Research in Social Sciences and Technology

https://ressat.org

E-ISSN: 2468-6891

Volume: 8 Issue: 4 2023

pp. 56-75

Analysis of Difficult Concepts in Senior Phase Mathematics Baseline Assessments: First-year Student Teachers' Reflections

Folake Modupe Adelabu*[a] & Jogymol Kalariparampil Alex[a]

* Corresponding author
Email: fadelabu@wsu.ac.za

a. Department of Continuing and Adult Professional Teachers Development, Faculty of Education, Walter Sisulu University, Eastern Cape Province. South Africa

10.46303/ ressat.2023.20

Article Info
Received: April 18, 2023
Accepted: July 20, 2023
Published: November 1, 2023

How to cite
Adelabu, F. M. & Alex, J. K. (2023). Analysis of difficult concepts in senior phase mathematics baseline assessments: First-year student teachers' reflections. *Research in Social Sciences and Technology*, *8*(4), 56-75. https://doi.org/10.46303/ressat.2023.20

ABSTRACT

This paper report on first-year student teachers' reflections on the difficulty levels of mathematics concepts in the senior phase baseline assessments. This paper emanated after first year student teachers completed the baseline assessments for each of the three grades in the senior phase, Grades 7, 8, and 9. One hundred and sixteen (116) first year mathematics student teachers were included in this study. Data were collected using purposive and convenience sampling methods. This qualitative research adopted a case-study design, using an interpretivist paradigm. Data was collected using an open-ended questionnaire as the research instrument. The questionnaire was designed to determine student teachers' thoughts about the difficulty levels of concepts of the mathematical content in the baseline assessments. The results of the study revealed that Algebra; Number Pattern; Statistics; Shapes; Geometry; Simplification; Sequences and Series; and Addition and Subtraction of numbers as easy topics to answer, Fractions, Mixed fractions, Factorisation, Probability, and Measurement were topics that were very difficult. The study recommended that teacher educators design instructions that will assist student teachers in constructing senior phase mathematical concepts to improve their understanding of these complex topics in higher education institutions.

KEYWORDS

First-year student teachers' reflection; baseline assessment; mathematics concepts; easy and difficult concepts.

INTRODUCTION

Teachers' knowledge and skills in teaching mathematics are crucial for the improvement of teaching mathematics in the senior phase. It is therefore imperative that their knowledge and skills of mathematical concepts should be improved. Martinez et al (2020) state to prepare student teachers for teaching, teacher educators must use relevant mathematical knowledge and language. Teacher educators need to provide pre-service teachers with clear perspectives of teaching purpose while developing student teachers to use their knowledge to appraise and adapt instructional materials in practice. Furthermore, student teachers need to be capacitated to use their knowledge to convey the subject in an appropriate and accessible manner, to organise and conduct instruction, and to assess what learners are learning. It is, therefore, imperative that teacher educators should assist student teachers in becoming aware of the trajectories along which fundamental mathematical ideas evolve, which is critical in promoting future learners' movement along the trajectories (National Research Council [(NRC], 2001). Mathematics is an essential school subject, therefore sound knowledge and understanding of mathematical concepts are critical to the teaching of school mathematics. According to Adelabu and Alex (2022), all mathematics student teachers should have a thorough knowledge, understanding and comprehension of the subject and its content.

Mathematics as a discipline encompasses knowledge of mathematical facts, concepts, procedures, and their relationships. This includes knowledge of how mathematical ideas can be represented and knowledge of mathematics as a discipline. The focus is on how mathematical knowledge is produced, the nature of mathematical discourse, and the norms and standards of evidence that guide argument and proof. Therefore, knowledge and understanding of mathematics entails thinking about the aims of mathematics training which serves as a foundation for separating and prioritising the subject. Furthermore, learning mathematics for teaching includes more than simply knowing mathematics. As a result, teachers should comprehend concepts and carry out procedures effectively (Norton, 2019a). Teachers should also be able to understand the conceptual underpinnings of mathematical knowledge. According to Kilpatrick et al (2001), conceptual understanding is the ability to comprehend mathematical concepts to conduct operations and connect ideas. Therefore, teachers need to understand mathematics to explain and dissect mathematical concepts diversely. Teachers must be prudent in guiding judgments and interpreting learner’s mathematical efforts (Ball, 2000; Shulman, 1986).

The teachers' ability to teach mathematics depends on their understanding of the subject matter. Several studies have found that teachers' mathematical knowledge and skills are limited in pedagogic, professional, personal, and social competencies (Ball et al., 2008; Danä & Tanişli, 2018; Norton, 2019b; Shulman, 1986; Yulian, 2018). According to NRC (2001), many teachers may grasp the facts and procedures they teach but often have poor comprehension of the conceptual basis for that knowledge. Many teachers struggle to understand mathematical concepts or solve problems that need more than simple

calculations. According to the NRC (2001), many prospective and practicing elementary school teachers are unable to explain the basis for multidigit multiplication, utilising place-value ideas and the underlying principles for adding and multiplying.

Furthermore, Tambychika and Meerah (2010) claim that solving and understanding mathematics problems demand various mathematics skills that many students are lacking from elementary to tertiary education. These authors argue that these essential skills are a requirement and must be acquired to show in-depth understanding and application. Therefore, many students face difficulties in mathematics concepts (Tambychika & Meerah, 2010). The researchers opine that to assist students in overcoming the challenges, mathematics teacher needs to understand the difficulties and challenges they face in solving and understanding mathematics problems. Teachers should also be able to provide solutions to issues and challenges. Therefore, Higher Education Institutions (HEIs) should train student teachers to be skilled, proficient and be solution providers to the learners in their mathematics classrooms. For this paper, first -year student teachers from a Bachelor of Education training programme for mathematics teaching were subjected to write a baseline test in senior phase mathematics concepts. These students were enrolled at a rural HEI in the province. This paper reports on their reflections on the difficulty levels of mathematical concepts in the baseline assessment.

