TEACHING PEDAGOGIES OF SOUTH AFRICAN MATHEMATICS TEACHERS TO MAXIMIZE LEARNER SUCCESS.

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Greetings

Professor Puleng Lenkabula: Principal and Vice Chancellor of the University of South Africa, Professor Thenjiwe Meyiwa, Vice Principal: Research, Postgraduate Studies, Innovation & Commercialisations, Professor Mpine Makoe, Executive Dean of the College of Education, Professor Pinkie Mabunda, Deputy Executive Dean of the College of Education, Professor David Mtetwa, Professor of Mathematics Education the respondent for my inaugural lecture, Professor Johannes Seroto School Director of Teacher Education, Professor Dhlamini COD Department of Mathematics Education, my family, Hatfield Christian Church pastors and the congregation, Ellel ministries, colleagues, and friends. I am pleased and humbled to be given this opportunity to deliver my inaugural lecture which encapsulates my lifetime research and practice accomplished in my academic journey in mathematics education. In this lecture I reflect on the development of my thinking through more than 35 years of research in mathematics classroom practice and teacher education.

Abstract

South African learners continue to achieve poorly in mathematics in comparison to other countries. Yet mathematics is a key requirement for not only entry into higher education, but also for overall economic development and growth. This is attested in several reports including TIMSS, Programme for International Student Assessment (PISA), Southern and Eastern Africa Consortium for Monitoring Educational (SACMEQ). Goal 4 of the South African Millennium Development Goals (MDG) states that, quality education for all should be ensured. Although there are numerous factors influencing learner achievement in South Africa, the instructional practices that mathematics teachers use have a profound influence on students' learning and achievement. In this lecture, I first present an autoethnographic account of my experiences as both an academic and a Mathematics educator. An autoethnographic approach is adopted to

express an individual account of my experiences in Mathematics education. I must admit that an emotional slant knits together a seamless narrative to this presentation largely influenced by a pedagogical perspective however, both challenges and successes permeate my entire journey as an educator and an academic. Understandably, the narrative of my journey as a Mathematics educator may not sufficiently represent the views and the enormous experiences recorded by some of my colleagues here present. Nevertheless, my own perspective on Mathematics education may add value towards improving learner achievement primarily when espoused by collective efforts from all stakeholders within the education system in South Africa.

The structure of my presentation focuses on broader issues in mathematics education in view of classroom practices in South Africa. In the final analysis, the lecture will culminate with some conclusions and recommendations.

INTRODUCTION

Generally obtained in our society is the fact that the quest towards accelerating the political and egotistic fanaticism have infiltrated key sectors such the Department of Basic Education and the Department of Higher Education and Training in South Africa (Mabena, Mokgosi & Ramapela (2021, p.451). What dominates the press (including social media) is the worsening of corrupt practices and other forms of criminality in our beautiful nation. In my view, low Mathematics pass rate can be attributed to the situation as explained above. The blame of learners' poor performance is leveraged on Mathematics educators. Henceforth, the development cited above is somehow confirmed by the truism of the following phrase: "The parents have eaten sour grapes, and the children's teeth are set on the edge" (see Waldman, 1989:1-5). Currently, investment into Mathematics education is far from registering a record achievement as expected. Like any adventure, an academic career is also interrupted by numerous challenges. Although the academic community, colleagues, family members and students, would celebrate with an individual for a spectacular achievement and notable accomplishments over long years of service as a Mathematics teacher cannot be enumerated without mentioning the curves and turns, highs and lows, ups and downs encountered along the way.

Educators play a critical role in both the relay and transmission of the much-needed knowledge among societies, and mathematics education specifically. A barrage of criticism has been reported in the past few years on the education system that comprises educators who allegedly lack competitiveness in a Mathematics classroom. (Department of Basic Education; World

Health Organisation, 2020, World Bank Education Global practice, 2020). According to reports, these educators are accused of being the cause for poor Mathematics pass rate in Grades 11-12. Department of Basic Education up to now, and researchers alike, are still looking for ways to improve mathematics pass rates. However, the problem of pass rates should be addressed from the primary school. Hence one of the Project that I lead in the Department of Mathematics Education (MTLIP- *Improvement of pedagogical content knowledge (PCK) and proficiency in mathematics teaching and learning: An intervention project for mathematics teachers*) targets grade 4 mathematics teachers in 20 Schools in Limpopo province to empower teachers on the foundational concepts of numerical and geometrical patterns, common fractions, time, length, properties of 2D shapes and the like giving teachers hands on experience and solving problems in context. (Ngoako, Mphuthi & Ngoepe, 2023).

Learners are also to blame in the context of poor school attendance, and lack of motivation and so forth. Ngoepe (2022) affirm that "motivation is an important factor and that learners should display the willingness to participate in motivating programmes implemented either inside or outside the school". Ngoepe (2022) established that though the learners were enthusiastic to learn Mathematical literacy subject, they raised several factors which hindered their learning that are linked to perceptions towards individual ML learning. These factors consist of the following: influence of peer relationships; lack of career guidance on choices of qualifications; lack of guidance on difficulties experienced; lack of resources and teaching materials; lack of teacher and parental support and social barriers. The above factors will be discussed in this presentation. It is my opinion that there are individuals in our midst today (tonight) who will concur that a calling for a career as an educator in general and a Mathematics teacher in particular is interrupted by numerous unprecedented inconveniences. For example, Makonye (2017:2) says "To date, very little research has been done to understand the problems that the teachers are facing", which serves to illustrate the general mood among educators; most of them exit their Mathematics education career and/or die in silence.

