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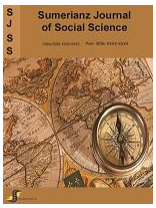

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Sustainable Professional Development of Primary School Mathematics Teachers in Zimbabwe Through Philosophy of Education 5.0: Challenges and Prospects

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Abstract

Teacher training colleges and universities in Zimbabwe currently fall under the Ministry of Higher and Tertiary Education, Science and Technology Development (MHTESTD) whose mission is to develop and deliver a knowledgeable and skilled human capital through higher and tertiary Education 5.0, science and technology development using a heritage based philosophy, for the production of quality goods and services. The core values of the Ministry are integrity, humility, innovation and productivity. The philosophy of Education 5.0 system is centred on five pillars which include teaching, research, community service, innovation and industrialisation while the previous 3.0 design was centred on three aspects which are teaching, research and community service. Thus, teachers who are being trained at Zimbabwe's colleges and universities will be required to acquire skills and knowledge to produce goods, services and ideas and also to impart such knowledge and skills to their learners. The mathematics curriculum inclusive of the syllabi, schemes of work and timetables at a teacher training institution in the Midlands Province of Zimbabwe was critically analysed. Two randomly selected lectures in progress were observed and five purposively chosen lecturers interviewed. The study addresses the questions of whether and to what extent Education 5.0 is being realised, the challenges currently being faced and the future prospects of the philosophy. The paper concludes by giving recommendations for sustainable professional development of primary school mathematics teachers in Zimbabwe.

Keywords: Challenges; Philosophy of education 5.0; Primary school mathematics teacher; Prospects; Sustainable professional development.

1. Introduction

The Zimbabwe Ministry of Higher and Tertiary Education, Innovation, Science and Technology Development (MHTESTD) has a mission to develop and deliver a knowledgeable and skilled human capital through higher and tertiary Education 5.0, science and technology development using a heritage based philosophy, for the production of quality goods and services (http://www.mhtestd.gov.zw/?page_id=1195). All teachers in Zimbabwe are trained by private or public colleges or universities which fall under this Ministry. As reported by ZIMSEC which is the national certification body for results of primary school subjects (http://www.zimsec.co.zw) and the national press (e.g., The Herald, 2 December 2019), the overall pass rate in Grade 7 examinations over the past five years has been below 50%, although it slightly increased to 52.08% in 2018 but dropped again to 46.9% in 2019. This was a poor result as compared to other nations such as China and Singapore (PISA, 2018) and this could be attributed to several factors including teacher competency and preparedness. Mathematics is one of the difficult yet important and useful subjects in society (Chirume, 2014); so how it is taught depends also on the teachers' beliefs about and attitudes towards it, and on how they were trained or professionally developed.

It would appear that there is a thin line between teacher training and teacher professional development since initially teacher recruits are trained and thereafter professionally developed although within the professional development process there is some training that goes on. This paper views professional development of teachers as including pre-service and in-service training, induction and support of those teachers. The paper is focussed more on pre-service training and less on in-service (or during teaching practice) development of primary school mathematics teachers.

1.1. Justification and Significance of the Study

The study was necessitated when the MHTESTD incorporated 5 pillars in its Education 5.0 philosophy which are teaching, research, community service, innovation and industrialisation. The old mission had only the first three pillars (Education 3.0). It was believed that Zimbabwe was lagging behind technologically and economically because of educating 'theoretical intellectuals' rather than innovators and inventors of goods and services for

commercialisation. By introducing Education 5.0, it was believed that pre-service teachers would be trained not only to become good teachers, but also researchers, innovators and industry-oriented members of communities which they serve. Zimbabwe would become an upper middle economy by 2030 (Government of Zimbabwe, 2018). Hence this study would add to the body of knowledge on how Zimbabwean primary teacher preparation models could help to meet the country's vision 2030, and on their effectiveness in meeting Education 5.0. It could be significant also to put the Zimbabwean situation in perspective with other countries.

1.2. Purpose of the Study

The purpose of the study was to address the issue of whether and to what extent the philosophy of Education 5.0 is being realised with regards to sustainable professional development of primary school mathematics teachers at teacher training institutions in Zimbabwe in general, and particularly those in the Midlands Province. The study also investigated the challenges currently being faced and the future prospects of the philosophy, visa-vis the training of primary school mathematics teachers.

1.3. Research Questions

The following research questions were crafted to give guidance and direction to the study:

1. Is the Education 5.0 philosophy being realised at primary school mathematics teacher training institutions in Zimbabwe and if so to what extent?
2. What challenges are currently being faced in order to realise Education 5.0 philosophy with regards to training of primary school mathematics teachers?
3. How can the challenges be rectified?
4. What are the prospects of professional development of primary school mathematics teachers in Zimbabwe visa-vis philosophy of Education 5.0?

2. Review of Related Literature

This section discusses the review of related literature under the following subheadings: Brief history of teacher training models in Zimbabwe, Current models and curricula of teacher education in Zimbabwe and other countries, 'Ideal' mathematics teacher training.

2.1. Brief History of Teacher Training Models in Zimbabwe

During the colonial era, education in Rhodesia (now Zimbabwe) was designed to produce according to the missionaries, disciplined and hardworking black natives and according to the white settlers, natives with vocational skills for the improvement of rural life but not to compete with whites (Maravanyika, 1990). However, the result was that the school leavers would serve as cheap labourers, aides and messengers for the dominant white class. Thus, even teacher training at that time would also produce tough and authoritarian teachers who would serve the interests of their colonial 'trainers' and pay masters. The school curriculum included strict adherence to orders, time discipline, basic English, arithmetic, cleanliness and 'good' manners, among others (Summers, 2002). Hence one would infer that even the teachers were taught to inflict corporal punishment if learners were not able to reproduce the taught definitions and algorithms through memorisation. Critical thinking, problem solving, creativity and innovation were therefore barely required and/or assessed. For example, instead of involving actual pupils during micro-teaching (as preparation for actual teaching practice), trainee teacher would talk to and 'teach' a tree and even beat it for not 'speaking up' or 'failing' the times tables. The supervisor (who was called inspector then) would assess the trainee teacher and pass or fail him/her based on such micro teaching sessions.