Simamora and Saragih (2019) state that mathematics implies problem-solving, therefore, mathematics teachers aim to motivate and equip learners to solve challenges in their daily lives. Mathematical problems are questions that involve facts and algorithms (Rahayuningdewi & Faradillah, 2020). Therefore, to solve some mathematical problems, learners need to comprehend basic mathematics. According to Ni Shé et al. (2017), solving a mathematical problem is a step-by-step procedure, and if learners struggle with the first step, they will be challenged to master the more difficult levels. Due to the failure of attaining the next level, learners will believe that the subject is difficult to understand and therefore may become averse to the subject (Ni Shé et al. 2017). According to Angateeah (2017) and Laamena and Laurens (2021), they found that most teachers present mathematics as an abstract subject and the contents are not situationally. Since it is abstract and not contextualised learners conclude that it is a difficult subject.

Wanamaker (2018) agrees that since mathematics is taught abstractly, learners find it difficult to comprehend the contents, therefore, most learners struggle with mathematics throughout their schooling career. This statement is supported by Jupri, and Drijvers, (2016) and Spangenbery and Pithmajor (2020) that many learners claim that mathematics is monotonous, abstract, lacking in creativity, complex, and difficult to understand, thus the most challenging school subject. Mathematics is a subject that requires attentive attention, therefore a lack of understanding of the subject presents a challenge for learners to complete the activities. According to finding solutions to mathematical problems is challenging to many learners due to the lack of understanding of basic mathematical language and processes.

Therefore, in the teaching of mathematics, teachers must first introduce the problem and how to solve it. Maluleka (2013) and Laamena and Laurens (2021) state that teachers need to translate mathematical problems into real-life examples and ensure thorough understanding of the problem before attempting to solve it. All teachers are required to have profound and insightful mathematical content knowledge to improve learners' skills in solving complex mathematics problems. Learners' performance is dependent on the teachers' knowledge of the subject (Norton, 2019a, Pino-Fan, Assis & Castro, 2015, Pournara et al., 2015). This view correlates with Ma (1999) who also believe that a thorough understanding of mathematics is essential for effective teaching of the subject.

The researchers wanted to investigate whether student teachers had a thorough comprehension of the various mathematical concepts in the curriculum. For this reason, students enrolled for the B.Ed programme in mathematics were required to write a baseline assessment at a rural HEI. The baseline assessments were pitched at the mathematics level the student teachers were expected to teach. The results revealed that the majority of students were unable to obtain more than 60% in the assessment. Since their performance is not at an expert level, immediately after the assessments, the researchers provided the students with the opportunity to reflect and share their experiences on the baseline assessment. Hence, the paper investigated first-year student teachers' reflections on senior phase mathematics baseline assessments based on the difficulty level of concepts. The research questions for the study were as follows:

- What mathematics concepts were considered easy in the senior phase mathematics baseline assessments?
- What mathematics concepts were considered difficult in the senior phase mathematics baseline assessments?
- What are the reasons for the first-year student teachers' reflection on the difficulty level of mathematics concepts in the senior phase mathematics baseline assessments?

In this paper, the authors focused on the content covered in the South African Senior Phase Mathematics curriculum and the challenges that student teachers who specialise in senior phase mathematics education in a rural HEI encountered when teaching.

LITERATURE REVIEW

Note: the use of learners and students are used interchangeably in this paper.

Difficult concepts in mathematics teaching and learning

Mathematical concepts are complex interwoven and contain interdependent elements. The use of operations such as division, addition, subtraction, ratios, percentages, word problem translation, and symbol across mathematics discourse demonstrates the interrelationship of mathematical concepts (Charles-Ogan & George, 2015). The interrelated elements are pattern discovery and analysis, logical reasoning applied to systems, and recognition and explanation of the underlying links between these mathematics systems (Charles-Ogan & George, 2015;

Olofinlae & Jimoh, 2020). According to Charles-Ogan and George (2015), the interrelationship of mathematical concepts reveals the necessary information that underpins mathematics difficulty and the lack thereof as a mathematics discipline. The reason is that certain concepts might be challenging for learners with poor logical reasoning and analytical skills. These students would also have visual or dyslexia difficulties, which will prevent them from perceiving patterns (Charles-Ogan & George 2015).

On the other hand, learners with excellent reasoning, thinking abilities, and intelligence may be competent in handling some mathematical ideas, but others may find difficult. In this study the authors used Charles-Ogan's definition 'difficult concept'. It is defined as a collection of mathematics problems that constitutes a *'persistent hitch'* and makes the procedural approach to cognition of a mathematics concept a hideous task all the time (Charles-Ogan, 2015). Several research studies revealed that learners need help with mathematical reasoning, mathematical ideas and understanding basic mathematical concepts, such as constructing mathematical meanings of symbols since these symbols mean differently in different situations (Charles-Ogan & George, 2015; Yetkin, 2003). Subekti et al. (2021) claim that students have difficulties identifying number patterns in problem-solving.

Since mathematics is seen as an abstract subject, some mathematical topics are difficult for teachers to teach and thus become difficult for learners to understand (Akanni, 2015). Therefore, Akanni (2015) states that difficult mathematics topics that exist in all high school phase levels (from elementary to tertiary) as those that are: very difficult for learners to understand, require more effort and skills for learners to understand and solve the problem, and unpopular topics that cause fear and anxiety among learners. Therefore, some learners need help answering finding examination questions on certain topics. According to Akanni (2015), due to a large number of problematic concepts, some learners do not attempt to answer certain examination questions that they do not understand. This results in these learners receiving low grades in some sections and topics (Akanni, 2015). Charles-Ogan and Georges (2015), found that the difficulty varies from idea to concept in some mathematics topics. Ni Shé et al. (2017) also point out that difficult or complex concepts are widespread across mathematics topics. As a result of several difficult mathematics topics, there is a substantial dropout rate of students attempting mathematics at the secondary level. According to mathematical statistics in South Africa, 26 % of learners took Mathematical Literacy as a subject rather than pure Mathematics (DBE, 2021). According to Lima et al. (2019), the difficulty of mathematics at school level is the cause of some students showing little to no interested in engineering and computer science courses in HEIs. Piaget (1968) believes it is due to an overly quick transition from the qualitative structure of the problem to the mathematical formulation when learners have difficulties with a concept of mathematics. Furthermore, Piaget claimed that a learner who gains knowledge through free inquiry and spontaneous effort showed long term memory of the concepts in later years. He believed that

the learner then would have learned a system that will serve him for the rest of his life and will continue to engage his interest without exhausting it (Piaget 1968).