As alluded to previously, the structure of my presentation focuses on broader issues in mathematics education as follows:

- Autoethnographic account
- Conceptualization of mathematics instructional practices,
- Strategies used in countries which are achieving high results in mathematics that lead to learners' success in mathematics,
- Teacher professional development

- Training of mathematics teachers,
- Training in the context of open distance e-learning
- The role of information and communication technology in instructional practices in Mathematics education.
- Attitudes of pre-service teachers
- The impact of the Covid-19 pandemic.
- Selected research projects of postgraduate students.
- Theoretical underpinning
- Decolonizing the mathematics curriculum

Autoethnographic account

Having had no research in my Bachelor of Education (B. Ed) honors degree in the 1980s, the springboard of my research trajectory started with my Masters research report in Mathematics Education at The University of Birmingham, UK entitled *an investigation into the attitudes of student teachers in Lebowa colleges of education towards Mathematics learning and teaching* (Ngoepe, 2001). The idea to investigate attitudes of student teachers was triggered by the negative comments that people always made when the word "mathematics" was mentioned and having observed the behaviors of some student- teachers at the teacher training college in a mathematics didactics. Reflecting on my experience as a lecturer at the Kwena Moloto teacher training college, I realized how some students disliked mathematics, yet primary school teachers are trained as generalists, and they will end up teaching it. They always passed negative comments about the subject, showed a distaste in their behavioral tendencies such as bunking mathematics lectures, late coming, inattentiveness, playful modes, failing tests and examinations, frowning, sleepy, dragging of legs when coming to class. The student- teachers often mentioned that,

> Mathematics is not difficult; teachers are short-tempered, and they ignore strugglers. They are in a hurry and that few teachers can teach mathematics (Ngoepe, 2001)

Often in conversations with people there was a confirmation that associated dislike of the subject with experiences they had with some of their mathematics teachers especially in the primary school. Their main complaint was lack of understanding mathematics concepts, and the seeming 'irrelevance' of the subject to daily life. These sparked my interest in classroom practice research.

My motivation to teach mathematics stemmed from passion. Also seeing that there was a shortage of mathematics teachers. Many learners were failing and not opting for mathematics in schools because there was a lack of qualified teachers. Fear was fueled by teachers and parents, who themselves had bad experiences and negative attitudes. Gough (1954) coined the term Mathema phobia to describe Mathematical anxiety - a feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of mathematical problems in daily life and academic situations. Individuals with math phobia do not necessarily lack ability in mathematics rather, they are not able to perform to their full potential because of the phobia. Before the violence eruption of 1976 in South Africa, very few schools offered mathematics and science subjects. The two options for mathematics were standard grade and high grade. Others were encouraged to opt for standard grade mathematics which was a gatekeeper for those who wanted to pursue careers such as medicine and engineering. Consequently, few Africans did mathematics major at university level in my time, they were discouraged to do this subject on the premise that they will fail and most of them did not get good grades in high school. The mathematics major was for individuals who intended to pursue a Bachelor of Science stream.

In high school (from Grade 8-12), I studied Rekenkunde (Arithmetic) in the medium of Afrikaans and standard grade mathematics (Wiskunde) in matric. I matriculated in 1976 in the heat of riots against teaching in Afrikaans. I studied Mathematics for the first time at university in the medium of English.

It was very hard to translate words from Afrikaans to English, I resorted to memorization of the mathematics concepts. On completion of my Bachelor of Arts degree, I enrolled for a university education diploma (UED) and opted for doing a Method of Mathematics course since I wanted to teach mathematics. At registration, I was not allowed to register for Method of Mathematics. I had to join the queue at Dean's office and persistently pleaded to be allowed to do method of teaching mathematics. The Dean ultimately conceded to my plea and allowed me on the premise that there was a shortage of mathematics teachers. On completion of my UED, as a schoolteacher in a rural village at Ga Mothapo, I was allocated Grade 11 and Grade 12 Mathematics classes. The previous year Grade 12 did not have a teacher. So, I had to teach both Grade 11 and 12 Mathematics. I was teaching morning and afternoon classes to catch up with the backlog. New brooms are supposed to sweep clean. I also volunteered to teach learners mathematics in the Winter school run by South African council of churches to reduce poor performance in mathematics. During my mathematics education career journey as a teacher the then DBE lacked strategies to motivate teachers to improve classroom practice. Alternatively,

teachers were punished through salary cuts. Unfortunately, I became a victim. My salary was cut since I was categorized in the group of poor teaching.

The closing of the College of Education, Mathematics, Science and Technology College (MASTEC) opened an opportunity for me to enter UNISA as a fixed term contract in the Institute of Science and Technology Education (ISTE) in the then Faculty of Science as a research assistant. I was responsible to facilitate data collection of a project that surveyed South African mathematics and science teachers' professional actions and attitudes (Grayson & Ngoepe, 2003). The project was funded by Carnegie foundation. The findings showed that the teachers had limited content knowledge, ineffective teaching approaches, and unprofessional attitudes. This project introduced me to qualitative data analysis research using NUDIST software and conference paper writing.