Later on, teacher professional development took other models. For instance, primary school teacher education ending in the Diploma in Education qualification now requires one to have five "O" Level passes including English and Mathematics. The student teacher spends 3 years (or 9 terms) following the 2-5-2 system whereby the first 2 terms are spent at the college specialising in the main subject area, pedagogy and educational courses, 5 terms of teaching practice is done in the field at an allocated school and the last 2 terms are for the residential studies at the college (Chirume, 2017; Nyaumwe, 2012). The mathematics main subject curriculum is pitched at the "A" Level difficulty although after attaining the qualification, the teacher will teach from Grade 1 up to Grade 7. The Diploma in Education - Primary students also do an action research project in their final year. For a Diploma in Education - Secondary program student teachers with "A" Level passes do a two-year program, those with "O" Levels do a three year course while those being trained thorough open and distance e-learning (ODeL) do a four-year program. Those already having a first degree (undergraduates) can also train as teachers via any of these routes: (a) three-year degree in the main subject (e.g., math) followed by one year post graduate Diploma in Education in the pedagogy and education courses, (b) four-year BSc in Mathematics content plus pedagogy, and (c) through the ODeL program (Nyaumwe, 2012). All the student teachers following any of the above routes do teaching practice and research (or action research). However, lectures, methodologies, assessment criteria and the mathematics content delivered may differ. It is also not clear whether and to what extent the other pillars of Education 5.0 (community service, innovation, modernisation and industrialisation) are being implemented at the different teacher training institutions in Zimbabwe.

2.2. Current Models and Curricula of Teacher Education in Zimbabwe and other Countries

In order to come up with sound recommendations for effective and sustainable professional development of (mathematics) teachers in Zimbabwe, it could be crucial to understand what obtains in other countries, and to compare this with what obtains in Zimbabwe. The researcher carried out a 'snap random' literature survey of the situation in Lesotho, Ghana, Tanzania, Finland, Ireland, Canada, USA, China, Philippines and Australia. The table below summarises the information collected.

Table-1. Primary mathematics teacher training/development models in some chosen countries

Country	Entry Requirements	Name and Duration of Programme	Content Course and Delivery Strategies	Pedagogy/Method Courses and Delivery Strategies	Assessment Strategies
Zimbabwe	At least 5 (Zimsec or Cambridge) Ordinary level passes including English language and Mathematics	Diploma in Education, 3 years (9 terms) with most institutions following 2-5-2 model	Upper secondary and Lower Advanced level mathematics (e.g., kinematics, descriptive statistics, normal distribution, coordinate geometry, calculus), lecture method	Revisiting Primary school math topics and how to teach them, curriculum planning, syllabus interpretation, scheming and lesson delivery and evaluation strategies, lecture method	In-class tests, Homework assignments, Written Examination
Lesotho	Four Cambridge Overseas School Certificate (COSC) credits and a pass in a fifth subject.	Diploma in Education, 3½ years (7 semesters of which 1st is for bridging courses, others are for residential content and pedagogy courses and about 4 months TP done in semesters 5 and 7)	15 modules around COSC standard, use of traditional mass lecture approach and small group discussions	5 modules, lecture method with occasional practical demonstrations, e.g., for micro teaching	50:50 coursework and exam, aims seem to be based on reflective practitioner and independent thinker approach but not on reality
Ghana	Credit passes or better in the WASSCE examinations. However, most colleges of education enrol those with poor grades who have failed to get places at university, polytechnic or nursing schools.	Diploma in Education, 3 years (2 years residential and one final year out on TP)	More emphasis on personal development studies and subject studies (content) than on methodology courses, lecture method	Little emphasis on methodology courses, lack flexibility to incorporate emerging changes such as literacy, numeracy, creativity, and innovation, lecture method	Still run like "old missionary teacher training schools."
Tanzania	Form 4 graduates with at least 28 points for Grade A Teacher and Advanced Level Certificate for Diploma Teacher	Grade A teacher who will teach nursery and primary school students, or Diploma Teacher who will teach secondary or primary school students, a 2 year training programme (1st year residential, 2nd year TP)	Less emphasis on content subjects and more emphasis on pedagogy courses	Training for 'Grade A' Teacher emphasises methodologies, Training for Diploma Teacher emphasises theories of education, teaching methodologies and ethics. Strategies include lecture method, micro teaching, portfolio.	Written assignment, Portfolio but little time given to TP in schools
Finland	Highest high	Needs Masters'	Main Subject	Theory of education,	Assessment