The South African context

The continued poor performance in mathematics in South Africa raises concerns for the public (Mabena et al., 2021), while some of the mathematics concepts pose a threat to the students. South African learners continue to perform poorly in mathematics throughout all grades compared to their counterparts internationally, locally, and regionally as reported by the Trends in International Mathematics and Science Study (TIMSS) and Southern Africa Consortium for Monitoring Education Quality (SACMEQ] (DBE, 2017). For instance, the report from TIMSS (2019) shows that Grade 9 learners performed very low in the international assessment. According to Govender (2012), most learners in South Africa need help solving number pattern problems due to limitations in teachers' mathematical pedagogical competence. The Diagnostic Report by the Department of Basic Education (DBE) 2019 and 2021 reported that some algebraic concepts were problematic to the learners in the National Senior Certificate (NSC) examination (DBE, 2019 & 2021). The DBE mandates that all teachers should concentrate on teaching algebra thoroughly to all senior phase students to minimise the gap in their understanding. The table below highlights the mathematical concepts for the senior phase in the South Africa curriculum.

Table 1.

Mathematical concepts for the senior phase in the South African Curriculum (see Appendix)

METHODOLOGY

In this study, the authors adopted a qualitative research approach with an interpretivist paradigm. They wanted to gain an understanding of the lived experiences of the participants. Since the focus of the study was on a particular cohort of student teachers, the case study was most appropriate. Yin (2003) states that a case study design allows for in-depth investigation of the phenomena within a particular cohort of participants. The authors used an open-ended questionnaire for senior which contained two questions to collect the data. The student teachers' reflections on the difficulty level of the mathematical concepts in the baseline assessments is used in the analysis.

The participants in this study included students studying towards the Bachelor of Education at a rural university in South Africa. One hundred and sixteen (116) students participated in the study. All the participants were studying senior phase mathematics (Grade 7, 8 & 9) using the South African Curriculum and Assessment Policy Statement. The participants included males (64) and females (52) in this study. Participants voluntarily consented to participate in this study by writing the baseline assessment. The baseline assessment was done through the authorised online Computer Aided Mathematics Instruction (CAMI) software, the student teachers were exposed to the Baseline Assessments for the

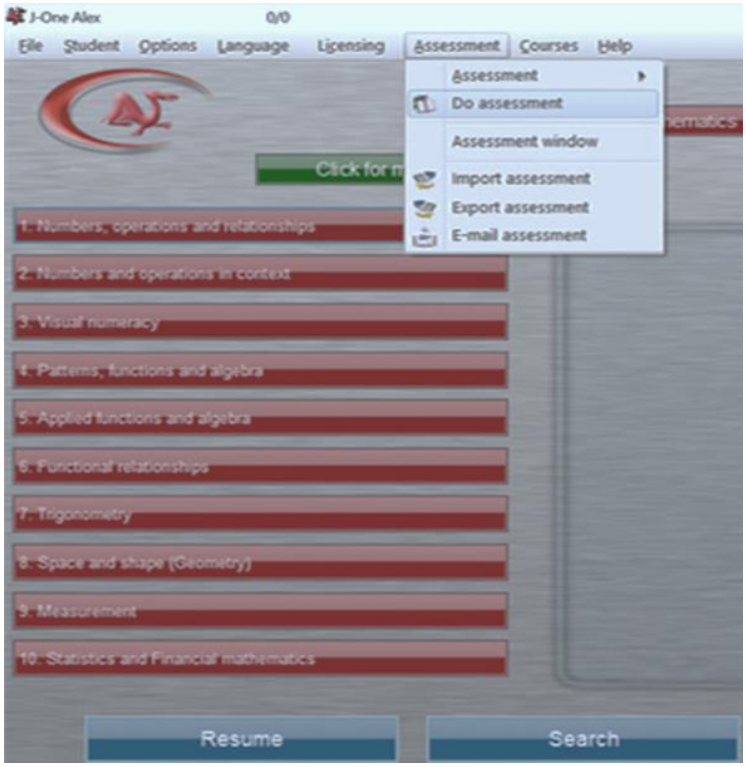
senior phase. CAMI is a comprehensive mathematics program with thousands of tasks with several difficulty levels. The mathematics software (CAMI) is a suite that includes K-12 mathematics topic areas to help students develop mathematical knowledge.

The Senior Phase and FET Teaching Bachelor of Education Course student teachers who participated in the study were mostly from rural secondary schools, and many had never been exposed to computer-assisted learning. Therefore, they needed to become more familiar with the CAMI software. After the completion of the Baseline Assessments, the student teachers were given an open-ended Google form questionnaire to reflect on the difficulty level of concepts. Data collection methods included convenience and purposeful samplings.

The two-week blocked session for the CAMI Baseline Assessments was conducted in a monitored computer lab under strict control. All student teachers who enrolled in the SP and FET Mathematics courses received passwords to use CAMI, which was placed on the lab computers, to complete the Senior Phase Baseline Assessments (Grades 7, 8, & 9). After logging in, student teachers select "Do assessment" from the Assessment box, which displays baseline and grade assessments. The student teachers then chose Grades 7, 8, and 9 from the Baseline Assessment and finished each test question individually. The baseline assessment for each grade (7, 8, and 9) contains 25 questions. The illustration below shows the displayed list of assessment categories from the assessment box.

Figure 1.

Displayed list of assessment categories from the assessment box.



The student teachers were then asked to fill in a Google form to reflect on each baseline test. The purpose of the reflective analysis was to provide the student teachers with

the opportunity to critically examine their ability to process their personal experiences about the difficulty level and to provide additional support to the difficult concepts during the course. The participants answered two open-ended questions reflecting on the baseline assessment themes that were easy and difficult descriptive data analysis was used to examine the outcomes of the survey. The student teachers who participated freely fulfilled all ethical criteria.

RESULTS

The findings from the open-ended questionnaire described the difficult and easy topics in the Baseline Test questions. The student teachers' responses are presented according to the items in the questionnaire.

The responses of the student teachers to the questionnaire

Item 1: Which topics in the senior phase Baseline Assessment were easier to answer? Why do you say so?

