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Zimbabwean mathematics pre-service teachers' implementation of the learner-centered curriculum during teaching practice

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Abstract

Effective mathematics teaching and learning is crucial not only for the purposes of examination and assessment but as well for the learners' empowerment so that they cope with the ever-changing technology and be able to solve real-life social and economic problems of the world. The study aimed at revealing the pre-service teachers' pedagogical practices during teaching practice as well as whether they aligned their practices to the teaching approaches recommended in the mathematics syllabus. The case study involved four secondary school pre-service mathematics teachers who were purposively sampled. Documents, interviews and lesson observations were the data collection instruments. The results showed that out of the four teachers only two used both teacher-centered and learner-centered methods, whilst the other two used purely traditional teacher-centered methods. The learner-centered methods used by the two teachers were only limited to group work and pair work out of the several learner methods recommended by the syllabus. In this era of technology, none of the teachers made use of technology whilst delivering their lessons, which is also not in line with the syllabus requirements. Pre-service teachers need to be more knowledgeable in learner-centered approaches, syllabus use and interpretation as well as technology integration in the teaching and learning of mathematics.

Keywords: learner-centered approaches, teacher-centered approaches, pre-service teachers, mathematics, learning, teaching

INTRODUCTION

Internationally, educating a nation is key to the development of any society because people's standards of living would probably improve as they would have been empowered to embark on creative ventures that would eventually lead to improved livelihoods. Mathematics education is a foundation and an essential tool for the scientific and economic development of individuals and a country (Nyaumwe & Mtetwa, 2013). Mathematics plays an important role in human life to the extent that in Zimbabwe it is a compulsory subject at the ordinary level ('O' level). Mathematics is crucial in the progress and academic development of Zimbabweans. It helps in the understanding of other subjects such as physics, chemistry and biology. In Zimbabwe, it is a gateway pass to various public tertiary institutions and for most jobs. Even though mathematics is regarded as an important subject in the school curriculum, it has been noted that the subject is difficult for learners. Learners' poor academic performance in mathematics has been a cause of concern among stakeholders and educators, which resulted in researchers searching for solutions. The poor performance of learners has been attributed to a number of factors such as ineffective instructional methods and inadequate resources (Makondo & Makondo, 2020).

In 1998, Nziramasanga Commission was tasked to look into the education system in Zimbabwe. The commission reported a high failure rate in mathematics as a sign of calamity that led different stakeholders to advocate for curriculum change to cater for the needs of the learners as well as improve performance (Magudu, 2012). The current competency-based curriculum aims to promote and cherish the Zimbabwean identity, prepare students for life and work in a largely agro-based

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Contribution to the literature

- To raise awareness of pre-service mathematics teachers' understanding and use of learner-centered approaches during teaching practice at a selected university in Zimbabwe.
- To update mathematics teachers' trainers with pre-service mathematics teachers' competences and non-competences to interpret and implement the mathematics syllabus.
- To provide an insight into the need for pre-service mathematics teachers to have adequate knowledge and preparation in teaching methods and technology integration into teaching and learning of mathematics.

indigenized economy in an increasingly globalized and competitive environment, foster life-long learning in line with the opportunities and challenges of society, prepare learners for participatory citizenship, peace and sustainable development (Ministry of Primary and Secondary Education [MOPSE], 2015). The new curriculum encourages teachers to do away with the idea of teaching mathematics as a set of facts and rules rather than helping learners to make sense of mathematics conceptually as well as engaging learners in mathematical practices such as justification, argumentation, and exhibition.

Teachers make sense of the curriculum documents, plan and then implement the curriculum. Teachers interpret the curriculum and translate it into the applied curriculum in their classrooms, as they engage with their curriculum resources in a design process (Cai & Hwang, 2021). Curriculum materials are vital resources that can support instructional change (Cai & Hwang, 2021). Hence, the study of curriculum would help identify the challenges in the curriculum and its implementation that would result in the changes in approaches that teachers use in the teaching and learning of mathematics. In addition, through the study of the curriculum, teachers would have an opportunity to reinterpret and reshape the curriculum materials and approaches (Cai & Hwang, 2021). As the teachers employ the materials and approaches, they can document what they have done and share their innovations as new curriculum materials and approaches for other teachers.

According to Sahlberg (2007), curricula are renewed because of the belief that changing the curriculum might bring anticipated improvements into the classrooms. The new curriculum advocates for learner-centered approaches that are intended to improve the learners' performance as well as their conceptual understanding that would allow for the transfer of knowledge and application of knowledge. With the aim of improving mathematics performance using learner-centered methods but especially through curriculum changes, learners are still performing poorly while teachers are not comfortable with teaching due to immediate changes without any training to cope with new changes. Nevertheless, the way the teachers actually taught in the classroom has basically remained a mystery (Cuban, 2006). This study intends to find out teachers' practices in mathematics teaching and learning towards learner-centered pedagogy as recommended in the new curriculum. The study was guided by the following research questions:

1. What are the pre-service teachers' characteristics and patterns of mathematics teaching and learning approaches?
2. Do the pre-service teachers' teaching approaches match the new mathematics curriculum pedagogy?

LITERATURE REVIEW

Curriculum Renovation

Curriculum revamping encompasses changing values, relationships, skills and attitudes and is not just a matter of providing apt procedural information. Curriculum revamping needs expertise, in the absence of a motivating force to introduce and implement change, the prevailing situation is likely to remain. All the stalk holders should be ready for the curriculum change. Some of the motives for curriculum change are political, individual and societal needs and knowledge. Curriculum renovation is important in making the curriculum relevant to the needs of the society such as skilled manpower.

Knowledge is a strong agent for curriculum renovation as it is constantly expanding. For that reason, curricula have to accommodate innovative funds of knowledge (Gatawa, 1999). Curriculum renovation is driven by the understanding that the education system of the late twentieth century is no longer relevant in terms of content, objectives, methods and relevance (Zindi, 2018). Curriculum renovation means changing some of the essential components of the curriculum such as aims, objectives content, methodology and assessment. According to Ndawi and Maravanyika (2011), curriculum renovation at any level is more complex than expected because a change in any one component of interconnected structures gives rise to a chain reaction of other changes. Such changes have implications for the teaching and learning of mathematics concepts for both teachers and learners as they are the vital implementers and recipients, respectively. The changes in the new mathematics curriculum have ushered in a range of changes in relation to mathematics teaching and learning.

In Sub-Saharan Africa, one of the major aims of curriculum reform is to promote learner-centered methods as well as active interaction between learners and teachers and learners (Bethell, 2016). Specifically, the use of group work and formative assessment have been encouraged to involve and support the learners (Bethell, 2016). In Zimbabwe, the secondary school mathematics curriculum has undergone several changes since gaining independence in 1980. In the mid-1980s, emerges of technologies such as scientific calculators resulted in 'O' level mathematics curriculum called the calculator version (4024). The content of the curriculum was the same as the non-calculator version (4004). The learners for the two curricula wrote the same mathematics paper 11 in which those sitting for 4024 used calculators, whilst those for 4004 used logarithmic tables. According to Nyaumwe (2006), the simultaneous use of 4004 and 4024 was envisioned to give mathematics teachers ample time to train in the proper use of calculators to improve the application of the tools in mathematics teaching and learning. The curriculum was contentment driven while teaching methods were teacher centered.