I went to the College of Education when it was constituted in 2012 and as the Chair of Department (COD) of the Mathematics Education. I witnessed the department grow from the staff of 6 to 19, the development of 42 new modules, and a few community engagement projects. Example of the projects include:

- Comparison of South African and Zimbabwean mathematics teacher pedagogical content knowledge (PCK).
- Analyses of Mathematics Teacher Professional Development Programs in Selected Developed and Developing Countries: Insights for quality Mathematics instruction in Sub-Saharan African countries (Math-TPDP). This project included international collaboration with 10 countries namely, Morocco, Korea, Namibia, Zimbabwe, Botswana, Swaziland, Tanzania, Singapore, and Poland. International colleagues from the above countries had the best performances in Trends in International Mathematics and Science Study (TIMSS) studies and shared established professional development programmes. (Kaino, Dhlamini, Phoshoko, Jojo, Paulsen & Ngoepe, 2015).
- FIRSTMATH project in collaboration with Michigan State University (MSU) - a cross-national study of novice teachers' development of mathematical knowledge for teaching and the influence of previous preparation, school context and opportunities to learn-on-the-job, on that knowledge.
- National Research Number Sense project leader for UNISA, jointly funded by European Union (EU)/ Department of Higher Education and Training (DHET)

- Mathematics Teaching and Learning Intervention Project (MTLIP) that focused on empowering primary mathematics teachers in 20 schools in the Limpopo Capricorn district. Founder of the Mathematics Education Departmental project

I acknowledge the contribution of these projects and several others, and the international visits associated with them as having played a major role in my growth as a researcher in mathematics education and successful supervision of Masters' and Doctoral students.

In my familiarization with Mathematics education, I learned that mental health was a serious challenge among numerous educators, especially mathematics teachers who are checked if they are following the phase pace. I regard educators as pillars of strength and support for their students and their insecurities with mathematics content and pedagogies. I also made a point of prioritizing my own mental health, taking time to practice self-care, and seeking support when I needed it.

In my view, it is critical for either the school or the Department of Basic or both to recognize that educators need support when they become vulnerable to various psychosocial challenges that threaten their wellbeing. In my opinion, the success of teaching and learning Mathematics lies in the wellbeing of the educator. This aspect is generally ignored.

Conceptualization of mathematics instructional practices

A multidimensional mathematics education is not only complex but also comprises a multiplicity of concepts such as practices, theories, and methodologies (see Kuznetsova & Matytcina, 2018: 401-416). This involves the teaching and learning of mathematics both formally and informally. In mathematics education, it is prudent for the educator to be endowed with problem-solving skills (see Geurts, 2018:271-285). Both the Department of Basic Education and the Department of Higher Education and Training (2011) established the Curriculum and Assessment Policy Statement (CAPS) which encompassed a set of problem-solving strategies as follows:

- use critical and creative thinking in making decisions of identification and solution of problems.
- work effectively as individuals and with others as members of a team.
- manage and organize themselves in handling their activities responsibly and effectively.
- collect, analyse, organize, and critically evaluate relevant data.

- use visual, symbolic and/or language skills in various modes to communicate effectively; and
- recognize that problem-solving contexts do not exist in isolation and demonstrate an understanding and interpretation of the world as a set of related systems.

Mathematics education also resonates with the use of technology and digital tools in the classroom. This includes the use of calculators, computers, and other technological devices to support teaching and learning. The conceptualization of mathematics instruction also encompasses accepting the cultural environment in which the subject is taught. This comprises identifying the experiential backgrounds of the learners and their impact on educational results. The conceptualization of mathematics education is a dynamic and evolving field that requires a multidisciplinary approach. By understanding the complex interplay between theory, practice, and context, educators can create effective learning environments that support the development of mathematical knowledge and skills for all learners.

Mathematics Classroom practices have a profound influence on learners' learning and achievement. The concepts classroom practices, instructional practices, teaching practices, and classroom instructions, are used interchangeably and there are no clear distinctions (Malatjie & Ngoepe, 2021). They can also mean, teaching methods, pedagogy, educational strategies, classroom techniques, learning approaches (Bayrak & Ufer, 2022).

Furthermore, they encompass a range of teaching strategies and approaches aimed at facilitating effective learning and understanding of mathematical concepts. Several studies have explored the relationship between different instructional strategies and students' mathematics achievement. I mention two of these.

First is a recent study of Atoyebi and Atoyebi (2022) which investigated the impact of various mathematics teaching strategies on students' mathematics anxiety. Several strategies identified in the study included problem-based teaching, direct teaching, single instructional approach, systematic and structured approach, creative and discovery approach, inclusive instructional strategies, inquiry-based learning, and student-centred learning. The Research findings indicated that *student-centred teaching methods, problem-based teaching approaches, creative and discovery approaches, inclusive instructional strategies, and inquiry-based learning were effective in reducing learners' mathematics anxiety and impact on student achievement.*

Second, is a study by Machaba (2017) which explored the pedagogical demands in mathematics and mathematical literacy (ML) teaching. The study highlighted that different teaching strategies are associated with mathematics and ML. Machaba emphasized the

importance of understanding the domain specificity of teaching strategies, particularly in the context of mathematics and ML.

Strategies used in countries which are achieving high results in mathematics that lead to learners' success in mathematics.

Researchers continually strive to identify problems in mathematics classroom practice and find alternative ways to solve them. High achieving countries for example, China, Singapore, India, Korea, Japan, USA use several effective instructional practices to continue to remain at the top echelons. The question is, which instructional practices are they using? Effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving.