Seventy percent (70%) of the student teachers acknowledged Patterns, Functions and Algebra as easy mathematics concepts. forty percent (40%) of the student teachers acknowledged Data and statistics, and thirty percent (30%) recognised Geometry and Number and Operations as easy mathematics concepts. Only ten percent (10%) of the student teachers acknowledged that all the topics were easy for them. In the presentation of the data, student teacher is denoted by ST. The sample responses of the student teachers are as follows:

Patterns, Functions and Algebra

ST1: "Number pattern. Because it's much easier."

ST5: "Number patterns were not as tricky as others were and their answers were easier to write using the computer, unlike other questions."

ST7: "Number pattern, I did not find any challenge while I was answering it."

ST13: "Number pattern, it is much more understandable."

ST19: "Number patterns, I am good in number patterns, and it was very easier."

ST22: "Number patterns because I like questioning skills and I enjoy answering them."

ST24: "Number patterns and graphs because I practiced them, and I did not find it challenging."

ST25: "Algebraic equations, because it is the easiest topic understandable then is the part of our lives every day, we solve problems."

ST26:"Algebra because I felt like they were very understandable."

ST27:"Algebra because it is the easiest part of mathematics."

ST29:"Algebra, Because I am good at these topics."

ST30:"Algebra, it was easy to simplify."

Data and statistics

ST2: "Statistics I still had the idea on how to do it unlike other questions."

ST4:"Statistics because it was simple and straightforward also, they were understandable."

ST6:"Statistics, because it has been done on grade 12 too."

ST7:"Statistics because I am good at these topics."

ST10:"Statistics, it was easy to answer."

Space and Shape (Geometry) and other concepts

ST13:"Shape, I love dealing with shapes."

ST20:"Shapes, questions were clear."

ST21"Geometry because I love it."

ST24"Euclidian geometry and finance and growth, I say so because I understand those questions."

ST25:"Sequence and series because they are always easier to calculate."

ST26:"Simplification. I like the topic."

ST29:"Addition and subtraction of big numbers because this topic is straightforward."

ST30: "Fractions because I've strategy of attacking those questions."

The student teachers acknowledged that Number Patterns; Algebra; Statistics; Shapes; Geometry; Simplification; Sequence and Series; and Additional and Subtraction of numbers as easy topics to answer in the baseline assessment. No topic from the measuring concept was acknowledged by the student teachers as being simple, however some of them did say that all the themes were simple.

Item 2: Which topics in the senior phase Baseline Assessment you felt difficult to answer? Why do you say so?

Numbers and Operations in context, Data and Statistics and Measurement were the concepts areas where most of the student teachers had difficulty answering the Baseline Assessment. The sample responses of the student teachers are as follows:

Numbers and Operations in context

ST1: "Mixed fraction, I didn't have any idea on how to solve them."

ST2:"Adding and subtracting mixed fractions. They are so difficult to and even difficult to punch on the computer."

ST3: "Fraction. Because it was difficult to punch fractions into the computer."

ST4:"Fractions, it was not easy to transfer the information into the computer."

ST5:"Fraction, because it is not easy to understand those mixed and proper fraction."

ST6: "Fractions because I could not solve."

ST7: "Multiplication of a fraction I could not break a fraction into a simplest form."

ST8: "Fractions it was not easy to control computer."

ST10: "Fractions, it is hard to simplify."

ST11: "Mixed numbers because they are tricky."

ST12: "Factorizations because it is difficult to find factors."

ST13: “Mixed fractions because the computer did not allow us to use different formulas…”

ST14: "Mixed fractions, the CAMI is set in a way that I do not understand."

ST15:"Fractions because I last encountered them in the senior phase."

ST16: "Fractions, I could not answer the questions."

ST17: "Mixed fraction, I do not know the basics."

ST18: "Multiplication of a fraction I could not break the fraction down while multiplying."

ST18: "Fractional problems. I'm Computer illiterate."

Data and Statistics (Probability)

ST4: "Probability, it is the difficult topic not easy to understand."

ST7: "Probability, it was challenging to answer."

ST9: "Probability because I do not know it at all."

ST10: "Probability because I always find it difficult to answer."

ST12: "Probability, it is not an easy topic to understand."

ST14:"Probability. It was difficult to answer."

ST15: "Probability. It was so hard for me to answer."

ST16: "Probability, it has been my challenging topic."

ST17: "That one with the dice, I did not understand that question."

Measurement and related concepts

ST20: "Measurements no formulas were provided."

ST21: "Measurements, because sometimes difficult."

ST23: "Measurements. I did not know the formula."

ST25: "Measurements it because it is annoying me."

ST27: "Measurements. They were confusing."

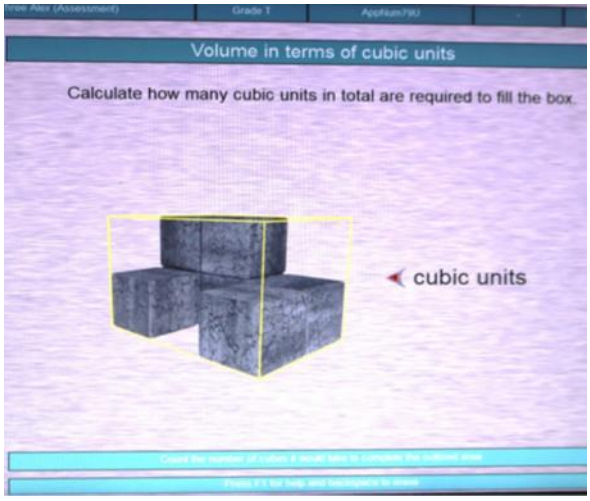
ST28: "Geometry, because geometry is always challenging."

ST29: "Surface area and volume of 3D object, transformation. Since the early grades, these topics were hard for me."

ST30: "Surface area and volume of 3D shapes, I was only done once when I was studying at senior phase and no more findings throughout."

Figure 2.

Measurement (Source: www.cami.co.za)



The most difficult topics for the student teachers were Fractions, Mixed fractions, Factorisation, Probability, and Measurement. Few student teachers acknowledged all the

topics because they have forgotten them. Their responses are: *"All because I have forgotten them*," *"I do not remember any question*. "The following figures are some of the difficult questions from the baseline assessments.