The mathematics curriculum was also revised in the mid -1990s to meet the country's new objectives for mathematics education. The 4004 and 4024 curricula were renamed 4008 and 4028 respectively. Zimbabwe Schools Examinations Council (ZIMSEC, 2015) 'O' level mathematics syllabi (4008/4028) suggest teaching approaches, which view mathematics as a process. It recommends that concepts should be developed from concrete situations in the immediate environment and move to abstract and that learners should be taught to identify problems in their environment, put them in geometrical form and solve them through project work. The learner-centered pedagogy was emphasized in the curriculum. This was a fundamental change, which was intended to do away with the content-driven curriculum and teacher-centered teaching. However, the examinations tested for rote memorization of facts, thereby forcing teachers to resort to teacher-centered pedagogy in their classroom practice.

In 2017, a new competence-based mathematics curriculum was adopted. The new curriculum recommends that the teaching and learning of mathematics must be learner-centered and that multi-sensory principles be applied during the teaching and learning process. The new curriculum encourages learner-centered teaching approaches and the use of multisensory approaches just like the previous 4008 and 4028 curricula. This indicates a problem in curriculum renovation in Zimbabwe as attempts to change classroom practice have been unsuccessful. It seems that there is a wide gap between what the curriculum documents require and what the teachers do. It is against this background of failed previous efforts to change classroom practice that the current study explores how pre-service mathematics teachers were transforming their classroom practices (if at all they were) in line with the learner-centered pedagogy as required by new curriculum framework 2015-2022.

The current study focuses on the pre-service teachers who were on teaching practice. The theoretical basics for building teaching skills are provided during training in institutions in lectures but the actual teaching skills are acquired during teaching practice. During the teaching practice pre-service teachers acquire various skills such as interpreting the curriculum goals, breaking the curriculum into teachable units, select appropriate teaching approaches, delivering the content to the students and assessing student learning. It is important to investigate the pre-service teachers practices during teaching practice as they implement the new curriculum so as to understand the way the implement and suggest ways of improving the way they are trained in teacher training program.

Teacher-Centered Pedagogy

Traditional approaches that include teacher-centered instructional approaches that limit learners' development of conceptual understanding of mathematics concepts have been disparaged because of their inability to encourage problem-solving skills in learners (Nyaumwe, 2004). Such approaches are mainly focused on teacher talk that does not include ample questioning, discussion or individual learner's development of understanding. The teacher-centered pedagogy of delivering mathematics content is linked to the behaviorist approach, which is communicated in the classroom through the use of repetition and drill of isolated skills, individual work, and an emphasizes on the use of routine procedures (White-Fredette, 2010). Teachers who embrace teacher-centered pedagogy favor instructional practices, for instance, lecturing, giving paper-pencil activities to learners, predominantly using textbook resources and circumventing teaching using authentic life problems. Teachers provide learners with routine mathematical tasks that include the use of memorized procedures, and deductive reasoning and they stress that each task has a single, static correct answer (Bethell, 2016; White-Fredette, 2010).

Learner-Centered Pedagogy

A learner-centered teaching method supports learners' development of mathematical reasoning as well as encourages them to view their teachers who are there to help them in making sense of mathematics whilst they create contexts that would help them to develop meaning in mathematics (Brodie, 2006). In learner-centered pedagogy, teachers inspire learners to explore many representations of mathematics concepts and different relations among them. Teachers tend to use whole class discussions, collaborative work in groups or pairs and fieldwork in the classroom. In addition to this,

they tend to create their problems using a multiplicity of resources including those from both the learners' and the teachers' environments. For example, some aspects of mathematics such as geometry might be taught by using various measurements from both the home and the classroom, for instance, the perimeter or area of the floors, windows, walls, and living area. Learners are encouraged to be actively engaged in knowledge construction as well as applying the acquired knowledge in a real-life situation. The application of mathematics knowledge in a real-life situation is viewed as successful learning. This implies that learning is complete if the learner acquires skills and practices that could be useful in future in solving different or similar mathematics real-life situations. Connecting the teaching and learning of mathematics to real-world contexts makes mathematics enjoyable and accessible to learners.

Teachers as facilitators try to create conducive learner-centered environments that encourage learners' construction of mathematics knowledge (Schunk, 2014). Learners are encouraged to be actively engaged in the construction of mathematical knowledge through the use of their prior knowledge. The new mathematics knowledge is built using the prior knowledge that the learners already possess. According to Boaler (2016), mathematics teaching and learning must draw from mathematical activities that have high intellectual demand, rather than resorting to memorization, in order to inculcate a positive attitude towards mathematics. However, it has been noted that is more difficult to implement the learner-centered approaches in the classroom than it seems to be in the syllabus (Chisholm & Leyendecker, 2008). According to Chisholm and Leyendecker (2008), learner-centered approaches are the most predominant notions that are difficult to be realized in the classroom.

Teachers' Teaching Practices

A study carried out by Umugiraneza et al. (2017) in South Africa, participated by 75 mathematics teachers revealed that most teachers used teacher-led explanations that include lecturing, explaining illustrations and showing and telling. Teacher-led instruction is an approach in which the teachers take an active and central role in the knowledge and instruction provided to a class (Umugiraneza et al., 2017). Such a form of instruction is not the most efficient method of delivering mathematics content knowledge to learners as it does not encourage active participation in the teaching and learning process. The same study showed that some teachers were using learner-centered approaches such as cooperative learning strategies that include group work and classroom discussion to a smaller extent as compared to the traditional methods. Co-operative learning strategies enable learners to share valuable information in groups, which cannot be achieved when learners work individually.

An earlier study by Hogan (2008) in Singapore showed similar pedagogical practices were dominated by teacher-centered approaches and little or minimum use of learner-centered approaches. Park and Leung (2006) carried out a study in Korea with three teachers where they analyzed ten consecutive lessons for each teacher. They found out that despite the seemingly procedural teaching and passive learning, the learners were deeply involved in exploration when following the prearranged classroom activities planned by the teachers. Another study carried out by Kaur et al. (2007) in Singapore with three teachers showed that despite the teacher-centered approach being dominant in the teaching and learning of mathematics the learners' thinking was considered during the lessons and included in their discussions.

Lim and Kor (2012) observed 12 mathematics lessons taught by six teachers and found that four out of six teachers concentrated on learners' intellectual development and learners' active participation. For instance, one of the teachers would ask learners to demonstrate their answers to a task in front of the class to enable the whole class analysis of the solution and comparison of learners' solutions with the teacher's prepared answer. In a Japanese classroom, the lessons are characterized by a review of the previous lesson, presenting the problems for the lesson, learners working as individuals or in groups, discussion of the solution and a highlight and summary of the main point (Stigler & Hiebert, 1999). The Japanese lessons to a significant extent are characterized as structured problem solving, where learners work on a problem and then discuss the solution processes, sharing vital notions found in the problem-solving procedures as well as the discussion.

RESEARCH METHODOLOGY

A qualitative research approach where data was collected at the site where the participants experience the problem under study (Creswell, 2015) was used. Gray (2011) defines qualitative research as a method that seeks to comprehend phenomena within their natural settings and uses several theoretical stances and approaches such as document analysis, observation, interviews and questionnaires. Data gathering was through talking to the teachers and observing them teaching within their classroom is a major aspect of qualitative research of studying individuals in their natural settings. A multiple case study was used in the current study, which focuses on participants as separate individuals. The multiple case study focused on each of the selected mathematics teachers as an independent classroom expert with the specific sovereignty to make decisions on various classroom issues including the teaching approaches.