	school scores, excellent interpersonal skills, high school diploma and out of school accomplishments and/or Bachelor's degree	university degree to become a teacher. First 3 year bachelor's degree, then 2 year masters' degree both majoring in at least two subjects	Content courses (e.g., math) as per degree regulations. Strategies include cooperative and problem-based learning, reflective practice, and computer-supported education	pedagogical content knowledge, subject didactics and practice (including peer teaching). Strategies include cooperative and problem-based learning, reflective practice, and computer-supported education	through examination, tests, written assignment(s) or some other kind of coursework, with some focus on creativity and innovation. TP (constituting about 15% of study time) is done and assessed in schools.
Ireland	The best students are selected based on high grades in national school leaving exam	Four year training leading to Bachelors' degree	Primary level subjects (e.g., literacy, numeracy, history), ICT in teaching and learning, Bachelor's thesis	Professional development, communication skills, learners with special needs, pedagogical studies.	More weight given to school placements and research skills, 30 weeks for school placement (or TP).
Canada (Ontario)	Post-secondary Bachelor's Degree	2 years (4 semesters) Bachelor of Education degree	[Subject or content areas for the grades were taught at first degree level]	Major focus on foundations of education, planning, classroom management, evaluation, etc. Integration of theory, practice and research. Focus on reflection and practice, collaboration and community involvement and use of technology as teaching or learning tool	Main courses assessed in 1st and 2nd year and Field Experiences (ie TP + classroom and community observations and participation) assessed in about 3 weeks (Block I) and 5 weeks at end of 1st year (Block II). TP Blocks III and IV done in year 2. Coursework, writing of blogs, oral presentations, practicum, 'hands-on' and exam are other assessment strategies.
USA (most states)	Upper secondary school passes, minimum GPA, scores on university entrance exams	At least 4 years leading to Bachelors' Degree in Elementary Education and a Licence to teach	Fewer school subject courses (e.g., Math). Various instructional strategies used	More Pedagogy (methods) for language, arts, social studies, and science and math and Education courses. Various instructional strategies used	Various tests and/or exams are given. About 5 to 18 weeks of student teaching (TP). Some states give Certification exam
China	Advanced high school mathematics	Four-year Bachelor's degree leading to a certificate to teach mathematics only.	Advanced Algebra, Analytic Geometry, Probability Theory, Mathematical Analysis delivered through lectures	Teaching theory of mathematics, Analysis of mathematical curriculum standards and textbooks, Micro-teaching delivered through lectures and	Pencil and paper examination (about 50-70% of final grade), research papers, short assignments, in-

			and workshops	workshops (Teacher-centred pedagogy)	class presentations. About 18 weeks of TP
Philippines	Graduation from secondary school (no specific math requirement)	Four-year Bachelor of Elementary Education and passing further tests before full entry into teaching	Grades 1-6 subjects content, greater emphasis given to experience in the field and in classrooms.	Curriculum development, lesson planning, instructional materials development, assessment, and innovative teaching, and gives greater emphasis than previously to experience in the field and in classrooms.	Greater emphasis given to experience in the field and in classrooms.
Australia	Must pass at least six secondary high school subjects (there is also minimum requirement of personal numeracy)	Two-year Masters' in Primary Teacher Education (online) OR Bachelor of Primary Education	Mathematics subject content as offered in other universities e.g., Advanced Algebra, Geometry, Probability etc.	Compulsory mathematics related courses (16hrs - Preparing to teach primary mathematics I and II for Masters and 84hr- Mathematics education curriculum I, II and III for Bachelors) + other courses. Delivered through online lectures, workshops, and research work and less face to face lectures, centred on connected problem-solving and reasoning.	For Masters' programme- Online quizzes, e-portfolio, 11 weeks TP and 6-weeks internship. For Bachelors' programme- portfolio, research project, written exam, about 12 weeks of TP + 30 day internship

Adapted from Bokdam *et al.* (2014); Eskola (2009); http://www.sussex.ac.uk/cie/projects/completed/tpa/uganda; IEA and TEDS-M (2012); Lefoka and Sebatane (2003); Mereku (2014); Norton and Zhang (2018); Nyaumwe (2012); and Sullivan and Wood (2008).

From the table above, it would appear that Zimbabwe's model of initial primary school teacher training somehow lacks in terms of meeting goals of Education 5.0 since aspects of 'cutting edge' research, innovation and industrialization are not explicit in the content, teaching and assessment strategies. Other African countries also seem to have similar shortcomings as depicted in the table. For example, it has been noted in Ghana that trained primary school math and science teachers lack basic "content knowledge in science and mathematics, and strong pedagogical skills for teaching their pupils" (Ghana Ministry of Education, 2014). "Also teacher education (undergraduate and graduate) programmes do not provide adequate training in assessment as part of teacher certification to ensure teachers are assessment literate" (p.38).

Elsewhere (in Western and Eastern countries) teacher education curricula have moved towards more modern trends than incorporate use of ICT's, teacher communities of practice, teacher as reflective and independent thinker with Finland considered as one good example (Bokdam *et al.*, 2014; IEA and TEDS-M, 2012; Norton and Zhang, 2018).

In general, it has been lamented that mathematics teachers in primary and lower secondary schools often show serious misunderstandings, and this may be caused by deficient teacher preparation (Tatto and Senk, 2011).

2.3. 'Ideal' Mathematics Teacher Training

Due to students in some countries lagging behind in international tests such as PISA and TIMMS and due to the blame levelled on teachers, an outcry on the quality of teacher training has been raised (Hurrell, 2013). Therefore, there is need for education stakeholders to deliberate on what constitutes a good teacher and therefore on what constitutes ideal or perfect teacher training although these terms are subjective across different cultures and contexts (Kyridis *et al.*, 2014). Kyridis *et al.* (2014) summarised that an ideal teacher should, among other personal and professional traits, be *highly trained, creative, critical, kind-hearted, tolerant, carrier of progressive ideas, objective, communicative, sociable, conciliatory* and *responsible.* In another study Issacson (2010) summarised the characteristics of an 'ideal' teacher in her 'ten commandments' which included professionalism [which incorporates (1) having a vast knowledge of the discipline, (2) teaching the 'how' not the 'what' only, (3) being organized and planning well, (4) exciting one's pupils – letting them be active, (5) criticizing oneself, (6) being creative and up-to-date], and humaneness and compassion (caring, feeling for, loving, respecting, reinforcing, and being firm and fair). In an investigation by Rusu *et al.* (2012) students' essays featured the following characteristics of an ideal teacher (in decreasing order): human relations skills, fair assessment, knowledge of the subject, facilitator of students'

intellectual development, respectful, dynamic lecturer, and availability/good listener. Yang *et al.* (2020), found out that there was a positive (though small) correlation between mathematics teachers' knowledge and their professional teacher noticing (i.e., attending to important classroom situations, ability to analyse, interpret and make good decisions), which are also characteristics of an ideal teacher.