Figure 3

Mixed fraction (Source: www.cami.co.za)

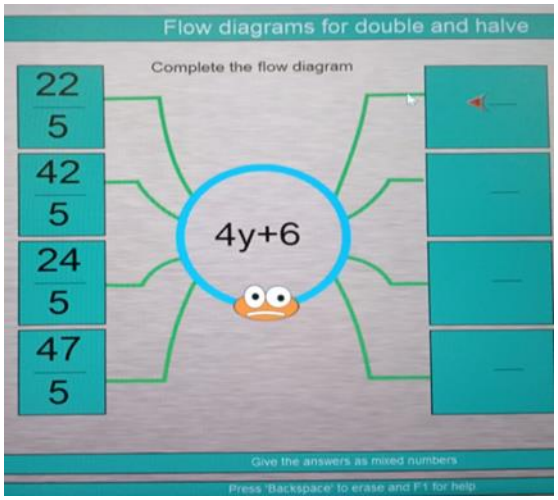
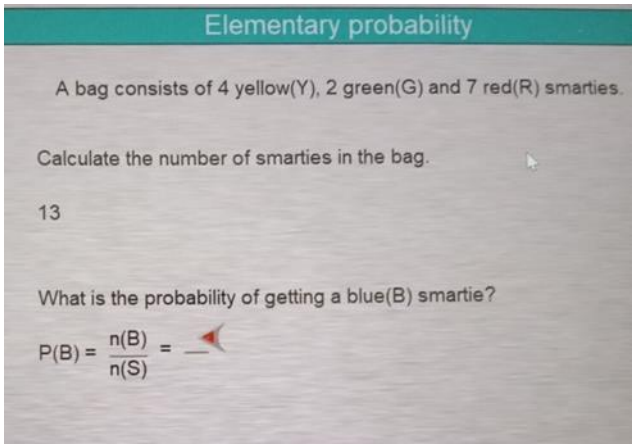


Figure 4.

Probability (Source: www.cami.co.za)



The analysis of the data shows that Algebra; Number patterns; Statistics; Shapes; Geometry; Simplification; Sequence and Series; and Additional and Subtraction of numbers are topics that the student teachers were able to answer without much difficulty. Questions pertaining to Fractions, Mixed fractions, Factorisation, Probability, and Measurement were topics which were very difficult for the student teachers. The main reason the student teachers found these topics difficult is that they are not easy to understand, and they need to remember the method to use to solve the problems based on them. The difficulties might also be linked to the students' positive or negative attitudes, which can sometimes become irrational, resulting in mathematics anxiety. Furthermore, inconsistency and absenteeism in the classroom during the school years, as well as a lack of mathematical background,

contributed to students' lack of understanding of specific topics. As a result, this made it difficult for them to solve some mathematical problems.

Furthermore, many students are psychologically distracted and struggle to concentrate on problems and mathematical concepts in the classroom. In this regard, some students find it challenging to focus on long-term undertakings; subsequently, they only pay attention to a small amount of information. Some students are also perplexed by mathematical terms such as area, volume, yard, power, and others. A lack of understanding typically hampers the inability to focus on these terms. In addition, students found computer representations of measurement in the CAMI challenging since they may have yet to be exposed to three-dimensional figures during their school years. They may have only seen it in textbooks. Furthermore, familiarity with computers might also have made students not complete the answers on time and could have been classified as difficult concepts. The above difficulties can be attributed to the rural underprivileged background from which the student teachers come.

DISCUSSIONS

The outcome of the reflection of the first-year student teachers revealed the difficulty level of the mathematics concepts in the baseline assessments. In the following sections student did not experience many challenges: Patterns, Functions and Algebra - (Algebra, Number patterns, Simplification, Sequence and Series, and Additional and Subtraction of numbers); Data and statistics - (Statistics); and Space and Shape (Geometry) - Shapes, Geometry. However, the challenging mathematics concepts in the baseline assessment where students struggled were Numbers and Operations in Context, Data and Statistics (Probability), and Measurement. The analysis showed that the topics under the following concepts: Fractions, Mixed fractions, Factorisation, Probability, and Measurement are difficult for the student teachers in the Baseline Assessments. The student teachers commented that these difficult topics needed to be better understood and many of the student teachers experienced challenges with the procedure to solve the problem on these topics.

The finding in this paper concurred with Mokhtar et al. (2019), who found that one of the difficult topics for learners is fraction which included word problems. According to Mokhtar et al. (2019) and Lima et al. (2019), fractions are among the most challenging topics for most learners. Although the topic is prevalent, it needs to be profoundly deeply understood by the learners. Poor understanding would lead to failure and apathy towards the subject. Mokhtar et al (2019) opines that learners' understanding of processes for addressing fraction problems still needs to be improved. To support students in understanding fractions topics should include simple problem-solving questions, whereby learners gain confidence in accurately answering the questions. Furthermore, Lima et al (2019) believes that that learners need help understanding the keywords and have an adequate grasp of basic mathematical concepts.

According to Paradesa (2018), undergraduate mathematics education, students need help to solve well-structured mathematical problems. As a result, to answer mathematical problems, learners must possess relevant knowledge and information and be able to coordinate the use of appropriate skills in mathematics (Yeo, 2009). According to Yeo (2009), learners needed help finding a suitable solution to a mathematical problem due to a lack of understanding, strategic knowledge, and the ability to employ formal mathematics. Furthermore, learners' lack of knowledge of mathematical concepts and procedural steps and learners' unwillingness to re-evaluate the answers that have been written to check the truth of the answers are all error factors in solving fractional problems (Yeni et al., 2020). Ndalichako (2013) in his study on found that learners tend to confuse fraction concepts with whole numbers. As a result, the possible reasons for these difficulties in solving questions related to fractions include a lack of understanding of appropriate procedures to apply in solving a problem, the task's complexity, and the task's difficulty in solving questions related to fractions. According to Kusuma and Retnawati (2019), learners must understand fractions to perform fraction calculations afterward. These researchers agree that learners need to understand fractional operations (mixed fraction) due to a need for quantitative numeracy skills. As a result, learners need help processing fractions correctly. For example, calculating multiplication and division of fraction material is difficult for students to perform correctly.