Participants and Context

The study was carried out at a university in Zimbabwe whose mandate is to train secondary school science and mathematics teachers. The study population consisted of thirteen secondary school pre-service teachers who were stationed at various schools in Zimbabwe on teaching practice (practicum) for one year. The pre-service teachers were studying towards a diploma in science education (DipScEd) specializing in mathematics. Four pre-service teachers were selected using purposive sampling. According to Creswell (2015), the common sample size for case studies is four to five cases. The selected pre-service teachers were stationed at the schools that were considered to have the best teaching and learning resources based on the information that was provided to the researchers by the teachers.

As part of the requirements of DipScED at the university under study, pre-service teachers go on teaching practice for one year. Teaching practice is sometimes referred to as practicum where pre-service teachers are attached to schools under a mentor for practical teaching in the actual classroom settings. It is a course where the pre-service teachers must marry theory and practice. During teaching practice, pre-service teachers are expected to develop and test their teaching skills in a real classroom setup. The pre-service teachers are required to interpret the syllabus, design schemes of work and lesson plans for the classes that they are required to teach. Mathematics lecturers visit schools to assess pre-service teachers' performances and award a teaching practice mark. Due to the COVID-19 pandemic visits were done during the third term that is from October 2021 to December 2021 where there were no lockdown restrictions. Therefore, the current study reports the findings of the third term only. Thirteen pre-service teachers in the 2021 cohort were on teaching practice.

Instruments

The use of in-depth interviews, documents and observation enables the current study of the teachers' classroom practice as well as triangulating the data. The transferability and trustworthiness of the findings and conclusions from the current qualitative study were increased through data triangulation. Data was collected through documents. Documents are standardized artefacts that occur in particular formats such as certificates, diaries, case reports and many others (Wolff, 2004). According to Yin (2014), one advantage of examining documents is that it is an unobtrusive source of data whose exactness and dependability can be counted on as the documents were not made at the researcher's request, therefore documents are expected to encompass authentic data. In addition, documents are a stable source of data because of their physical availability as well as being time convenient to the examiner. The researchers had a chance to revisit as well as re-examine the documents to make clear any grey areas, or gain more insights whenever necessary (Creswell, 2015). Documents that were examined in this study were the mathematics syllabus, the scheme of work and the applied science education (ASE) student's handbook. The mathematics syllabus is a national document produced by MOPSE (2017) together with ZIMSEC and Curriculum Development and Technical Services Unit. A scheme of work is a document that is produced by the teachers as they interpret the mathematics syllabus as well as break it down into weekly teachable lesson units. The purpose of examining the mathematics syllabus was to find out the teaching approaches recommended for use. Schemes of work were examined in order to identify the teaching approaches the mathematics teachers planned to use in their lessons and evaluate the extent to which they adhere to the mathematics syllabus. ASE student handbook is a guide that helps pre-service teachers to become effective teachers. ASE student handbook was examined for the documents required in the teaching practice file. In addition, documents were examined as a way of checking whether the approaches indicated in the schemes of work by the mathematics teachers were the ones they really used in their lessons.

An observation is a systematic method of recording observable activities or phenomena in a natural setting (Gorman & Clayton, 2005). According to O'Sullivan (2006), observing a lesson reveals the progressions of teaching and learning practice, and reveals the teachers' working conditions including the possibility of providing recommendations that would improve the teaching and learning process. O'Sullivan (2006) noted that observing lessons may possibly provide answers to the how, why and what research questions. For instance, in this study, through lesson observation researchers can obtain data on the teachers' classroom practices, the approaches that they are using and how they bare using such approaches. During the lesson observation, the researchers observed the lessons in a natural environment as well as recording what occurs during the teaching and learning process rather than depending on oral or transcribed interpretations (Cohen et al., 2015). The structured observation was used in the current study where an observation schedule was used to examine the teachers' classroom practices.

An interview is described as a purposive conversation between two or more people in which one of them has the role of the researcher (Gray, 2011). Interviews have long been the most common technique in qualitative research that is normally used in case studies because most of them are human matters that can provide insights into a multifaceted situation (Biggam, 2011). Semi-structured interview questions were used to allow the teachers an opportunity to express themselves

without restrictions, to clarify as well as extend the participants' comments. Interviews allow the researchers to gather the information that could not be collected through observations, namely teachers' emotions.

Data Analysis

Data collected from the documents, lesson observations and interviews were subjected to qualitative analysis processes using thematic analysis. Thematic analysis is a qualitative practical data analysis approach, applicable to a number of qualitative methods through data coding, searching for, and refining themes (Kiger & Varpio, 2020).

Validity and Reliability of Research Findings

The framework that was proposed by Lincoln and Guba (2011) for guaranteeing the trustworthiness of qualitative research results was applied in the current study to enrich the accuracy and the reliability of research outcomes. The four components of the framework are transferability and dependability, conformability and credibility. The transferability and dependability of the research enable the readers of the study to judge the degree to which the research results are applicable to their settings as well as repeat the study if necessary (Shenton, 2004). Transferability and dependability of the research findings were ensured through the provision of thick descriptions of the design and context of the research. According to Polit and Beck (2012), conformability is the extent to which the research findings accurately represent the data provided by the participants and the interpretations of those findings are not generated by the researcher. As recommended by Schreier (2012), the analysis was performed by two researchers in order to increase the comprehensivity as well as provide a comprehensive interpretation of the data. Credibility means ensuring that the phenomena being observed are accurately represented. Member checking, which involves taking the transcribed data to the pre-service for validation was used to determine the credibility of the qualitative data. Methodological data triangulation involving the use of interviews, documents and observation was also used to validate the data.

FINDINGS AND DISCUSSION

An analysis of the four case profiles and interviews resulted in the following three themes: teachers' knowledge of learner-centered approaches, pedagogical approaches and patterns and ICT-based pedagogy.

Teachers' Understanding of Learner-Centered Methods

Learner-centered approaches have been claimed to be more developed in modern teaching practice. Learners develop different methods of solving problems if teachers encourage them to solve problems using their methods instead of following processes demonstrated by the teachers (Yackel et al., 1990). Teachers to have a clear understanding of such approaches to enable them to make learners get involved in deep learning activities. The teachers were interviewed on their knowledge of the learner-centered methods. The following are the teachers' extracts:

> "Learner-centered methods involve the activities that are done by learners whilst the teacher guides. An example is guided discovery learning where the teacher said clues are given to guide the learners on given activities" (NS).

> "Learner-centered approaches are when learners are involved more in their learning, which includes problem-solving, discussion and simulation, but I do not know how to use these methods when teaching mathematics" (RM).

> "Learner-centered methods are those that allow learners to interact and work together whilst the teacher guides" (NT).

> "Learner-centered is when learners work in groups, whilst the teacher moves around helping them to understand. Peer teaching and group work are learner-centered approaches" (EM).