According to Magen-Nagar (2016) some of the key practices used by high achieving countries are:

- *Foundational knowledge*: emphasis on teaching fundamental concepts before proceeding to complex concepts,
- *Rigorous curriculum and high expectations of learners.* Teachers challenge learners to set ambitious goals and foster a culture of academic excellence.
- *Active learning strategies* use of various instructional strategies (e.g., small groups), problem-solving, project based. The goal is to promote critical thinkers, problem solvers, hands-on experience, and learner participation.
- *Effective use of technology*- tool to enhance teaching and learning.
- *Formative assessment and timeous feedback.* When learners are assessed continually and given feedback quickly their weakness and strength can be identified sooner and intervened appropriately
- Teachers are *experts and provision of professional development.* Teachers continuously update their content and pedagogical teaching strategies, equipped with the new pedagogical techniques.
- *Parental involvement* and support, teachers collaborate with parents.

Furthermore, they *use memorization and repetition* to reinforce Mathematics concepts, they have a longer school day and a high number / many instructional hours devoted specifically to mathematics. This allows for more in-depth coverage of topics and additional time for practice.

Teacher professional development

It is important for teachers of mathematics to constantly improve their knowledge and skills of teaching mathematics to enable them to meet the challenges of today's transformation in mathematics curricula and pedagogy to impact classroom practice.

Schmidt (1999: 81) argues that: “What teachers teach and how they teach it are affected by their subject matter, belief and preferred pedagogical approaches, which are consequences of their training and experiences”. Ball, Thames and Phelps (2008: 13), affirms the relationship between teachers’ mathematical content knowledge and their ability to teach well in classrooms. According to Shulman (1987) , the teaching of mathematics includes (1) content knowledge – knowledge of the concepts, procedures, and problem-solving processes within the area of mathematics they are teaching, (2) pedagogical knowledge – the capacity of a teacher to transform the subject knowledge that he or she possesses into forms that knowledge and their ability to teach well in classrooms are pedagogically powerful and yet adaptable to the variations in ability and background of the learners and (3) technological competency. Therefore, mathematics educators should have strong mathematical knowledge, a positive attitude towards mathematics and teaching, as well as an alignment with proper pedagogical beliefs and integration of technology to be effective in their instructional practices.

A confident and competent teacher will test different instructional strategies focusing on conceptual understanding, balanced with the use of graphical, numerical, algebraic, and verbal representation in the teaching of mathematics topics.

Teacher professional development is a critical aspect of ensuring that educators are equipped with the knowledge, skills, and resources they need to effectively teach their students. Professional development can provide teachers with new strategies and techniques for teaching, as well as the opportunity to collaborate and share ideas with other educators.

Moreover, in this Fourth Industrial Revolution era, professional development can be tailored to meet the specific needs of teachers in different contexts. For example, in areas with high levels of poverty, professional development can focus on strategies for addressing the needs of disadvantaged students. In areas where technology is rapidly evolving, professional development can focus on the integration of digital tools and resources in the classroom.

The training of mathematics teachers in South Africa.

During the apartheid system of government in South Africa, teacher education was racially stratified with separate teacher education colleges for the different races. This created multiple

and separate programmes for teacher education of different races. This multiple system determined where teachers were trained and where they would eventually teach (Schäfer & Wilmot, 2012). The bulk of the training in Black colleges of education was limited to humanities and arts subjects, the effect of which was the underdevelopment of mathematics, science, and technology education in the black schools. The initial training was 2 years. Most black teachers who trained under apartheid government only had a 3-year College Education diploma. The quality of training was poor. Therefore, many mathematics teachers have not had the opportunity to learn further mathematics. Nkabinde (1997) maintained that the Bantu Education Act of 1953 was aimed at providing separate and unequal education for different races of South Africa. Arnold and Kubeka (1997) also concur that the consequences of this were inferior education, unequal distribution of resources, crowded classrooms, poor teacher training, poor matriculation results and underqualified teachers among the Black people of South Africa. According to Nkabinde the decision that was made by the Prime Minister Verwoerd, who was the architect of the Bantu Education system, to enforce a regulation requiring that half of all high school subjects be taught in Afrikaans (Nkabinde, 1997), was responsible for tension over language in education. Verwoerd was further reported saying:

"I will reform it [Bantu education] so that Natives will be taught from childhood to realize that equality with Europeans is not for them" (Parsons, 1982, p. 291). Parsons (1982) criticized the rationale of teaching a Bantu child mathematics when he cannot use it in practice. This statement pronounced a curse on the African people, and hence even to date we are still discussing strategies of how to improve poor mathematics performance in South Africa.

The Integrated Strategic Planning Framework for Teacher Education and Development in South Africa (2011–2025) was established to improve the quality of teacher education and development with the priority of producing mathematics, sciences, and technology education teachers in the country. The Centre for Development and Enterprise (2010) provided statistics which showed that 90% of South African schools failed to meet the minimum performance standards in mathematics and science education. Other studies have indicated that the performance of learners in a school is determined by what happens in the classroom (Barbour & Mourshed, 2007). Some of these studies that have been productive in assessing the teacher knowledge are from the Michigan State University (MSU) for example, the *Teacher knowledge in the context of Mathematics teaching in the 21st Century* (Schmidt et al, 2011) and *Teacher Education and Development Study: Learning to Teach Mathematics* (*TEDS-M*) (Blomeke et al, 2012 & Tatto et al, 2012).

The South African education system has a long history of unresolved challenges. For example, 17 years ago it is alleged that: "Approximately 20% of grade 10-12 mathematics teachers are professionally unqualified and of those that are qualified, still only 21% have some university level courses" (see Parker, 2006: 59-73). Until now (2023), it is astonishingly disappointing for the nation to continue hearing the unchanged discord and still experiencing the crisis of Mathematics education teachers. Yarkwah, Arthur & Takramah (2020) stated that: "A key aspect of the education system in every state has to deal with the quality of teachers produced to train citizens for a prospective aspirations and development to be achieve" (p. 26). Universities play a critical role in the training and development of mathematics teachers. In the digital era, universities have moved to online platforms. The programs are designed to prepare teachers for the challenges of teaching mathematics in diverse contexts, with an emphasis on promoting critical thinking, problem-solving, and inquiry-based learning.