These findings support other studies' conclusions. Students have difficulty grasping the basic ideas of probability, according to Anggraini and Kusrini (2018); Memnun et al., (2019); Yusuf et al., (2021); Zhou (2019). Lack of procedural and conceptual knowledge to solve probability problems; lack of understanding of proportional reasoning; difficulty in resolving misconceptions in probability such as representativeness of probability, measuring probability as a mathematical problem, extension of inappropriate conclusions, inappropriate reasons, beliefs, equiprobability bias, and possible means specific are among the difficulties. Students also needed help understanding probability problems, computational processes, and selecting and employing effective problem-solving strategies. As a result, probability is a challenging and demanding topic for student teachers. According to Yáñez (2002), students find it challenging to answer the conditional probability problem on the computer due to a lack of understanding and confidence in the simulation method, as well as trouble interpreting the graphics of relative frequencies for estimating probabilities. This has been evident in the present study.

According to Jones (2010), many students need help with measurement principles, and the move from informal to formal measurement takes time and effort. Jones mentioned that topics on ‘Area’ and ‘Volume’ are challenging for students since area measurement is generally estimated from lengths rather than ’measured.’ While volume measurement poses a considerable challenge to learners’ spatial organization, the nature of the things measured with volume makes it even more difficult. As a result, Jones (2020) argued that students' problem stems from their inability to envisage the connection between iterated units on the ruler and imagined equivalent units on the line being measured. According to Battista (2007),

a lack of focus on measurement and a poor grasp of measure could be a primary cause of learning difficulties for various complex mathematical concepts, including graphs of functions and problems with the location and vectors. Furthermore, the findings are supported by Olofinlae and Jimoh's (2020) and Charles-Ogan and George's (2015) that students struggle to solve problems in fractions, mixed fractions, factorization, probability, and measurement. According to Gafoor and Kurukkan (2015), many students believed that mathematics was challenging because of the unpleasant teaching approach, difficulty following instructions, difficulty understanding the topic, and difficulty recalling its equations and problem-solving methods.

In contrast to the findings in this study, Akanni (2015) discovered that student teachers have difficulties completing problems in geometry and trigonometry. He believed that there is a need for more knowledge about the subject matter. Fabiyi (2017) also noticed that some geometry concepts needed to be clarified for students. Construction, coordinate geometry, and the circle theorem are three examples of geometric concepts. According to the above researcher, students' difficulties in learning and solving problems involving geometry ideas could be due to various factors, including method of instruction, lack of instructional materials, insufficient time allocation, complexity, and concept misunderstanding. In the present study, the geometry concepts were found to be easy due to the nature of the questions asked in the baseline assessments.

CONCLUSION

The student teachers' reflections revealed the topics that were easy and challenging in the senior phase mathematical curriculum. Many student teachers stated that topics like Number Patterns, Algebra, Statistics, Shapes, Geometry, Simplification, Sequence and Series, and Additional and Subtraction of Numbers are easy because they are understandable, straight forward, and the questions in the baseline assessment were easy to comprehend and solved. The student teachers also recognized the complex topics in the senior phase's mathematical curriculum. According to them the following topics were most challenging and difficult: Fractions, Mixed Fractions, Factorisation, Probability, and Measurement are the most difficult topics.

These topics were difficult because the student teachers lacked the appropriate knowledge and understanding. They still needed to answer several of the questions in the baseline assessments. Therefore, educators must support student teachers in connecting conceptual and procedural knowledge to solve problems linked to difficult topics to improve their understanding of these difficult topics. This means that student teachers must be able to understand senior phase mathematical concepts, and their characteristics, recognise similarities and differences between concepts based on the characteristics and construct conceptual knowledge links between them. Additionally, student teachers must be able to build skills, procedures, and algorithms that represent a desired outcome. Furthermore,

educators in higher education institutions should help student teachers enhance their mathematical knowledge, especially on complex topics, so that they can teach the topics in secondary school in the future.

Recommendations

According to the findings, Higher Education Institutions (HEIs) should design learning environments that assist first-year student teachers in connecting formal and informal mathematics knowledge, employing suitable representations based on the problem context, and combining procedural and conceptual knowledge. Educators should design instruction that assists student teachers in constructing senior phase (Grades 7- 9) mathematical concepts that will be useful for them in the future to have good mathematics skills, especially in complex concepts.

REFERENCES

Adelabu, F. M., & Alex, J. K. (2022). Mathematical Knowledge for Teaching in Further Education and Training Phase: Evidence from Entry Level Student Teachers' Baseline Assessments. *International Journal of Learning, Teaching and Educational Research*, *21*(8), 1 - 20. http://www.ijlter.org/index.php/ijlter/article/view/5225

Akanni, O. (2015). An Investigation of Difficult Topics in the Senior Secondary School Mathematics Curriculum as Perceived by Student Teachers. *American Journal of Educational Research*, *3*(7), 844-848. https//doi.org/10.12691/education-3-7-7

Angateeah, K. S. (2017). An investigation of students' difficulties in solving non-routine word problems at lower secondary. *International Journal of Learning and Teaching*, *3*(1), 46-50. https://doi.org/10.18178/ijlt.3.1.46-50

Anggraini, S., & Kusrini, E. (2018). The Analysis of Students' Difficulties in Solving Problems of Probability for 8th Grade. *Advances in Social Science, Education and Humanities Research (ASSEHR)*, 160. 166-169. https://d1wqtxts1xzle7.cloudfront.net/61386659/

Ball, D. L. (2000). Bridging practices: Intertwining content and pedagogy in teaching and learning to teach. *Journal of teacher education*, *51*(3), 241-247. https://journals.sagepub.com/doi/abs/10.1177/0022487100051003013

Battista, M. T. (2007). The development of geometric and spatial thinking, in: F. Lester (Ed) *Second Handbook of Research on Mathematics Teaching and Learning*. Charlotte, NC: NCTM/Information Age Publishing.