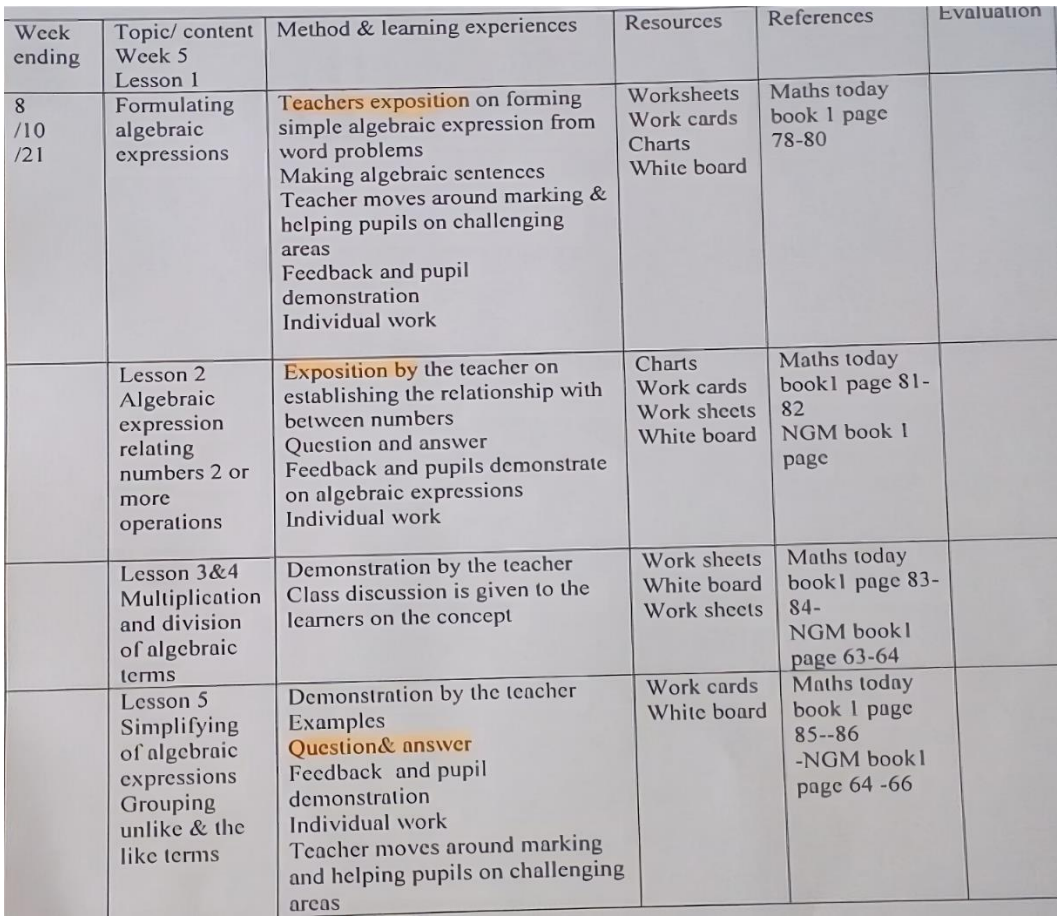
The four teachers presented various definitions of learner-centered approaches. Their definitions showed an understanding of learner-centered approaches. Their definitions mainly focused on learners being actively involved in their learning whist the teacher acts as a facilitator. These findings are in line with those from Schunk (2014).

The teachers were asked whether they used the syllabus for scheming and how they chose the teaching methods that they used in both schemes and the lesson plans. The following are the teachers' extracts:

> "I did not use the syllabus when scheming to check for the required teaching methods. I was not aware that the teaching methods were found in the syllabus. I used it to check for concepts to be taught under each topic" (EM).

> "I used the mathematics syllabus when scheming, l looked for the topics and the teaching approaches, but l chose the approaches such as demonstration and explanation that I thought will make the learners understand" (NT).

> "When scheming, l did not use the mathematics syllabus to find the teaching approaches that were recommended, I only used it to find some topic objectives. I copied my mentor's scheme of work



Week ending	Topic/ content Week 5 Lesson 1	Method & learning experiences	Resources	References	Evaluation
8 /10 /21	Formulating algebraic expressions	Teachers exposition on forming simple algebraic expression from word problems Making algebraic sentences Teacher moves around marking & helping pupils on challenging areas Feedback and pupil demonstration Individual work	Worksheets Work cards Charts White board	Maths today book 1 page 78-80	
	Lesson 2 Algebraic expression relating numbers 2 or more operations	Exposition by the teacher on establishing the relationship with between numbers Question and answer Feedback and pupils demonstrate on algebraic expressions Individual work	Charts Work cards Work sheets White board	Maths today book1 page 81-82 NGM book 1 page	
	Lesson 3&4 Multiplication and division of algebraic terms	Demonstration by the teacher Class discussion is given to the learners on the concept	Work sheets White board Work sheets	Maths today book1 page 83-84- NGM book1 page 63-64	
	Lesson 5 Simplifying of algebraic expressions Grouping unlike & the like terms	Demonstration by the teacher Examples Question& answer Feedback and pupil demonstration Individual work Teacher moves around marking and helping pupils on challenging areas	Work cards White board	Maths today book 1 page 85--86 -NGM book1 page 64 -66	

Figure 1. An excerpt of the methods NT planned to use (Source: NT's scheme of work)

> for teaching methods. The mentor provided the topics that l schemed for" (RM).
>
> "I did not use the syllabus when choosing the teaching approaches, so l does not know the learner-centered approaches recommended in the syllabus. The topics that l schemed for were provided by the mentor" (NS).

Data from the interviews showed that the three teachers (SN, EM, and RM) were not aware of the teaching approaches that are recommended in the syllabus. Yet the mathematics syllabus was supposed to be filed in the teaching practice file as revealed in the document analysis of ASE student handbook. They also did not consult the syllabus for teaching methods during scheme work and lesson plan development. Although NT admitted to using the syllabus for planning and selecting the traditional approaches that she used, she pointed out that she did not know how to use the learner-centered approaches stated in the syllabus. Yet the learner-centered methods are recommended in the mathematics syllabus and are one of the major reasons for curriculum reform as indicated by Boaler (2016). These findings concur with Chisholm and Leyendecker (2008) who reported the difficulty of implementing the learner-centered methods in the classroom than the impression given in the syllabus.