Related to the training of mathematics teachers in South Africa, worth mentioning is the disruptions of teacher training of preservice mathematics teachers that took place in the mid1990s. As part of the restructuring of higher education, all colleges of education in South Africa (22) were closed whilst others were merged with universities' education departments. These disruptions of teacher training of preservice mathematics teachers led to dispatching of several college staff members to sections of the Department of Education. Whilst some staff members were sent to schools, others opted for severance packages. I was sent to the Education Management Information Systems (EMIS) section where my job was sadly to clean schools' data. Another disruption worth of mention was the closing of Mathematics Science and Technology College (MASTEC) (2001). This college which was instituted by the then minister of Education Dr Aaron Motsoaledi (1998 - 2001) with a focus of redressing the shortages of mathematics, science, and technology education teachers. The focus of this college was to train teachers of mathematics, science, and technology education with full funding. Unfortunately, the college died a premature death even before preservice teachers would graduate for their four-year diploma. The student- teachers had to be moved to the Universities to complete their teacher training. In the interim, some of the students could not complete their teaching qualification. What a loss to the nation? To date (23 years after the closure of MASTEC) there is still a shortage of Mathematics, Science and Technology Education teachers. One would wonder where mathematics education would be in the country if MASTEC was still producing Maths, Science and Technology Teachers. Up to now Departments of Mathematics, mathematics Education, science education and technology at institutions of higher learning are still very small and recruitment of lecturers to teach these scarce skills is almost impossible.

The effect of this disruption on mathematics as a field of study, especially among the rural black communities is posing a serious challenge. I was personally involved in training mathematics teachers in those colleges STD, SPTD and PTD. Several of my postgraduate students profess to have passed through these colleges of education even though sadly some of the student teachers did not complete their qualifications because of the closure. Efforts to contact the Department of education to assist them in completing the course did not lead to fruition.

Training student teachers in the context of open distance e-learning

As I already indicated previously, I served at Unisa's Department of Mathematics Education since 2008. Unisa is widely recognised as a leading open distance education university on the African continent. ODEL instruction of mathematics education is a possibility in the case of students who are widely removed and remotely dispersed but can access interaction online through digitalised systems. ICT plays a key role both in the administration and progress of ODEL. The covid-19 pandemic has triggered the need for different innovative approaches to teaching practice. Globally, institutions of higher learning had to come up with different models to replicate face to face practicum instructional activities in a purely online digital platform. UNISA teaching practice department was successful in implementing the online teaching practice student's assessment. For example, I had the privilege to assess students that are placed at schools anywhere in the province from my home office. The student teachers placed their laptop or cell phone at the back of the class with a camera on. Even during loadshedding, I was able to assessment their lessons through WhatsApp which worked very well.

When the Covid-19 pandemic emerged, Unisa was able to adapt to and cope with the changes which impacted against teaching and learning. Drijvers' (2020) study on the impact of the lockdown because of the Covid-19 pandemic, with particular focus on teaching and learning in countries such as: Belgium, Germany, and the Netherlands, had different conclusions. According to Drijvers (2020, cited in Chirinda, Ndlovu & Spangenberg, 2021:177), "The findings were that teachers' engagement in distance teaching may have caused them to forget the mathematics tools and mathematics didactic approaches". In my view, Drijvers' findings should be considered seriously in view of the mathematics teacher training program itself. Unisa programs are tailor-made not only to offer professional development training for Mathematics teachers, but also to make it achievable through flexible and personalized learning.

The role of information and communication technology in Mathematics education instructional practices

In this digital era, students learning needs are changing due to rapid changes aligned with the 21st Century skills; problem-solving, creative skills, information communication technology, and collaborative skills are intended to enable students to fit in the labour market. For students to acquire those skills, they require teachers that are updated with the competencies that suit their current needs. As such, continuous professional development for teachers is paramount to ensure teachers are updated to keep up with the changing needs of students. to Darling-Hammond et al., (2017) and DuFour et al. (2016), among the approaches which ensure effective continuous PD are those which are teacher-led, ongoing, sustained over time, and embedded in classroom practices.

Niess (2005) cited in Ngoepe (2021, p175) argues that for technology to become an integral component in the teaching and learning process, pre-service teachers must develop an overarching conception of their subject matter with respect to technology and teaching approaches (TPCK). The interplay between the various components of TPACK—technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), technological content knowledge (TCK), technological pedagogical knowledge (TPK) and pedagogical content knowledge (PCK) is what makes effective teaching with technology possible (Mishra & Koehler, 2009). Teacher education curriculum should include the infusion of TPACK model in the training of pre-service teachers of mathematics and science teachers to expose them to the integral nature of the components of the model before sending them into the field.