Research on forms or types of knowledge for teaching in general (Shulman, 1986) which may include knowledge of the use of ICT's or media and technology in teaching or mathematical knowledge for teaching (MKT) in particular (Ball *et al.*, 2008; Hill *et al.*, 2008) has been done. For example, the Technological Pedagogical Content Knowledge framework (TPACK) (Koehler and Mishra, 2009) is a framework for teacher knowledge for technology integration and in this 21st Century is it very rare for institutions not to include the use of technology in their teacher training curricula. Apart from having or developing the 'ideal' characteristics of a teacher as outlined above, a teacher should be helped and supported to acquire the following types of knowledge for teaching mathematics. These types of MKT which overlap and may need refinement are according to Ball *et al.* (2008):

- Common Content Knowledge (CCK) which is mathematical knowledge and skill used in general settings which may not necessarily be unique to teaching,
- Specialised Content Knowledge (SCK) which is the mathematical skills and knowledge particular to teaching,
- Knowledge of Content and Students (KCS) which is that knowledge concerning knowing about students and about mathematics,
- Knowledge of Content and Teaching (KCT) which involves knowing about teaching and knowing about mathematics,
- Knowledge at the Mathematical Horizon (KMH) which is knowledge about connections across the topics and strands in mathematics and how they fit into the mathematics which comes later, and
- Knowledge of Content and Curriculum (KCC) which involves articulation of strands, proficiencies and structure of the mathematics curriculum.

Therefore, what makes 'ideal' mathematics teacher training could be viewed as teacher training that involves the characteristics of a good teacher as outlined above, training on TPACK and also training that involves MKT. How best these types of knowledge are delivered and learned varies widely across different contexts (Opolot-Okurut *et al.*, 2008).

2.4. Conceptual Framework for Teacher Education

This study is guided by the whole teacher (Chen and Chang, 2006; Chen and Mcray, 2012) conceptual framework. The whole teacher approach emphasises promoting full development of the teacher in terms of knowledge, skills, methods, practices, attitudes and behaviours. Thus the social/emotional, cognitive, psychomotor and behavioural aspects of a teacher's growth are catered for. For instance, Plymouth State University's teacher education faculty is guided by the core values of Commitment, Holism, Experience, Collaboration and Knowledge (CHECK) (Holmes Center for School Partnerships and Educator Preparation, 2019). Zimbabwe's teacher training programmes which fall under the MHTESTD share, at least in theory, the same goal of producing and developing the 'ideal,' 'perfect' or 'whole' teacher although they might have different core values and mission statements to achieve that.

2.5. Research Innovation and Industrialisation in Teacher Education

The concept of the 'whole' or 'ideal' teacher entails that the teacher plays a very crucial role for the growth of the society as well as for self. Thus research, innovative ideas and practices should be fully incorporated in teacher education programmes (Kundra, 2018). Commenting about the Tanzania's industrialisation programme for 2016-2056, (Mufuruki *et al.*, 2017) say "People development is key to the success of the industrialisation project" and people development includes teacher professional development. However, teacher education programmes in some countries have been shown to only pay lip service to high impact research, innovation and industrialisation initiatives. In Lesotho for example, Lefoka and Sebatane (2003) contend that "NTTC as a whole does not seem to be the kind of 'learning institution' where innovation and renewal are part of the ethos." "The College, as an academic institution governed by Government, seems to lack the culture of intellectual debates and research that would otherwise contribute to improvement in academic development" (p. xiv).

In Zimbabwe, the concept of Education 5.0 seems to be a noble one but it would appear that many stakeholders have mixed feelings towards it and the success of its implementation remains to be seen. With regards to teacher training institutions, "The challenge for teacher educators is to produce innovative teachers who will go out into the schools to break the mould" (Lefoka and Sebatane, 2003).

3. Materials and Methods

A critical analysis of the mathematics curriculum including syllabi, schemes of work and timetables was done at one conveniently selected teacher training institution in the Midlands Province of Zimbabwe. Tests, assignments and computer software for teaching mathematics were not accessible for analysis. The researcher also observed two randomly selected lectures in progress, one for mathematics main subject (MMS) and the other for mathematics professional studies Syllabus B (MPSB). Five mathematics lecturers (L1-L5) were purposively chosen and interviewed. These methods and the curriculum documents were used with the view of addressing the questions of whether and to what extent Education 5.0 was being realised, the challenges currently being faced and the future

prospects of the philosophy. It was therefore seen worthwhile to investigate what mathematics is taught, how it is taught and assessed and what seems to lack in the teacher training programmes.

4. Results and Findings

4.1. Interview with lecturers (L1-L5)

L1 (Age 58, Male, 18yrs experience) was of the opinion that philosophy of education 5.0 is currently at its infancy. He said that people talk about it and innovation hubs have been opened at universities. However, he raised some concerns by saying:

> *At this college, there is lack of personnel with requisite technological, scientific and managerial skills. There is therefore need to have more focused education that requires and makes use of Science. The lecturers need to find out how to use indigenous knowledge to solve problems such as investigating chemical composition of herbs. The mathematics teacher training curriculum should include use of scientific principles in answering social problems.*

L1 further opined that a well-qualified mathematics teacher should be one who is able to use mathematical knowledge to solve problems in society. He pointed out that in the classroom settings teachers should give learners problem solving situations, discuss and debate with them entrepreneurial skills and let them start mini businesses. However, lack of modern equipment was deemed to be one of the challenges hindering the training of competent and effective teachers, so colleges needed to be resourced. He suggested that since mathematics cannot be divorced from industry, teachers could help in the improvement of Zimbabwe's economy by running small businesses with learners and giving advice to communities on small and medium scale enterprises. Commenting about the prospects of professional development of mathematics teachers in Zimbabwe, he said, "… the prospect is bright since professional teachers would to help improve the teaching of mathematics." On the prospects of philosophy of education 5.0, he said, "They are very bright if innovation and industrial hubs become a reality."