Pedagogical Practices and Patterns

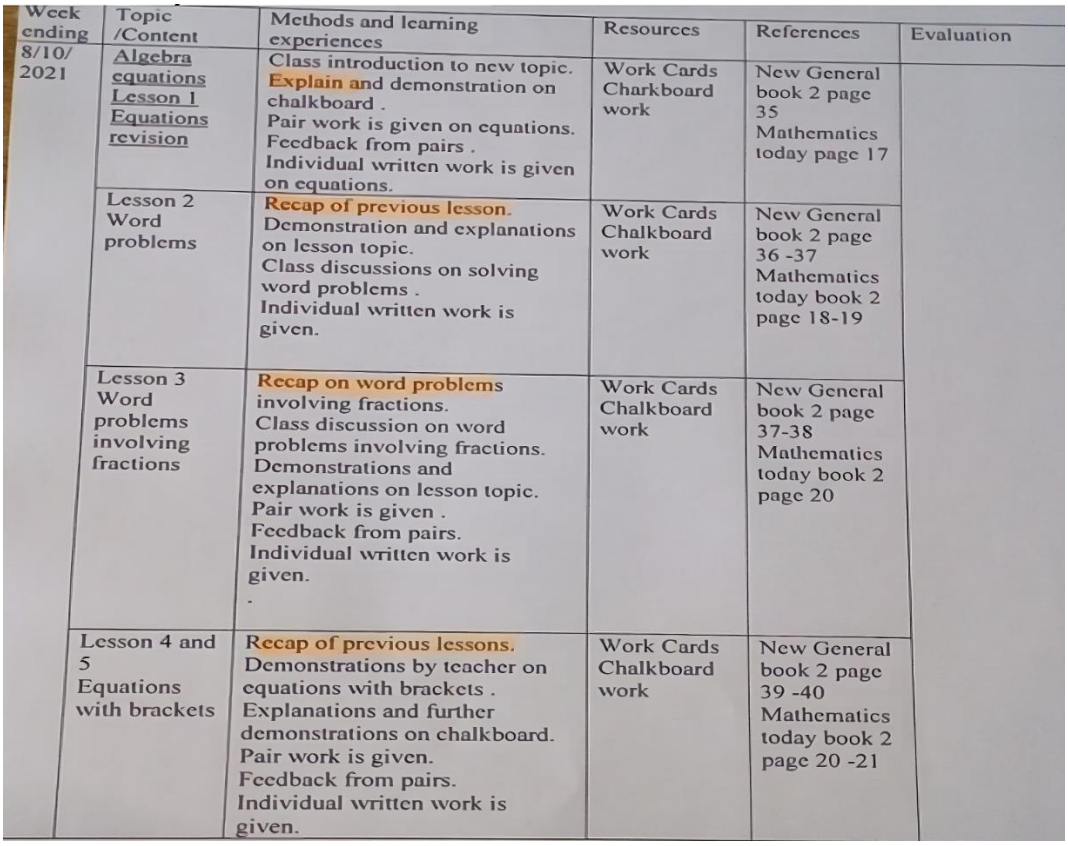
The data from schemes of work and classroom observation were presented. The purpose of the observations was to observe the real teaching practices of pre-service teachers and to check whether what they had schemed was consistent with what they actually do in the classrooms. Below are the four teachers' teaching practices.

NT's case study

NT's scheme of work was analyzed to identify the teaching methods that were planned to be used during the lessons against the recommended learner-centered and multi-sensory approaches in the mathematics syllabus.

The teaching approaches that NT intends to use were teacher exposition, demonstration, question and answer, individual work and class discussion.

From **Figure 1**, NT planned to use both learner-centered and teacher-centered approaches. The teaching methods planned for were not completely matching the new mathematics syllabus because they comprised teacher exposition. In light of such mismatches between NT's schemes of work and the mathematics syllabus, NT was observed to find out how the pre-service teacher implemented the new curriculum.



Week ending	Topic /Content	Methods and learning experiences	Resources	References	Evaluation
8/10/ 2021	Algebra equations Lesson 1 Equations revision	Class introduction to new topic. Explain and demonstration on chalkboard . Pair work is given on equations. Feedback from pairs . Individual written work is given on equations.	Work Cards Charkboard work	New General book 2 page 35 Mathematics today page 17	
	Lesson 2 Word problems	Recap of previous lesson. Demonstration and explanations on lesson topic. Class discussions on solving word problems . Individual written work is given.	Work Cards Chalkboard work	New General book 2 page 36 -37 Mathematics today book 2 page 18-19	
	Lesson 3 Word problems involving fractions	Recap on word problems involving fractions. Class discussion on word problems involving fractions. Demonstrations and explanations on lesson topic. Pair work is given . Feedback from pairs. Individual written work is given. .	Work Cards Chalkboard work	New General book 2 page 37-38 Mathematics today book 2 page 20	
	Lesson 4 and 5 Equations with brackets	Recap of previous lessons. Demonstrations by teacher on equations with brackets . Explanations and further demonstrations on chalkboard. Pair work is given. Feedback from pairs. Individual written work is given.	Work Cards Chalkboard work	New General book 2 page 39 -40 Mathematics today book 2 page 20 -21	

Figure 2. RM's choice of teaching approaches in the schemes of work (Source: RM's scheme of work)

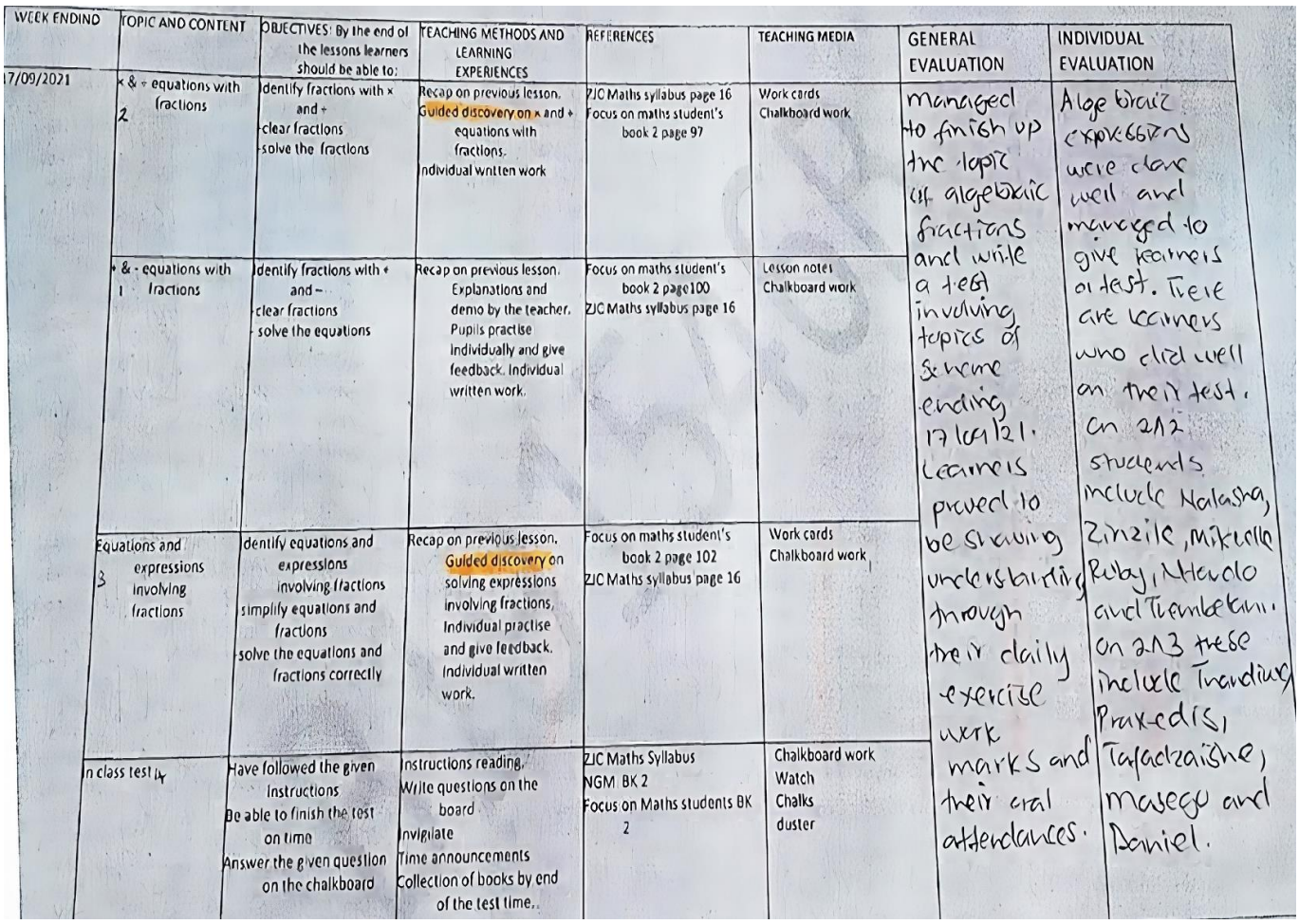
Lesson observation: NT was on teaching practice at a school in the capital city of Zimbabwe. The form 1 classes were streamed according to grade seven results and the classes range from 1^1 to 1^5. The form 1^4 class that NT taught comprised 37 learners who were below average in terms of performance. The learners were always sited in rows. NT introduced the topic of simplifying algebraic expressions through teacher explanations and working examples on the chalkboard. NT focuses more on working on the chalkboard and does most of the talking. NT, then wrote six problems on the chalkboard, and asked one learner to work on the first problem on the chalkboard, whilst the rest of the class were asked to individually find solutions for the remaining five problems. The teacher moved around checking learners' work and then went on to work on all the problems that were given on the chalkboard.