Attitudes of pre-service teachers

In our dual collaboration (see Ngoepe & Nyaumwe, 2012:84) we pointed out that: "ODL pre-service teachers' study at their pace, choice of time and place but go for school attachment during a common period". In my view, pre-service teachers' attitudes towards mathematics can have a significant impact on their own learning, as well as the learning outcomes of their future students. Research has shown that attitudes towards mathematics are complex and multifaceted, influenced by a variety of factors including past experiences, cultural backgrounds, and individual beliefs. Thus, in our previous contribution (see Ngoepe & Nyaumwe, 2012:85) we penned that: "So black pre-service teachers from such a system may have instructional understanding that is influenced by the social and cultural environment in which they grew up". One important factor that influences pre-service teachers' attitudes

towards mathematics is their own self-efficacy. This refers to their belief in their own ability to learn and teach mathematics. In my autoethnographic account above, I tried to show how I managed to move from one level to another in terms of professional development. In the same way, professional development empowers pre-service teachers "to increase their professional authority, especially as it relates to issues of curriculum and instruction" (Ngoepe & Nyaumwe 2012:86). Pre-service teachers with higher levels of self-efficacy tend to have more positive attitudes towards mathematics and are more likely to use effective teaching strategies. The cultural context of a community plays a key part in the training of pre-service teachers. Accordingly, Cobb and Yackel (1996) support the above view by asserting that: "The sociocultural approach…focuses on the social and cultural bases of personal experience, whereas analyses developed from the emergent [cognitive] perspective account for the constitution of social and cultural processes by actively cognising individuals" (p. 188). Cobb and Yackel's opinion received solidarity from Bruner (1996) who argued that:

> …you cannot understand mental activity unless you consider the actual setting and its resources, the very things that give mind its shape and scope. Learning, remembering, talking, and imagining all of them are made possible by participating in a culture (pp. x-xi).

Brunner's argument was transcribed by Graven (2002) who elucidated the following:

> Mathematics is an induction for learners into what it means to be a mathematician, to think mathematically and to view the world through a mathematical lens. Mathematics has its own beauty and can be explored for its own sake. Mathematical investigation and exploration (without necessarily utilitarian value) is emphasised. School mathematics in this sense is seen as part of a broader mathematics culture, which is produced and reproduced uncritically in accordance with the norms and conventions of the broader mathematics culture (p. 50).

The impact of the Covid-19 pandemic

On the 10th of January 2020 and on the 11th of March 2020, The World Health Organization (2020) declared the outbreak as a "Public Health Emergency of International Concern and a Global Pandemic", respectively. According to a report by the World Bank Education Global Practice (2020), "…many governments around the world began to experiment with emergency remote teaching (ERT) to cope with the COVID-19 pandemic". Chirinda, Ndlovu and Spangenberg (2021, p. 177) concurred "The COVID-19 outbreak was first identified in

Wuhan, China in December 2019". Many education authorities across the world, including the South Africa's Department of Basic Education, implemented online platform to continue providing education to learners. Moreover, the COVID-19 pandemic brought the need for all teachers, even university professors, to adjust the delivery of instruction and managers of mathematics school curriculum to adjust their management strategies. In a book edited by Nontando Hadebe, Daniela Gennrich, Susan Rakoczy and Nobesuthu Tom on the title *A Time like No Other: Covid-19 in Women's Voices* (2021), various authors (including myself Mapula G. Ngoepe), expressed their deepest and sincere concerns about the devastation caused by the Covid-19 pandemic. In their entirety, the contributions in the book focused on Covid-19 and its impact on education in general, and not precisely on Mathematics Education. The book is characterised by individual experiences of the pandemic. However, it is interesting to note that some contributions are gender specific. For example, I (Ngoepe 2021:178) wrote that: "COVID-19, and our social responses to it in the South African context, come with particular risks for women". In addition, I (Ngoepe 2021) reaffirmed that:

> COVID-19 heightens risks for many women and girls trapped at home with abusive family members, most of them juggling the pressures of gendered labour in the home and in society, their roles in housework, childcare and caring for the sick, or facing the loss of vital economic resources as jobs are lost or go on hold (p. 179).

Nevertheless, contributions in the book address the devastation of the pandemic on education. One outstanding feature of the book is its ability to address the impact of the pandemic on every member of society, regardless of their cultural and educational orientations. My familiarization with the afore mentioned book has informed the development of my presentation. One of the indirect challenges on education which were posed by the Covid-19 pandemic comprised the loss of life of parent/s who left children still going to school, either at primary, high school, or college/university. Numerous widowed mothers found themselves exposed to severe impoverishment in the absence of income resulting in the withdrawal of their children from school because they could not afford the payment of school fees. Patriarchy in Africa does not allow justice to prevail on the girl-child to access further education. This means that most African girls end up into child-marriage to fend for the entire family. So, the girl-child faced two obvious challenges because of the Covid-19 pandemic and following the death of the father as the breadwinner: (1) She had to drop out of school to pave way for the boy-child, and (2) most child-headed households depended heavily on the girl-child even for the miniature survival strategy. The widowed mother is also unable to provide for the orphaned children because she too was denied the opportunity to go to school by the patriarchal society of her

time. Without the emancipation strategy of education, the cycle of poverty on the girl-child is deliberately perpetuated. Thus, Venkat et al. (2009) proposed "a significant new role in contributing to the acceleration of eradicating poverty, promoting gender equality and universal primary education" (p. 5-27). One certainty that the African patriarchal society continues to ignore is that educating a girl-child is salvific in character because in the event of an unpredicted natural phenomenon and one of the spouses is no more, there is a back-up to lean on because education by its very nature empowers individuals for rewarding opportunities. Venkat et al. (2009) agrees with the above notion by writing that: "In order to create employment and to fight poverty, mathematics education can be used to empower people with knowledge and skills that are necessary to reach the targeted economic growth rates" (p. 5-27). The abyss caused by the Covid-19 pandemic has impoverished many households, especially the children still attending school, who were orphaned following the passing on of the parent/s. My experience has shown that, in numerous instances, a pupil's performance in a Mathematics class was generally poor due to disproportionate housed-hold responsibilities and/or contextual challenges.