In general, it can be concluded that this lecturer was aware of Education 5.0 philosophy and maybe had attended some workshops on that concept.

L2 (Age 46, Male, 6yrs experience) seemed not aware of the pillars of Education 5.0 because he said, "it is a philosophical branch focusing on nature, educational aims and problems that emerge in implementing varied educational theories." He said this philosophy is being realised since, "... teacher education programs have doses of theory which preservice teachers are supposed to reflect on." He did NOT mention the practical, innovation or hands-on aspect that Education 5.0 is supposed to include. However, he probably correctly mentioned that in Africa we should be sensitive to 'Afrocentrism.' Commenting on obstacles of realising the philosophy, L2 mentioned socioeconomic challenges, and naïve adoption of Eurocentric theories. To overcome the challenges, L2 gave useful suggestions such as follows:

> *We need to be resourceful, hold workshops and organise research. In the curriculum of maths teacher training, technology and indigenous knowledge systems should be included. Hence a well-qualified math teacher should be good at both math content and pedagogy and should be technologically advanced. In the classrooms teachers should use methodologies that challenge traditional conventions. And to impart entrepreneurial skills to their leaners, math teachers should use practical assessments involving community tasks, and should apply their mathematical knowledge to solve 'real life' not 'fake' problems.*

L2 also outlined some challenges being faced in the training of math teachers as fear of math by student teachers and socioeconomic challenges resulting in low motivation. He suggested that the challenges could be rectified by de-mystification of mathematics and providing sustainable salaries so that both lecturers and teachers can deliver. He further said, without mentioning examples, that there are very high prospects of professional development of math teachers. He said philosophy of Education 5.0 has the prospect and potential of growing the economy since innovative graduates may create some new knowledge and products. He further echoed that there is need for sufficient funding for all the 'good' points to materialise which this researcher agrees with.

L3 (Age 48, Female, 1yr experience) started by alluding that Education 5.0 encourages motivation in the departments. However, she said, "it is not realised because everyone was not made aware of it," but she was also of the opinion that it had been realised to a very lesser extent. The challenges which she highlighted were lack of awareness among the stakeholders and lacking knowledge on how to implement the philosophy. In a bid to address this philosophy, she said the lecturers were encouraging student teachers to teach using scientific means. But she was not clear on what these 'scientific means' were. Speaking about the curriculum for math teacher training, L3 opined that it should include the preparation and use of locally manufactured learning and teaching aids as a component like CDS (the research project). She further said that:

> *A well-qualified maths teacher is one who can connect mathematics to the local culture rather than treating it as a culture-free subject. Teachers should cease to teach maths as a 'textbook subject' and connect classroom maths to the leaners' culture. The locally available teaching aids should be marketed to schools.*

L3 also said that one major challenge currently being faced in the training of math teachers is that those "enrolled as student-teachers are not the best for the job because most of them have to re-sit for mathematics several times.". Hence, she pointed out that Government should improve the welfare of the teachers so that they can produce the best students and so that the best students can enrol.

The interviewee suggested that math teachers can help in the improvement of the economy by connecting mathematics problems to the Zimbabwean context so that the learners who are produced can come up with solutions

to local problems. The professional development of math teachers in Zimbabwe has prospects or bright future of having a curriculum that markets the graduate teacher globally and locally, said L3. The Education 5.0 philosophy, if embraced and well implemented, also has prospects of contributing in solving problems in schools which include lack of teaching and learning resources.

L4 (Age 41, Male, 1yr experience) said he had heard of the concept of philosophy of Education 5.0. "The philosophy revolves around our heritage as Zimbabweans. Our teaching-learning should be contextualised in our environment." L4 was of the view that the philosophy is being realised as a new curriculum is now being implemented in all the schools in the country. However, resources for its effective implementation are scarce, echoed L4. Nonetheless, this interviewee could not clearly differentiate the updated curriculum from Education 5.0 philosophy.

L4 outlined the challenges currently being faced to implement Education 5.0 as (1) shortage of humane and material resources, (2) the panic approach used by authorities to launch it before resources were in place and (3) implementers' failure to subscribe to the ideas in faith. To alleviate the challenges, L4 suggested that (i) more resources which are appropriate need to be found, (ii) authorities need to adhere to systematic approaches to curriculum development and (iii) implementers need to be involved mostly in curriculum development. To address challenges of Education 5.0, the lecturer pointed out that they were currently undertaking research on a number of research areas that are linked to pedagogy and teaching. However, the researcher could not establish how many research outputs were there currently or in progress. Major concepts to include in the math teacher training curriculum were suggested as number concepts, measurement, geometry, data, algebra and concept of taking a limit. However, the researcher noted that these were only content areas exclusive of pedagogy, methodology and professional areas. A well-qualified mathematics teacher should be well drilled in conceptual and procedural knowledge. He/she also needs to be committed to the profession. To impart creativity in their leaners, L4 had the idea that teachers have to craft mathematical problems that provoke mathematical thinking in leaners whereas to impart entrepreneurial skills, math teachers should teach business mathematics to every learner despite ability. It was also suggested that teachers can help in the improvement of Zimbabwe's economy by teaching mathematics for business to all learners so that they have an understanding of running a sustainable business model. It was not clear to the researcher, however, what aspects of business math to include and how teachers should teach it to all 'despite ability.'

The challenges currently being faced in the training of math teachers were viewed as shortage of critical resources in the form of technologies, i.e., calculators and laptops, because "even some lecturers cannot buy them." Hence L4 encouraged colleges to purchase scientific calculators and laptops as a way to enhance effectiveness of lectures. But the researcher noted that lecturers and students had to be trained on how to effectively use them. L4 further said that the prospects for professional development of math teachers in Zimbabwe are inhibited by the economic environment as many math teachers cannot pay university fees for their professional development. The lecturer was nevertheless enthusiastic by saying "… this philosophy can take our education system to a better level as it will be aligned to our resources."