In some instances, NT asked questions that were responded to as chorus answers. Generally, the teacher spent more time teaching and explaining the concept and getting feedback as chorus answers from learners during the lesson through posing questions. From the three lessons that were observed NT mainly used question and answer, demonstration and explanations.

RM's case study

As indicated in **Figure 2**, the teaching approaches planned for by RM were explaining, class discussion, teacher recap, demonstration, pair work and individual work. Most of the teaching methods planned for by RM were not learner-centered as recommended in the new mathematics syllabus.

Lesson observation: RM taught form 2 at a rural day secondary school in Mashonaland Central Province. Form 2E consisted of 45 learners. The learners were streamed using the grade seven result and two east was considered to be the best class among the two form 2 classes. In all the three lessons that were observed the class was never full. The learners were always sited in rows facing the chalkboard. The teacher introduced the lesson on algebraic equations through the question and answer technique, where two learners were asked to work on the problems on the chalkboard. The first learner asked to work on the problem was talking and gave explanations to the other learners. The second learner worked the problem wrongly, then the teacher worked the problem on the chalkboard without seeking opinions from other learners. The teacher then went on to work on several other problems on the chalkboard without asking or facing the learners. After that, the teacher wrote five problems on the chalkboard that learners were asked to work on in pairs. Teachers moved around assisting learners and then asked them to present their solutions on the chalkboard. Learners who presented were explaining their work to other learners. After presentation, learners were asked to write an exercise whilst the teacher was moving around marking work. From three lessons that were observed RM mainly used demonstration, explanations, and pair work.



WEEK ENDING	TOPIC AND CONTENT	OBJECTIVES: By the end of the lessons learners should be able to:	TEACHING METHODS AND LEARNING EXPERIENCES	REFERENCES	TEACHING MEDIA	GENERAL EVALUATION	INDIVIDUAL EVALUATION
17/09/2021	× & ÷ equations with fractions 2	identify fractions with × and ÷ clear fractions solve the fractions	Recap on previous lesson. Guided discovery on × and ÷ equations with fractions. Individual written work	ZJC Maths syllabus page 16 Focus on maths student's book 2 page 97	Work cards Chalkboard work	managed to finish up the topic of algebraic fractions and write a test involving topics of scheme ending 17/09/21. Learners proved to be showing understanding through their daily exercise work marks and their oral attendances.	Algebraic expressions were done well and managed to give learners a test. There are learners who did well on their test. On 2A2 students include Natasha, Zinzile, Mikaella Ruby, Ntando and Tremeka. On 2A3 these include Tinotiwa Praxedis, Tafadzwaishe, Masego and Daniel.
	+ & - equations with fractions	identify fractions with + and - clear fractions solve the equations	Recap on previous lesson. Explanations and demo by the teacher. Pupils practise individually and give feedback. Individual written work.	Focus on maths student's book 2 page100 ZJC Maths syllabus page 16	Lesson notes Chalkboard work		
	Equations and expressions involving fractions	identify equations and expressions involving fractions simplify equations and fractions solve the equations and fractions correctly	Recap on previous lesson. Guided discovery on solving expressions involving fractions. Individual practise and give feedback. Individual written work.	Focus on maths student's book 2 page 102 ZJC Maths syllabus page 16	Work cards Chalkboard work		
	In class test 4	Have followed the given instructions Be able to finish the test on time Answer the given question on the chalkboard	Instructions reading. Write questions on the board Invigilate Time announcements Collection of books by end of the test time.	ZJC Maths Syllabus NGM BK 2 Focus on Maths students BK 2	Chalkboard work Watch Chalks duster		

Figure 3. SN's scheme work showing the teaching methods selected (Source: SN's scheme of work)