Charles-Ogan, G. & George, N.R. (2015). Investigating difficult concepts in senior secondary school mathematics curriculum as perceived by students. *International Journal of Academic Research and Reflection 3*(6), 67-74. https://www.idpublications.org/wp-content/

Danä, Å., & Taniåžli, D. (2018). Examination of mathematics teachers' pedagogical content knowledge of probability. *MOJES: Malaysian Online Journal of Educational Sciences*, *5*(2), 16-34. https://mojes.um.edu.my/article/view/12622

Department of Basic Education (2017). The SACMEQ IV Project in South Africa: A Study of the Conditions of Schooling and the Quality of Education http://www.sacmeq.org/sites/default/files/sacmeq/publications/ pdf

Department of Basic Education (2021). National Senior Certificate (NSC) Examination Report 2021. https://www.education.gov.za/Portals/0/Documents/Reports/2021NSCReports/

Fabiyi, T. R. (2017). Geometry concepts in mathematics perceived difficult to learn by senior secondary school students in Ekiti State, Nigeria. *IOSR Journal of Research & Method in Education (IOS-JRME)*, *7*(1), 83-90. https//doi.org/10.9790/7388-0701018390

Gafoor, K. A., & Kurukkan, A. (2015). *Why High School Students Feel Mathematics Difficult? An Exploration of Affective Beliefs.* Paper presented In UGC Sponsored National Seminar on Pedagogy of Teacher Education- Trends and Challenges at Farook Training College, Kozhikode, Kerala on 18th and 19th August 2015. https://files.eric.ed.gov/fulltext/ED560266.pdf

Govender, V. G. (2012). *Using the South African mathematics challenge to develop pre-service mathematics teachers' problem-solving abilities*. In M. Lebitso, & A. Maclean (Eds.), 20th Annual National Congress of the Association for Mathematics Education of South Africa (AMESA): Demystifying mathematics (pp. 87-104). Kimberley, South Africa: AMESA. Retrieved from http://www.amesa. org.za/AMESA2014/Proceedings/images/Front %20Matter%202014%20AMESA.pdf

Jones, K. (2010). Measurement: Everywhere and nowhere in secondary mathematics. *Proceedings of the British Society for Research into Learning Mathematics*, *30*(3), 142-146. https://eprints.soton.ac.uk/191403/

Jupri, A., & Drijvers, P. (2016). Student difficulties in mathematizing word problems in algebra. *Eurasia Journal of Mathematics, Science and Technology Education*, *12*(9), 2481-2502. https://www.ejmste.com/.pdf

Kilpatrick, J., Swafford, J., & Findell, B. (2001). *Adding it up: Helping children learn mathematics* (Vol. 2101). J. Kilpatrick, & National research council (Eds.). Washington, DC: National Academy Press. http://citeseerx.ist.psu.edu/

Kusuma, U. I., & Retnawati, H. (2019, October). Analysis of Sixth Graders' Difficulties in Solving Mathematics Word Problems on Whole Numbers, Fractions, and Decimals. In *Journal of Physics: Conference Series, 1320*(1), 012008. IOP Publishing. https://iopscience.iop.org/article/10.1088/1742-6596/1320/1/012008/pdf

Laamena, C. M., & Laurens, T. (2021). Mathematical literacy ability and metacognitive characteristics of mathematics pre-service teacher. *Infinity*, *10*(2), 259-270. http://www.e-journal.stkipsiliwangi.ac.id/index.php/infinity/article/view/1985/1239

Lima, P. D. S. N., das Almas Silva, L., Félix, I. M., & de Oliveira Brandão, L. (2019, October). Difficulties in basic concepts of mathematics in higher education: a systematic review. In *2019 IEEE Frontiers in Education Conference (FIE),* 1-7. IEEE. https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber

Mabena, N., Mokgosi, P. N., & Ramapela, S. S. (2021). Factors contributing to poor learner performance in Mathematics: A case of selected schools in Mpumalanga province, South Africa. *Problems of Education in the 21st Century*, *79*(3), 451. https://files.eric.ed.gov/fulltext/EJ1301930.pdf

Maluleka, B. K. (2013). *Improving grade 9 learners' Mathematical processes of solving word problems* (Doctoral dissertation, University of Limpopo (Turfloop Campus)). http://ulspace.ul.ac.za/bitstream/handle/10386/965/Maluleka_bk_2013.pdf

Martínez, S., Guíñez, F., Zamora, R., Bustos, S., & Rodríguez, B. (2020). On the instructional model of a blended learning program for developing mathematical knowledge for teaching. *ZDM*, *52*(5), 877-891. https://doi.org/10.1007/s11858-020-01152-y

Memnun, D. S., Ozbilen, O., & Dinc, E. (2019). A Qualitative Research on the Difficulties and Failures about Probability Concepts of High School Students. *Journal of Educational Issues*, *5*(1), 1-19. https://files.eric.ed.gov/fulltext/EJ1206642.pdf

Mokhtar, M. A. M., Ayub, A. F. M., Said, R. R., & Mustakim, S. S. (2019). Analysis of Year Four Pupils' Difficulties in Solving Mathematical Problems Involving Fraction. *International Journal of Academic Research in Business and Social Sciences*, *9*(11), 1560–1569. http://dx.doi.org/10.6007/IJARBSS/v9-i11/6766

National Research Council. (2001). Chapter 10. Developing proficiency in teaching mathematics. *Adding It Up: Helping Children Learn Mathematics*. Washington, DC: The National Academies Press. https://doi.org/10.17226/9822.

Ndalichako, J. (2013). Analysis of Pupils' Difficulties in Solving Questions Related to Fractions: The Case of Primary School Leaving Examination in Tanzania. *Creative Education, 4,* 69-73. https://doi.org/10.4236/ce.2013.49B014.

Ní Shé, C., Mac an Bhaird, C., Ní Fhloinn, E., & O'Shea, A. (2017). Problematic topics in first-year mathematics: lecturer and student views. *International Journal of Mathematical Education in Science and Technology*, *48*(5), 715-734. https://www.tandfonline.com/doi/pdf/10.1080/0020739X.2016.1272142

Norton, S. (2019a). The relationship between mathematical content knowledge and mathematical pedagogical content knowledge of prospective primary teachers. *Journal of Mathematics Teacher Education*, *22*(5), 489-514. https://doi.org/10.1007/s10857-018-9401-y

Norton, S. (2019b). Middle school mathematics pre-service teachers' content knowledge, confidence and self-efficacy. *Teacher Development*, *23*(5), 529-548. https://doi.org/10.1080/13664530.2019.1668840

Olofinlae, O.O., & Jimoh, S.O. (2020). Students perceived areas of difficulties in senior secondary mathematics and teachers' views on the causes of identified difficulties in ikere Local Government Area Ekiti state. *IJRDO - Journal of Mathematics*, *5*(12), 5-21. Retrieved from https://ijrdo.org/index.php/m/article/view/3384