Selected research projects of postgrad students

Research reveals that "better teachers lead to better learner performance, and better performance leads to higher learner motivation" (British Council, 2015). Having said this, Postgrad student research projects need to inform practice. Research in schools in mathematics education involves collaborations between researchers, teachers, and learners, aimed at improving the quality and effectiveness of mathematics education. This type of research can take many forms, from classroom-based studies and action research projects (see McNiff & Whitehead, 2005:3-5) to larger-scale studies of mathematics education policy and practice. I have supervised many dissertations at both Master's and Doctorate levels. My assessment of the students' research projects revealed a demonstration of independent rationale and thoughtful analysis of the scenario under scrutiny by the students. Other examples of research in schools in mathematics education may focus on different aspects of the subject, such as the development and evaluation of new teaching materials, the use of technology in the classroom, or the impact of different teaching methods on student learning. In addition, other examples indicate that teachers "researched information on digital learning platforms such as Google Classroom, Blackboard Collaborate, WhatsApp and flipped classrooms" (Chirinda, Ndlovu & Spangenberg, 2021:177). Below, I cite a few examples of postgraduate projects:

Ncube (2022) investigated how concept-based instruction improved learners' performance in mathematics. The results confirmed that concept-based instruction enabled learners to relate new and prior knowledge to grasp concepts in algebraic functions.

Malatjie (2021) developed and implemented a framework for effective mathematics instructional practices. The study revealed that before training, teachers' practices were ineffective, traditional, and didactic. After training and implementation of the framework for effective mathematics instructional teaching practices, teachers made significant changes in their instructional practices.

Mumanyi (2014) examined the ways the teachers interacted with and mediated the textbooks in mathematics lessons. The results indicated that the use of these textbooks raised the teachers' and learners' motivation, created some opportunities for teacher learning, and improved the learners' performance in mathematics.

Mashingaidze (2018) explored Mathematics teachers' use of students' out-of-school experiences in the teaching of Transformation Geometry. The results revealed teachers' limited knowledge on transformation geometry concepts embedded in out-of-school experience.

Orevaoghene (2021) investigated the strategies used in teaching geometry in primary six as well as the perception of teachers on geometry vocabulary teaching, how geometry vocabularies were taught and how the teaching of geometry vocabulary influenced primary six learners' performance in geometry. The teaching of geometry vocabulary improved learners' performance,

Rankweteke (2021) investigated the use of cooperative learning to enhance conceptual understanding of trigonometry in a Grade 11 mathematics classroom. The study found that many learners were passively engaged, listened to, or watched the teacher.

Theoretical underpinning

The theoretical framework that underpins the exploration of mathematics instructional practices is the sociocultural theory. Sociocultural theory, developed by Lev Vygotsky (1978), emphasizes the influence of social interactions, cultural context, and the role of language in learning and development. This framework provides a lens through which to analyze the dynamics of mathematics in classroom settings and consider the socio-cultural factors that shape instructional practices.

The sociocultural theory can be applied to examine the interactions between teachers and learners in the mathematics classroom. According to Vygotsky, learning is a socially mediated process, and knowledge is co-constructed through collaborative interactions. In South African schools, where learners often come from diverse cultural backgrounds, the cultural and social contexts play a significant role in shaping instructional practices and teacher attitudes towards mathematics. Moreover, the sociocultural theory aids to explore the role of language and communication in mathematics instruction. Language acts as a tool for learners to make meaning and negotiate mathematical concepts. In mathematics classroom settings where language diversity may be present, considering the ways in which language is used to support mathematics learning becomes critical. It is incumbent on the teacher to use simple and clear language and expressing that can assist learners make meaning of the content being taught to them. In other words, because the language of instruction is often not the native language of many of the learners, the teacher should come down to the level of the learners by explaining concepts and contents painstakingly to enhance learning among the learners from diverse cultural and language backgrounds. To make learning more practical and interesting the teacher should employ examples that are familiar to the day-to-day life of the learners. I argue that when the sociocultural theory is used as a lens it may enable the teacher to examine aspects of the lesson that emphasise Cultural relevance and responsiveness. In that way the mathematics teachers' instructional practices would have considered the cultural backgrounds, the experiences, and contexts of the learners, important elements that can enhance learning of mathematics.

The sociocultural theory emphasises collaborative learning and scaffolding which requires the teacher to introduce contents, concepts, lead and support learners to own the learning instead of attempting to spoon feed them. In such a collaborative learning environment, the teacher literary hold the learners' hands and walk with them through examples and then request them to use the examples to solve similar tasks. Such an approach can motivate and support learners' mathematical understanding and problem-solving skills.