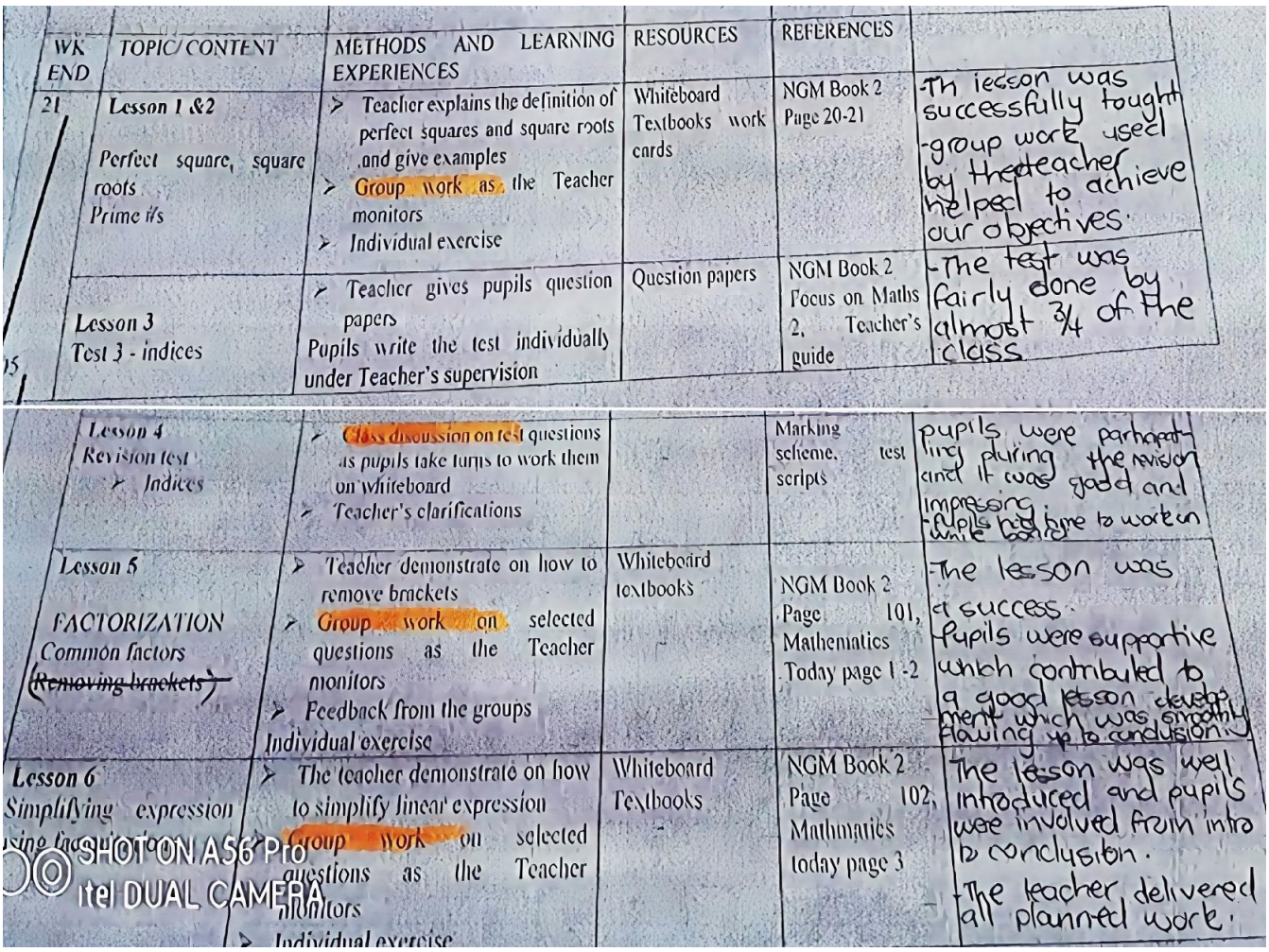
SN's case study

Figure 3 shows that SN is over-reliant on the traditional teaching approaches such as teacher explanation, teacher recap, individual work and teacher demonstrations. The only learner-centered approach planned for in the scheme work is guided discovery, an indication that learner-centered approaches were not planned for in the lessons. The scheme of work reveals mismatches between planned teaching approaches and the multi-sensory learner-centered methods recommended in the new mathematics syllabus.

Lesson observation: SN was attached for teaching practice at a boarding school in the southern border of Zimbabwe. The school had both boarders and day scholars. SN was teaching form 2 learners who were streamed using the grade 7 results. Form 2K was second from the best class. Form 2K seemed over-crowded as it comprised 49 learners. For the three lessons that the researchers observed the class was never full, which was surprising for a boarding school. 44 learners out of the forty-nine were always present. The learners were always sited in rows facing the chalkboard.

NS introduced the lesson by recalling the previous lesson through the question and answer technique, then NS introduced the topic of the lesson, multiplication and division of fractions. NS went on to write the procedures for multiplying and dividing fractions on the chalkboard whilst the learners were copying the notes. After demonstrating how fractions are multiplied through cross multiplication, another task was written on the chalkboard where one learner was asked to work on the chalkboard. The teacher did most of the explanations and talking even when the learner had worked the problem on the chalkboard. NS wrote another problem where another learner was asked to work on the chalkboard. The learner did it quietly without any explanations. The teacher had to do most of the talking and explaining.

Most of the work was done by the teacher on the chalkboard. A problem was written on the chalkboard, and then learners were instructed to work on the problem individually, whilst the teacher moves around marking and assisting the learners. Then a learner was tasked to work on the problem on the chalkboard, where it was wrongly done. Then NS again without going back to the learners for feedback went on to work on the problem on the chalkboard. From there, learners were instructed to work on problems that NS wrote on the chalkboard as their daily exercise. From the lesson observation, NS used the traditional teacher-centered lesson to deliver the lesson.



WK END	TOPIC/CONTENT	METHODS AND LEARNING EXPERIENCES	RESOURCES	REFERENCES	
21	Lesson 1 &2 Perfect square, square roots Prime #s	➢ Teacher explains the definition of perfect squares and square roots ,and give examples ➢ Group work as the Teacher monitors ➢ Individual exercise	Whiteboard Textbooks work cards	NGM Book 2 Page 20-21	-Th lesson was successfully taught -group work used by the teacher helped to achieve our objectives.
	Lesson 3 Test 3 - indices	➢ Teacher gives pupils question papers Pupils write the test individually under Teacher's supervision	Question papers	NGM Book 2 Focus on Maths 2, Teacher's guide	-The test was fairly done by almost 3/4 of the class
	Lesson 4 Revision test ➢ Indices	➢ Class discussion on test questions as pupils take turns to work them on whiteboard ➢ Teacher's clarifications		Marking scheme, test scripts	pupils were participating during the revision and it was good and impressing pupils had time to work on
	Lesson 5 FACTORIZATION Common factors ~~Removing brackets~~	➢ Teacher demonstrate on how to remove brackets ➢ Group work on selected questions as the Teacher monitors ➢ Feedback from the groups Individual exercise	Whiteboard textbooks	NGM Book 2 Page 101, Mathematics Today page 1 -2	-The lesson was a success. Pupils were supportive which contributed to a good lesson development which was smoothly flowing up to conclusion.
	Lesson 6 Simplifying expression using brackets	➢ The teacher demonstrate on how to simplify linear expression Group work on selected questions as the Teacher monitors ➢ Individual exercise	Whiteboard Textbooks	NGM Book 2 Page 102, Mathmatics today page 3	The lesson was well introduced and pupils were involved from intro to conclusion. The teacher delivered all planned work.

Figure 4. EM's scheme work showing the teaching methods selected (Source: EM's scheme of work)

EM's case study

As indicated in **Figure 4**, EM planned to use traditional teaching approaches such as teacher explanations, demonstration and individual work. The learner-centered approaches planned for are group work and class discussions.

Lesson observation: EM taught form 2 at a rural day school in Mudzi District, Mashonaland East Province. The class had 47 learners. Form 2 class was not streamed according to ability. The class was overcrowded. For the three lessons that were observed, learners were always sited in rows except for group and pair activities and the teacher would always move into the classroom with a mathematics textbook. The lesson was on factorization and the teacher introduced it through the question and answer technique followed by writing notes on the chalkboard, whilst the learners were copying. EM wrote three problems on the chalkboard and worked on two of the problems on the chalkboard explaining all the steps to the learners. The third problem was worked on the chalkboard by a learner. After that learners were instructed to work on different problems on worksheets distributed by the teacher in groups of four. After the teacher had moved around marking and assisting the learners, learners were asked to present their work on the chalkboard. The teacher's comments were on whether the solution was correct or wrong. The teacher wrote six problems on the chalkboard that were copied from the textbook and instructed learners to write the work in their daily exercise book. Although more time was devoted to the individual daily exercises, the learners worked on the problems on the chalkboard after writing them in their exercise books. From the three lesson observations made, EM used both the traditional teacher-centered method and the learner-centered method to deliver the lesson.

ASE student handbook encourages teachers to help learners in developing skills in the process and methods of inquiry that enable learners to understand mathematics instead of giving them specific content. In this study two teachers, SN and NT made use of the traditional teacher-dominated practices whilst EM and RM used both traditional and learner-centered approaches. All the teachers widely demonstrated on the chalkboard where rules and procedures of mathematics activities are prioritized. NS when interviewed confessed to the use of the teacher-centered approaches as said below:

> "I mainly use teacher-centered approaches where, I introduce the topic through a lecture method, give the learners notes followed by explaining the notes. I sometimes pick on or two learners to work on the board to check whether they have understood the concepts and then give the learners work to do that I will supervise in the class" (NS).

These findings are in line with Umugiraneza et al. (2017) who noted the overdominance of teacher-centered approaches in the classroom. Most of the interactions were initiated by the teacher through questioning where the learners responded in chorus or an individual was selected to provide the answer, especially in NT's case. These findings were supported by Umugiraneza et al. (2017) who observed that such forms of interactions are very short and closed. In NT's case if the learner's response is correct the teacher moves on and if it's wrong the teacher would work for the learners or select another learner to react to the problem. Such kind of interactions does not result in a deeper exploration of the source of the error or an extensive discussion of different methods of solving the problem (Bethell, 2016). Generally, the four teachers commonly used whole class questions and answers techniques and individual exercises to assess their learners' understanding. All the teachers preferred to move from learner to learner particularly after assigning some work. The findings concur with Hiebert et al. (2003), whose findings across the seven countries showed that individual work and teachers talking too much than learners was common during the lesson.