L5 (Age 46, Female, 11yrs experience) rightly pointed out that the "Philosophy 5.0 has five missions: teaching, research, community service, innovation and industrialisation. But it is not being fully realised due to ***financial constraints*** and ***lack of motivation*** on the part of implementers." (researcher's stress). She stressed that the philosophy had been realised to the extent that "industrial incubation hubs have been set up and researches are compulsory to all programmes in the sector." Challenges being faced to realise this philosophy were outlined as lack of sponsorship and procurement of equipment. She said these challenges could be rectified by Government putting in place procurement regulations on essential equipment like computers, WIFI gadgets and other consumables and regulations on importation of such equipment to be liberalised. Lecturers were said to be involved in research and use of pedagogy that is technology compliant. However, there were no evidences to such claims. L5 further commented that:

> *The curriculum for maths teacher training should include ICT for maths education and context based curriculum* (sic). *A well-qualified maths teacher is one who is well grounded in both theory and practice. Maths teachers should impart creativity and innovation skills amongst their learners by being innovative in their teaching and including problem based contexts. On imparting entrepreneurial skills, teachers should assign research tasks to leaners. Nevertheless, shortage of resources and manpower are hindering the training of maths teachers so that they become competent and effective. These challenges could be alleviated by providing sponsorship for maths student teachers. And in the schools, maths teachers should also be exemplary entrepreneurs.*

L5 also hinted the prospects for professional development of math teachers in Zimbabwe as "a bright future with well organised and focussed staff development for maths teachers provided the Government sponsors and motivates its workforce." The Education 5.0 concept was viewed as a well thought out philosophy with prospects of a far reaching impact if well implemented.

4.2. Lesson Observations

4.2.1. Observation for MMS

The lecture topic was Integration of Trigonometrical Functions taught to a group of 28 third year students who were present. As an introduction, the lecturer recapped the previous lesson on differentiation of trig functions and then defined integration as the reverse of differentiation. Worked examples were given on the white board and then students were asked to solve some integration problems as individuals on pieces of paper. The lecturer moved

around marking and then more difficult exercises were given on the board. The lecture took 90 minutes after which some ten homework exercises from the main textbook were given. There was no mention of applications of trig functions to real life situations nor on the purposes or aims of integration. Students did not use calculators or computers to solve the problems or to sketch some graphs.

4.2.2. Observation for MPSB

The topic 'Measurement' was taught with the following aspects assigned to small groups of the 43 first year students to discuss: What is measurement? Which are the measurement topics? How should we teach measurement (methods of teaching in general)? How should we teach measurement (examples of how measurement aspects are taught)? After the group discussions, there was a report back session. The lecture lasted for 90 minutes. However, no practical demonstrations were given except 'chalk and talk.' Students were then asked to go and write their own notes.

4.3. Document Analysis

Documents such as timetables, schemes of work and lecture programmes for MMS and MPSB were analysed. Each scheme of work lasts for a term and each lecturer teaches his/her topic for 3 weeks or so and then gives an end of topic test. Each lecture lasts for 1½ hours. For example, some of the aims of the Diploma in Education (Secondary) lecture programme for Term I of 2019 read as follows:

(c) explore general applications of the various branches of mathematics; and

(d) provide a firm foundation upon which students can pursue further studies in applied mathematics and related fields.

However, it is not clear (from this programme) what teaching or learning approaches/methods will be used to achieve these aims.

For the Diploma in Education (Primary), MPSB Intake 20/2019, the researcher noted that the programme is not clear on what activities/tasks students will engage on in order to master measurement (2 weeks) concepts and skills which they will impart to their learners. On scheming and lesson planning (4 weeks), the programme seems to be silent on the need for scheming/planning and the formats. There are no tests or assignments indicated in the programme.

For the Diploma in Education (Primary), MMS Intake 20/2019, the researcher noted that there is a test at the end of each unit. But the test is silent on what knowledge and skills (competencies) need to be imparted and for what reasons.

5. Discussion

Some lecturers echoed similar sentiments in the interview leading up to the following common themes to be incorporated in teacher training: Indigenization, Creativity, Innovation, Entrepreneurship. Afrianto (2018) alludes to similar points such as critical thinking, communication and collaboration skills. Themes related to the challenges could be listed as sponsorship or financing programs, motivating lectures and student-teachers, and workshops for implementers. One could also come up with poor selection criteria, weak knowledge base or poor background of the recruits as other challenges.

Drawing from the interviews with lecturers, it could be noted that meaningful comments and suggestions were offered but the lecturers' lessons as observed by the researcher and the math teacher training syllabi as analysed did not seem to reflect these ideas and opinions. Maybe the lecturers did not have much powers, expertise and resources to implement them. This corroborates Villegas-Reimers (2003) who asks what kind of professional do different institutions hope to produce: Clinicians (teachers just following processes)? Researchers? Teachers with capacity for leadership in innovation and enquiry? Lefoka and Sebatane (2003) also lament about innovations at the teacher training college which seemed to be "superficial and cosmetic since they refer more to changes of names of programmes than of the content and strategies."

A list of different kinds of teachers can also be added to the conceptual framework to answer the questions posed above and these are Knowledgeable teacher, Collaborative teacher, Industrious teacher, Innovative teacher, Creative teacher, Student and Community-Oriented teacher, Patriotic teacher, Dedicated teacher, Disciplined teacher, Problem-Solving teacher, Technologically-Oriented teacher and so on. These teacher qualities point to innovative practices in teacher education (Kundra, 2018). In Tanzania, for example, the BSc(Ed) or BEd (Sc) students, apart from their main subject, take the following common courses for all science students as depicted in Table 2.

