inherent in mobile-phone learning and factors that limit its visibility. *The JALT Call Journal* , 2006 (2.1).

Jaffe, D. (1998). Institutionalised resistance to asynchronous learning networks. *Journal of Asynchronous Learning Networks, 2*(2), 21—31.

Kim, S. &Chang, M. (2010).*Computer games for the math achievement of diverse students*. Educational Technology & Society, 13(3), 224—232.

Kolko, B; Nakamura, L. & Rodman, G. (2000). *Race in cyber-space: An introduction*. New York: Routledge.

Lamond, H. & White, B. (2008). *Issues in equivalence: information literacy and the distance student*. Paper presented at the Distance Education Conference in New Zealand.

Lucass, J.W. (2003). Theory-testing, generalization, and the problem of external validity. The University of Akron. https:// journals.sagepub.com.

McLaren, P., Hammer, R., Sholle, D. & Reilly, S. (2009). Rethinking media literacy: a critical pedagogy of representation. New York: Peter Lang.

Mahony, M.J. & Wozniak, H. (2006). Roger's Diffusion of Innovation Theory and professional development in e-Learning: a case study of the 'CHS e-Learning Resource and Staff Support Project'. *Breaking Down Boundaries: Institutional Perspectives in ODL*: 70—78.

Mason, R. (2002). "E-learning: what have we learnt? Improving student learning using learning technologies" in *Proceedings 9th Improving Student Learning Symposium*: 27—34.

McKellar, P. & Warburton, S. (2013). Developing an e-reader and e-publishing model for ODeL in LLB programme at the University of London'. *European Journal of Law and Technology,* 4(1).

McNally, B. & Rutland, P. (2009). The baby or the bath water? Computerised technologies, educational provision and social injustice in New Zealand. Collected Conference Papers and Abstracts September 2009. *The Cambridge International Conference on ODL*. CUP and COL, Cambridge.

Murphy, A., Martin, N. & Farley, H., (2012). Using e-readers to increase access to course content for students without internet Access. *Ascilite Wellington*, pp. 689—691). Accessed on 4/3/2019 from https://www.ascilite.org.au/conferences.pdf.

Nakamura, L. (2002). *Cyber-types: Race, ethnicity, and identity on the internet*. London: Routledge. NEPAD. (2003). NEPAD e-Initiative: Ensuring that young people participate actively in the global information society and knowledge economy. Johannesburg. Retrieved on 22/3/2019 from http://www.eafricacommission.org.

Newman & Couturier. (2001). Higher Education and International Student Mobility in the Global Knowledge. New York, State University of New York Press.

Nussbaum, M. (2012). Children's rights and capabilities approach: the question of special priority. *Public Law and Legal theory Papers*. Chicago, Chicago Unbound.

Perraton, H.D. (2002) *Open and distance learning in developing world*. London: Routledge.

Polsani, P. (2003). Network learning. Kristof Nyíri Ed. Communications in the 21st Century. *Essays on Philosophy, Psychology, Education*. Passagen Verlag, Vienna: 139-149.

Razak, F.H.A. (2004). Understanding interaction experience in mobile learning. *Computer Human Interaction: Proceedings Lecture Notes in Computer Science*, 3101, 672—674.

Reid, E. (1998). "The self and the internet: variations on the illusion of one self." In Gackenbach, J. (ed). Psychology and the Internet: Intrapersonal, interpersonal, and transpersonal implications. San Diego: Academic Press.

Rovai, A.P. (2003). "A practical framework for evaluating online distance education programmes" in *The Internet and Higher Education*, 6(2): 109—124.

Scardamalia, M. & Bereiter, C. (2003). Knowledge building. In *Encyclopaedia of Educatio*n. (2nd ed., pp. 1370—1373). New York: Macmillan.

Siegrist, M., Earle, T.C., Gutscher, H. & Keller, C. (2005). Perceptions of mobile-phone and base station risks. *Risk Analysis*, 25(5): 1261.

Sievert, U., Eggert, S. & Pau, H.W. (2005). Can mobile phone emissions affect auditory function of cochlea or brain stem? *Otolaryngology* — Head and Neck Surgery, 132 (3): 451—455.

Smith, M. & Marx, L. (1994), *Does technology drive history? The Dilemma of Technological Determinism*. Cambridge, MA: MIT Press.

Smith N.S. (2005). Solving the "Cottage Industry" Problem in E-Learning Programmes. Xplanazine. January 5, 2005. http://www.xplanazine.com.

Wani, H.A. (2013). The relevance of e-learning in higher education. *Jurnal Kajian Pendidikan*, 3(2). Atikan: Sopore.

Zozie, P. (2017). *Integrating e-learning technologies into teaching and learning in higher education in Malawi*. PhD thesis. University of Glasgow, Glasgow.

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