Learner-centered approaches such as pair work and group work were used by two teachers EM and RM. EM when interviewed confessed to the use of the learner-centered approaches, as said below:

> "Group work and pair work were mainly used because it enables learners to work and practice the problems in groups. In groups, learners understand better if a concept is explained by another learner in the group or to the whole class" (EM).

The use of group work and pair work as learner-centered approaches are in line with Bethell's (2016) regarding such approaches that engage learners in mathematics learning. The teachers used class presentations that were ranging from individual, pair, and group presentations with varying degrees of success. During the class presentations, the teacher will no longer be at the forefront of mathematics instruction but will be part of the learners. Such class presentations would enable the sharing of views between the teacher and the learners. Peer-to-peer interactions were encouraged through group work where learners were allowed to work together to solve a mathematics problem (Bethell, 2016).

All the observed classes had more than 35 learners, which is not in agreement with the recommended teacher-student ratio of 1:35 (MOPSE, 2017). When classes are too large, teachers tend to avoid learner-centered approaches and prefer memorization learning practices such as note giving, dictation and lecturing (Geoff, 2014). However, teachers (EM and RM) classroom practices appeared to challenge the opinion that teachers with large classes prefer teacher-centered approaches. In spite of the large classes EM used group work and presentations, whilst RM used pair work and presentations. The class discussions that followed group or pair presentations afforded learners opportunities to understand the meanings of the problems and discuss the correct answers. EM and RM attributed their use of such approaches to their previous experiences with such approaches. EM also said:

> "The reason that I used group work and pair work is that these are the methods that l learned during training and had the experience to use it in my class. For example, I even separated the two learners who were friends and were always making noise during group work or pair work as they did not want to work" (EM).

Similarly, RM said:

> "I thought it is the best method to use when teaching mathematics because l have experience using such a method. I did not use other teaching methods because l lack experience in using them" (RM).

Even though the mathematics syllabus recommends the use of learner-centered approaches the large class sizes might hinder the use of such approaches.

Despite the large classes inhibiting the use of the learner-centered approaches, the nature of learners also affected the use of the learner-centered approaches in the classroom. The findings of the study showed a strong connection between the cognitive ability of learners and the teaching approaches that the two teachers (NS and NT) chose to use in their lessons. It gave the impression that the less gifted the learners, the more the possibility of the teachers' use of teacher-dominated approaches, which are against the recommended learner-centered approaches in the syllabus. For instance, NT and NS explained how streaming affected the choice of the methods that were used in 1^4 classes. NT said:

> "The learners do not like mathematics, and they do not comprehend the mathematics concepts if you do not demonstrate all the procedures on the chalkboard" (NS).

NS said:

> "If you really want the learners to achieve something in mathematics, it's better to work for them the problems on the chalkboard showing all the stages so that they can follow, because if you give them say work to go and research they will not attend the lessons, so l resorted to the traditional way of teaching to enable them to learn" (NS).

In this case, the nature of the learners contributes to the persistent use of the teacher-dominated methods that are against the recommended learner-centered methods in the syllabus. The findings are in line with earlier findings by Bethell (2016), who noted that teacher-dominated approaches are widely used in the classroom. Learners do not attend lessons when they are assigned tasks by teachers. This finding is in line with Hall et al. (2004) who reported that learners are likely to stay away once tasks and investigations activities have been assigned.

In addition, in all the four classes that were observed, learners were sited in rows facing the board except for those who were involved in group work activities. Such sitting arrangements do not support learner interaction and are most suitable for the traditional approaches. However, when using the learner-centered approaches learners are expected to interact using technology-based tools and the internet.

ICT-Based Pedagogy

As researchers, we were anticipating that the teachers will use a variety of ICT tools when teaching mathematics. Surprisingly, none of the four teachers made use of technology in delivering their lessons, despite the that the mathematics curriculum recommends the use of various technologies when teaching mathematics. Three teachers (RM, EM, and NS) pointed to the lack of ICT resources at the various schools that they were attached to. Even though NT did not use ICT tools in the teaching and learning of mathematics, she did not even bother to check whether the school had the required ICT tools. She even said '*I did not know how to use technology to teach mathematics*. This implies that even if the ICT tools were available NT was not in a position to use such tools due to a lack of knowledge. The findings are in line with earlier findings by Simsek (2020) who pointed out that even if the ICT tools are available numerous teachers are not confident or lack the competence to use ICT tools in teaching.

CONCLUSIONS

Even though the mathematics syllabus recommends the use of learner-centered approaches, the research findings showed that pre-service teachers did not even use the syllabus for scheming and lesson planning. Teachers play a crucial role in curriculum change because they are responsible for the implementation of the curriculum. In order for them to interpret and make sense of the curriculum, they should be professionally prepared for such activities both in mathematics content and pedagogy (Rezat et al., 2021).

In addition, all the teachers through their definitions showed an understanding of the learner-centered approaches. However, their knowledge of the definition of the learner-centered approaches did not guarantee automatic use in the classroom as shown by the findings of this study. The teachers' understanding of the structure of mathematics and how best concepts can be taught for maximum involvement of students is crucial for effective planning and subsequently teaching and learning (Chinofunga et al., 2022). The research findings indicated that out of the four pre-service teachers only two used learner-centered approaches. The learner-centered approaches were limited to group work and pair work, which they used because of the experience that they have acquired previously. The traditional approaches were used mainly by the two teachers who never used the learner-centered approaches. Those teachers attributed their use of traditional approaches to the nature of the learners. The learner-centered approaches advocated for in the mathematics syllabus were not widely used by the learners, to the extent that three of the teachers did not even consult the syllabus for scheming and lesson planning. This is worrisome as the syllabus is considered to be the guiding document for all the teaching and learning activities in the Zimbabwean secondary school context. Despite the fact that the pre-service teachers did not make use of approaches recommended in the syllabus, the findings suggest that they use the approaches that they know, and their selection of approaches was limited both from learner-centered or traditional approaches.

In this study, the findings show some barriers that hinder the implementation of the mathematics curriculum by the teachers. It appears some of the barriers are connected to a lack of adequate knowledge on how to use various learner-centered approaches, traditional approaches and how to use technology in the teaching and learning of mathematics. The finding concurs with Rafiepour and Farsan (2021) who indicated that teachers' lack of adequate knowledge and skills in mathematics teaching results in disappointing results in curriculum change. Curriculum resources such as technological tools are designed to implement instructional change in the teaching and learning of mathematics classrooms through the use of innovative classroom practices and various pedagogical approaches (Rezat et al., 2021). Three teachers were of the view that schools did not have the technological resources required for the teaching and learning of mathematics, whilst one teacher indicated a lack of knowledge on how to use technology in mathematics teaching and learning.

Rafiepour and Farsan (2021) suggested that in such situations teachers need to be supported for them to implement the mathematics curriculum, particularly in the rapidly changing digital era where the school mathematics curriculum must reflect those changes. Supporting teachers through in-service and pre-service programs might improve the implementation of any mathematics curriculum change. The study recommends that pre-service teachers need to be trained on syllabus use and interpretation.

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