Table-2. BSc(Ed) or BEd (Sc) common courses for all science students

Course code	Course title	Units	Core/Optional
DS100	Perspectives of development I	2	Core
IS131	Introduction to Informatics and Microcomputers	2	Core
EV200	Environmental Science	2	Optional
DS211	Entrepreneurship, Small Business and Development	2	Optional
SC215	Scientific Methods	2	Optional

Source: Eskola (2009)

According to Mufuruki *et al.* (2017), the Tanzanian Government considered that "practical skills and knowledge of doing things practically is more important and more profitable than the sheer mastery of the theory of those same things" (p.64) and hence the President John Pombe Magufuli said "We will have to revamp our educational institutions, build an innovation culture and entrench entrepreneurship in our society" (p. viii). Hence, this researcher advocates for all such courses as in Table 2 to be 'core.'

5.1. Math Teacher Training Curriculum Proposals for Zimbabwe

Therefore, to answer the questions "what do (mathematics) teachers need to know?" or "what are the different types of teacher knowledge or mathematical knowledge for teaching?" (Hill *et al.*, 2008), and "how can a teacher training institution produce an 'ideal' teacher?" the researcher, basing on the results and findings of this study, hereby proposes an ***innovative, entrepreneurial and industry-centred*** mathematics education curriculum for primary school pre-service teachers in Zimbabwe:

Entry requirements: At least five 'O' Level subjects inclusive of Mathematics, English and one or more indigenous languages (Shona, Ndebele, Tonga, Nambya, Kalanga, etc.) at grade C or better. The recruit should demonstrate willingness and some capability to learn one or more of the indigenous languages other than his/her mother tongue. This will ensure that after completing the course and when posted to any province in Zimbabwe, the teacher will be able to communicate, at least at the rudimentary level, with the children and community members while learning their language, customs and traditions which are some of the key factors that affect learners' performance.

Duration and model: 3 years comprising 9 terms of which will be 2½ **in** - 4 **out** – 2 **in** - ½ **out**.

Delivery mode: (Blended) i.e., Conventional with Industrial and ODeL. First 2½ terms **in** college (doing general courses, MMS and MPSB), 4 terms **out** (doing action research, TP and application of ICT's and small business and entrepreneurship skills- with learners and community members, school and community members partnering and selling produced artefacts, etc.), 2 terms **in** (doing general courses, MMS , MPSB, learners' languages, and creativity, small business, entrepreneurship, innovation and ICT's which will be research based), ½ term **out** (On selected School and Industrial Visits – observing lessons, team teaching, reduced emphasis on 'too much documentation,' industry experts to help in applying innovations and more business and entrepreneurship skills).

General Courses: Theory of education (philosophy, sociology, psychology), theories of teaching, knowledge of teaching profession, classroom practice and management, public service regulations and conditions of service, special needs education, creativity and innovation theory and practical, learners' languages, ICT's including computers, small business and entrepreneurship, action research.

Mathematics Content: History of Mathematics, Indigenous Mathematics, Computer Applications, among the traditional math topics pitched at or above "A" Level.

Mathematics Pedagogy: Include Real-life Applications, Teaching Creativity and Innovation, Teaching 'Mathematical' Entrepreneurship, Humanising Mathematics - preventing and reducing mathematics anxiety and building positive mathematical beliefs and attitudes, Teaching and Learning Mathematics and Keeping Classroom Records using Computers, Grades 1-7 math topics, among the traditional topics. Lecturers could use inquiry-based pedagogical instruction as recommended by (Wang, 2020).

As an example of how learners can become creative and innovative, a video shared from the WhatsApp social media platform can be used by teacher trainers or educators to demonstrate to and encourage their student teachers:

VID-20191126-WA0001 African Innovation.mp4

The student teachers should do the same to their learners.

Assessment Strategies: Both formative and summative assessments in forms of practical and theoretical exercises, assignments, tests and examinations should be used. For example, 'practical' assignments of using mathematical concepts and skills to make artefacts, equipment, products, etc., for use in the classroom or at home and for sale, small business projects and small 'home' industries, innovative applications of computers and other technologies, among the traditional topics, should all be included.

6. Conclusion

Findings in this study have pointed to the conclusion that the ways of professionally developing mathematics teachers (and probably other subject teachers as well) in Zimbabwe continue to follow the old systems. While the concept of Philosophy of Education 5.0 is a noble one, many students are not aware of it and more so lecturers just pay lip service to it. Thus, it has barely been implemented and it seems it is difficult to implement it. Hence, the author has proposed and drafted an innovative mathematics education curriculum for college and university primary school teacher trainees.

Recommendations

- Lecturers in teacher training institutions and those in charge of professional development of mathematics teachers should undergo thorough induction and in-service workshops on how to implement Philosophy of Education 5.0

- Curricula for mathematics teacher training should be overhauled and geared more towards producing creative, innovative, practical and industry-oriented professionals rather than only 'theoretical' ones. This is so if Zimbabwe is to attain an upper middle economy status by the year 2030.
- There is need by the Ministry of Primary and Secondary Education to pilot-test and evaluate the researcher's proposed *innovative, entrepreneurial and industry-centred* mathematics education curriculum for primary school pre-service teachers.
- Further research on sustainable professional development of primary school mathematics teachers could also be carried out on a wider scale.

References

Afrianto, A. (2018). Being a professional teacher in the era of industrial revolution 4.0: Opportunities, challenges and strategies for innovative classroom practices. *English Language Teaching and Research*, 2(1): 1-13.

Ball, D. L., Thames, M. and Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, 59(5): 389-407. Available: http://dx.doi.org/10.1177/0022487108324554

Bokdam, J., van den Ende, I. and Broek, S. (2014). *Teaching teachers: Primary teacher training in europe - state of affairs and outlook study*. European Union: Brussels.

Chen, J. Q. and Chang, C. (2006). Testing the whole teacher approach to professional development: A study of enhancing early childhood teachers' technology proficiency. Available: https://files.eric.ed.gov/fulltext/EJ1084920.pdf

Chen, J. Q. and Mcray, J. (2012). A conceptual framework for teacher professional development: The whole teacher approach, nhsa dialog: A research-to-practice. *Journal for Early Childhood Field*, 15(1): 8-23.