Paradesa, R. (2018). Pre-service mathematics teachers' ability in solving well-structured problems. In *Journal of Physics: Conference Series, 948*(1), 012015. IOP Publishing. http://dx.doi.org/10.1088/1742-6596/948/1/012015

Piaget, J. (1968). Quantification, Conservation, and Nativism: Quantitative evaluations of children aged two to three years are examined. *Journal of Science*, *162* (3857), 976-979. https://www.science.org/doi/pdf/10.1126/science.162.3857.976

Pino-Fan, L. R., Assis, A., & Castro, W. F. (2015). Towards a methodology for the characterization of teachers' didactic-mathematical knowledge. *EURASIA Journal of Mathematics, Science and Technology Education*, *11*(6), 1429-1456. https://www.ejmste.com/download/

Pournara, C., Adler, J., Pillay, V., & Hodgen, J. (2015). Can improving teachers' knowledge of mathematics lead to gains in learners' attainment in Mathematics?. *South African Journal of Education*, *35*(3), 1-10. https://doi.org/10.15700/saje.v35n3a1083

Rahayuningdewi, P. D., & Faradillah, A. (2020). How Does Problem-solving Method Affect Students' Self-confidence and Mathematical Understanding? *Indonesian Journal of Science and Mathematics Education*, *3*(2), 165-177. https://doi.org/10.24042/ijsme.v3i2.6640

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational researcher*, *15*(2), 4-14. https://journals.sagepub.com/doi/abs/10.3102/0013189X015002004

Simamora, R. E., & Saragih, S. (2019). Improving students' mathematical problem-solving ability and self-efficacy through guided discovery learning in local culture context. *International Electronic Journal of Mathematics Education*, *14*(1), 61-72.

Spangenberg, E. D., & Pithmajor, A. K. (2020). Grade 9 mathematics learners' strategies in solving number-pattern problems. *EURASIA Journal of Mathematics, Science and Technology Education*, *16*(7), em1862.

Subekti, F. E., (2021, June). Students' mathematical reasoning abilities on number sequence pattern material: viewed from a gender perspective. *Journal of Physics: Conference Series, 1918*(2021) 042107. https//doi.org/10.1088/1742-6596/1918/4/042107

Tambychika, T., & Meerah T. S. M. (2010). Students' difficulties in mathematics problem-solving: What do they Say*? Procedia Social and Behavioral Sciences, 8*(2010), 142–151. https://pdf.sciencedirectassets.com/277811/1-s2.0-S1877042810X00131/1-s2.0-S1877042810021257/main.pdf?

Wanamaker, C. (2018). Practical applications of mathematics in everyday life. The universal language of math. https://owlcation.com/stem/

Yáñez, G. (2002). *Students' difficulties and strategies in solving conditional probability problems with computational simulation*. http://iase-web.org/documents/papers/icots6/10_86_ya.pdf

Yeni, E.M., & Wahyudin, T. H. (2020). Difficulty analysis of elementary school students in mathematical problem-solving in solutions. *International Journal of Scientific & Technology Research, 9*, 44-47. https://www.ijstr.org/final-print/mar2020 pdf

Yeo, K.K. (2009). Secondary 2 students' difficulties in solving non-routine problems. *International Journal for mathematics teaching and learning*. 1-30. https://www.cimt.org.uk/journal/yeo.pdf

Yetkin, E. (2003). Student difficulties in learning elementary mathematics. ERIC Digest. https://files.eric.ed.gov/fulltext/ED482727.pdf

Yin, R. K. (2003). *Case study research: Design and methods* (Vol. 3). sage. https://iwansuharyanto.files.wordpress.com/2013/04/

Yulian, V. N. (2018, November). Analysing categories of mathematical proficiency based on Kilpatrick opinion in junior high school. In *Journal of Physics: Conference Series* (Vol. 1132, No. 1, p. 012052). IOP Publishing.

Yusuf, M., Rahim, S. S. A., & Eu, L. K. (2021). Obstacles faced by college students in solving probability word problems. *Jurnal Pendidikan Matematika*, *15*(1), 83-90.

Zhou, T. (2019). *Exploring the grade 11 mathematics learners' experiences and challenges in solving probability problems in selected Soshanguve schools,* Unpublish PhD thesis. Unisa. South Africa

APPENDIX

Table 1.

Mathematical concepts for the senior phase in the South African Curriculum (see Appendix)

Mathematical Concepts	Grade 7	Grade 8	Grade 9
Numbers, Operations and Relationships	Place value, long addition Product of prime factors (table) Product of prime factors (factor tree)	The expanded notation of a number Horizontal addition and subtraction of integers Ratio and fractions indices Highest common factors Lowest common factors Calculator exercises with operator precedence Calculation with cube numbers	Bigger and smaller on a number line (4<>=1) Multiplication and division of integers Square and cube numbers Number sequences
Numbers and Operations in context	Place value addition of fractions Subtraction of fractions Addition of decimals, long addition	Distributive law of multiplications Addition and subtraction of three mixed numbers Simple interest Addition and subtraction	Mixed operation of decimal numbers (addition and subtraction) Calculating percentage point

		Calculating percentage parts Factor trees	Ratio
Patterns, Functions and Algebra	Number patterns (triangle number) Continue patterns	Picture pattern Solving simple equations	Completing tables Simplify algebraic expression Removal of brackets Horizontal addition of polynomials Square root of exponentials Exponentials and fractions Solving linear equation: removal of brackets
Space and Shape (Geometry)	Identify lines of symmetry Identify type of angle Angles of rotation - calc measure of 50min on clock	Enlarge or reduce geometric figures Compare and/or 2D shapes Properties of 3D shapes Classification of angles Double bar graphs Translations of pint	Ordered pairs on the Cartesian plane Angles formed by parallel lines Introduction to circles Reflexion in the x and y axis Translations of regions Enlarge or reduce geometric figures Double bars graphs
Measurement	Volume Convert units of time (centuries, years, months) Convert units of time (months, days, hrs) Coordinates on grid Ordering of numbers - descending order of natural	Perimeter and area. Complex rectangle shape	
Data and Statistics	Statistics - bar graph Statistics - median and mode Probability - compound event (2 dice), list outcomes	Average and median and mode	Interpreting pie charts Average median and mode