Decolonizing the Mathematics curriculum

Decolonization is the term that appeared in the past few years and applied to protest activism to reverse the gains and privileges of colonialism. It is maintained that colonialism and apartheid left behind broken individuals with a damaged sense of self, leading to fractures in the fabric of society which continue to influence South Africa to this day (Gumede, 1965:11). Hence, Ocheni and Nwankwo (2012) wrote of "the hollowness or emptiness of colonial

education which is partially responsible for the present African underdevelopment" (p. 51). Although it assumed a new meaning in our century such as the phrase "decolonization of the curriculum" (see for example, Fanon, 1963; wa Thiong 1986), the term "decolonization" had first and foremost a geopolitical thrust. Borrowing Mudimbe's (1994) idiom, namely a "paradigm of difference",

I am proposing that decolonization of the curriculum in the South African education system, the beginning is the adoption of and adaptation to vernacular language/s in teaching and learning Mathematics. I argue that if the education system in South Africa continues to emphasize and recognize English Language and Afrikaans as the modes of teaching and learning Mathematics, local learners will continue to struggle in the comprehension of Mathematics concepts. The challenge facing South Africa on Mathematics education is far from being resolved. For Falola (2001) to argue that: "Africa's modern intellectuals owe their origins to the spread of Western formal education, which began in some parts of Africa in the sixteenth century and were soon joined by the British, Danes, French, Dutch, and Germans" (p.5), was an indubitable manifestation about the impact of colonialism on the Third World's education system. Jita (2002), who wrote his thesis after Falola, also confirmed that: "The challenge has been that of finding ways to shift classroom practices from modal (traditional) to transformative forms" (p. 10)

I am reminded of Arowolo's (2010:1) argument that Africans have become "westernised" so much that in everything they do a western assimilation in terms of culture and European mode of civilization is apparent. Talking of "openness to change" (Askew, 2008) and "western mode of civilisation" (Arowolo, 2010), Planas and Ngoepe (2020) concluded that:

> The richness of languages, cultures and communities produces a complex heterogeneous picture of what it means to teach, learn, and think school mathematics…Learners and people in general have the right to use their languages, and importantly the right to learn in settings that are linguistically, culturally, and pedagogically responsive.

Planas and Ngoepe's affirmation is supported by Meeran and Van Wyk's (2022:73) conclusion which states that: "For almost three decades of curriculum changes, teachers were left behind, unprepared in applying culturally responsive pedagogies within the many diverse classroom settings". I am sceptical to pitch a dictum in support of Ocheni and Nwankwo's (2012) finding for asserting that: "The colonial education was not rooted in African culture and therefore could not foster any meaningful development within the African environment because it had no organic linkage" (p. 51). However, it appears in my view, that a dialogue on colonial education

is a two-sided narrative. Nevertheless, the underlying undertaking which I regard as drawing unanimous retort is that a curriculum review on Mathematics education in South Africa is necessary.

Conclusions

Allow me to conclude this lecture by recounting the key aspects discussed so far. My autoethnographic account was just a representative example of the journeys traversed by Mathematics educators and the terrain under which they perform their duties. An attempt was made to highlight some challenges that educators in general and Mathematics teachers are facing. Topical issues comprised poor performance in mathematics, remuneration and mental health of the educator. It was explored that failure of the mathematics examination by learners should not be duly and wholly blamed on the educator. As explained, there are various factors that contribute to both poor performances in class and low pass rate in the final examination by Grades 11 and 12. Although in some instances the educator might be blamed for under-performance (this one is also due to macro-economic factors), the Education Departments and learners themselves cannot be exonerated. I have also discussed the importance of continued teacher professional development which, in my view, should include revolutionising teacher training institutions, improvement on ICT facilities (including proximity to rural schools), and emphasis on ODEL usage. Our world is fast developing technologically. Education, research, and study are largely happening online. It was highlighted that both classroom practice and pre-service teachers need to sufficiently familiarise themselves with developments taking place in ICT and ODEL. The negative impact of the Covid-19 pandemic on Mathematics education was also discussed. With regards to continued e-learning during the lockdown, Unisa (as largely an online education system), was able to cope up with the scourge of the pandemic due to its aristocratic achievement on distance learning. Thanks to those who participated in dreaming for the distance learning which has become a reality. It was noted in the presentation that the pandemic also impacted negatively on people's earnings and their general lifestyles. Revolutionising the curriculum (decolonisation), was also on the spotlight in which the language of instruction, among other things, needs to be revised. Explaining terms and the difficulty encountered in understanding Mathematics concepts in English might be contributing to poor performance in Mathematics. In this regard, I honestly and humbly plead with the Education authorities to be more proactive in fostering a pathway that facilitates a "win-win" situation for both those who had a historical and cultural privilege of understanding English and those who are trying hard to understand English as a second language.

Recommendations

In this lecture, the following recommendations are made:

(1) *Establishment of more Mathematics training institutions*. It is my personal proposal that the South African Department of Higher Education and Training needs to work towards establishing more teacher training colleges for Mathematics education such as MASTEC. It appears that one of the factors which are detrimental to poor performance in Mathematics education can be attributed to shortage of qualified Mathematics teachers. Increase in teacher training colleges (e.g., MASTEC) will attract qualifying prospective candidates to enrol for training as Mathematics teachers.

(2) *The need for self-care practice*. Self-care practice and widened support networks will circumvent a mental health challenge when the phenomenon begins to manifest as well as on how to manage it. As highlighted in this presentation, when the wellbeing of an educator is at stake, it is highly likely that performance in a Mathematics classroom is compromised.

(3) *Remuneration*. It is incumbent on the part of the Department of Basic Education and the Department of Higher Education and Training to prioritize encouraging remuneration for teachers. There is an on-going debate among most Mathematics teachers whether it is necessary to continue committing themselves to the teaching profession in the country when other rewarding opportunities are available elsewhere.

(4) *Emphasis on research in Mathematics education*. Research in Mathematics education is key in solving Mathematics problems. A thrust in Mathematics research must be promoted at the teacher training colleges. Interaction with the global scholarly community tend to achieve desired research skills that will enrich the teaching and learning of Mathematics.

Gratitude

I thank the Lord God my creator who walked with me in this journey up to this far.

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