Chirume, S. (2014). A critical analysis of the factors affecting achievement in secondary school mathematics in Zimbabwe: A case study of Gweru District. *Merit Research Journal of Education and Review*, 2(9): 194-202.

Chirume, S. (2017). Towards a new teacher-training model for ODL: The challenges faced by PGDE students and their mentors and supervisors during teaching practice. *US-China Education Review A*, 7(10): 463-77.

Eskola, A. (2009). *Tanzanian and Finnish teacher training and curriculum in mathematics.* Unpublished Master of Science Thesis: Tampere University of Technology, Finland.

Ghana Ministry of Education (2014). Inspiring science and mathematics in basic schools. Report of the committee that reviewed basic science and mathematics education in Ghana. Available: https://www.academia.edu/33123477/INSPIRING_SCIENCE_AND_MATHEMATI

Government of Zimbabwe (2018). *Towards an Upper-middle Income Economy by 2030, New Dispensation Core Values.* Washington DC.

Hill, H. C., Ball, D. L. and Schilling, S. G. (2008). Unpacking pedagogical content knowledge: Conceptualizing and measuring teachers' topic specific knowledge of students. *Journal for Research in Mathematics Education*, 39(4): 372-400.

Holmes Center for School Partnerships and Educator Preparation (2019). Conceptual framework for teacher education (check). Available: https://campus.plymouth.edu/educator-preparation/conceptual-framework-for-teacher-education-check/

Hurrell, D. P. (2013). What teachers need to know to teach mathematics: An argument for a reconceptualised model. *Australian Journal of Teacher Education*, 38(11): 54-64. Available: http://dx.doi.org/10.14221/ajte.2013v38n11.3

IEA and TEDS-M (2012). *Policy, practice, and readiness to teach primary and secondary mathematics in 17 countries. Findings from the IEA Teacher Education and Development Study in Mathematics (TEDS-M).* International Association for the Evaluation of Educational Achievement (IEA): Netherlands.

Issacson, A. (2010). Defining the ideal teacher: Productive dialogue in schools in Israel. *Educational Practice and Theory*, 32(2): 57-85.

Koehler, M. J. and Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education*, 9(1): 60-70.

Kundra, T. (2018). Innovative practices in teacher education programme. *International Journal of Applied Research*, 4(4): 238-40.

Kyridis, A., Avramidou, M., Zagkos, C., Christodoulou, A. and Pavli-Korre, M. (2014). Who is the ideal teacher? Greek pre-service teachers express their views about the characteristics of the "perfect" teacher. *Journal for Educators, Teachers and Trainers*, 5(2): 143-59.

Lefoka, J. P. and Sebatane, E. M. (2003). Initial primary teacher education in lesotho- multi- site teacher education research project (muster) country report two, educational papers, Dfid Sussex, Uk.

Maravanyika, O. E. (1990). *Implementing educational policies in Zimbabwe, World bank discussion papers No. 91. Africa technical department series.* Washington, D.C: The World Bank.

Mereku, D. M., 2014. "Sixty years of teacher education in Ghana." In *A presentation made at the The launching of the 60th Anniversary Celebration and the Annual Graduation Ceremony of Peki College of Education on Friday, 13th June 2014.*

Mufuruki, A. A., Mawji, R., Kasiga, G. and Marwa, M. (2017). *Tanzania's industrialisation journey 2016-2056, from an agrarian to a modern industrialised state in forty years, moran (E.A.).* Publishers Limited: Nairobi.

Norton, S. and Zhang, Q. (2018). Primary mathematics teacher education in Australia and China: What might we learn from each other? . *Journal of Mathematics Teacher Education*, 21(3): 263-85.

Nyaumwe, L. J., 2012. "Analysis of mathematics teacher education curriculum in Zimbabwe: Challenges and opportunities." In *Paper presented at the 12th International Congress on Mathematical Education, 8 July - 15 July, 2012, COEX, Seoul, Korea.*

Opolot-Okurut, C., Julie, C., Mikalsen, O. and Oluka, S. (2008). *Mathematics teacher practices in ugandan secondary schools, in Holtman, L., Julie, C., Mikalsen, O., Mtetwa, D. and Ogunniyi, M. (eds). Some developments in research in science and mathematics in sub-saharan Africa: Access, relevance, learning, curriculum research.* African Minds, Somerset West, South Africa.

PISA (2018). Insights and interpretations. Available: https://www.oecd.org/pisa/PISA%202018%20Insights%20and%20Interpretations%20FINAL%20PDF.pdf

Rusu, C., Soitu, L. and Panaite, O. (2012). The ideal teacher. Theoretical and investigative approach. *Procedia-Social and Behavioural Sciences,* 33(2012): 1017-21.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher,* 15(2): 4-14.

Sullivan, P. and Wood, T. (2008). *Knowledge and beliefs in mathematics teaching and teaching development.* 079 The International Handbook of Mathematics Teacher Education (1), Sense Publishers: Rotterdam, Taipei.

Summers, C. (2002). *Colonial Lessons: Africans' Education in Southern Rhodesia, 1918-1940.* Heinemann: Portsmouth, NH.

Tatto, M. T. and Senk, S. (2011). The mathematics education of future primary and secondary teachers: Methods and findings from the teacher education and development study in mathematics. *Journal of Teacher Education,* 62(2): 121-37.

Villegas-Reimers, E. (2003). *Teacher professional development: An international review of literature, international institute for educational planning.* UNESCO: Paris.

Wang, J. (2020). Compare inquiry-based pedagogical instruction with direct instruction for pre-service science teacher education. *International Journal of Science and Mathematics Education,* 18(6): 1063-83.

Yang, X., Kaiser, G., König, J. and Blömeke, S. (2020). Relationship between chinese mathematics teachers' knowledge and their professional noticing. *International Journal of Science and Mathematics Education*: Available: https://doi.org/10.1007/s10763-020-10089-3