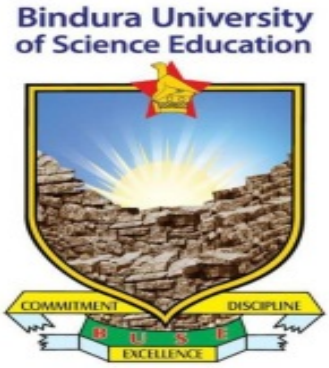

EFFECTS OF ETHNOMATHEMATICS-BASED INSTRUCTIONAL METHOD ON LEARNERS' ACADEMIC ACHIEVEMENT

BY

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REG NO. B225427B

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Title of the dissertation: Effects of ethnomathematics-based instructional methodology on learners' academic achievement at Mururi Secondary in Zvimba District.

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DEDICATION

This study is dedicated to my lovely wife Loinah Kapfudza who encouraged me through all circumstances to reach beyond the stars. To my daughter Channun you are the reason l have so much courage to move when the going gets tough. To my dear friends and colleagues thank you for your unwavering support and encouragement.

ABREVIATIONS/ACCRONYMS

HBSCED- Honours Bachelors Science Education Degree

ABSTRACT

1.1 Abstract

This study investigated the effects of an ethnomathematics-based instructional method on learners' academic performance in Sets at Mururi Secondary School in Zvimba District. The objectives were to identify mathematical concepts found in the rural learners' out-of-school mathematical practices that can be integrated into the teaching and learning of Sets. The second objective is to explore how Sets concepts can be integrated into Secondary School Mathematics. The last objective is determine challenges faced by Mathematics teachers in integrating ethnomathematics in Mathematics lessons.

This study employed a pragmatism research paradigm, utilizing both qualitative and quantitative methods. The chosen approach utilizes a concurrent design. To ensure representativeness in participant selection, proportional stratified sampling is employed. The participants included 5 Mathematics teachers and 40 learners from form 3. The study aims to collect both quantitative and qualitative data through interviews, questionnaires and observations to examine the integration of ethnomathematics-based instructional approach in teaching and learning of Sets. Data was collected through interviews, questionnaires and observations. Data analysis in this study involves

comparing and triangulating data from various sources such as interviews, observations and questionnaires.

The findings suggests that rural learners' out-of-school mathematical practices such as grouping, classifying, partitioning, counting and spatial reasoning, closely align with the concept of Sets. Connecting these familiar practices to the formal learning of Sets made the content more relatable, relevant and engaging for the learners. However, teachers faced various challenges in bridging the gap between informal and formal mathematical knowledge including lack of guidance, resources, flexibility, curriculum constraints and systemic barriers.

The study concludes that the integration of mathematical concepts found in the rural learners' out-of-school practices can effectively enhance the teaching and learning of Sets, leading to improved learner achievement and engagement.

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CHAPTER 1: INTRODUCTION

Effects of ethnomathematics based instructional approach on learners' academic performance in Sets at Mururi Secondary School in Zvimba District.

1.1 Background to the study

In Zimbabwe, ordinary level Mathematics is widely dreaded, with statistics showing few candidates excel in this subject. Statistics display that much few candidates manage to excel. Manyadze (2021). The persistent low performance in Mathematics in third world countries stems from a lack of cultural relevance in the curriculum. Deficiencies in teaching strategies and methodologies used by way of teachers were alluded to the root reason of this pathetic circumstance. Additionally, Acharya (2019) links this problem of continuous low performance in mathematics of students from third world countries in general to lack of cultural consonance in the mathematics curriculum. Sunzuma & Maharaj (2019) blamed the poor performance in mathematics on the traditional approaches used by the teachers. Overusing traditional Mathematics teaching neglects foundational philosophies, leading to rote learning and poor performance as seen in Zimbabwe (Sunzuma & Maharaj, 2019). Heritage-based curriculum uses local factors to develop citizens with relevant skills, knowledge and values for community and national development (Delgado-Algara et al, 2020).

The scourge has been a serious problem at Mururi Secondary where passrate at ordinary level has been oscillating beneath provincial targeted passrate of 60% since the opening of the school. At the above named school where the research will be conducted, symptoms of terrible orientation to mathematics learning included; incapability for form 3 learners to understand concepts of Sets. Retnawati et al (2017) states that in reality, most students do not easily understand the concept of Sets due to the weak practice of teaching Sets in the classroom. Ristina et al (2019) propound that learning Sets are very important for students because understanding and manipulation of symbols as well as applying rules and properties of Sets help to develop problem-solving skills. Sets plays a major role in other mathematical fields and it is full of

challenges and interesting concepts (Shoenfield, 2018). The learners should discover Sets and how mathematics basically travelled throughout Zimbabwe and civilization from Zimbabwe throughout Africa, which from all intents and purposes is pretty significant. This has caused the researcher to researcher to research effects of ethnomathematics based instructional approach on learners' academic performance in Sets at Mururi Secondary School in Zvimba District.

1.2 Statement of the problem

Despite the growing attention of the significance of cultural relevance in mathematics education, there is a limited understanding of specific influence of ethnomathematics instructional strategies on learners' educational success in mathematics. The effectiveness of incorporating ethnomathematics into the curriculum as an educational strategy stays understudied, leaving a gap in our understanding regarding its possible to beautify students' mathematical mastery outcomes. Therefore, this research goals to check out the effects of ethnonomathematics teaching strategy on learners' academic achievement in Sets, exploring to what extent this approach positively influence learners' conceptual understanding, problem solving abilities and general engagement with the subject. By addressing this gap in literature, the findings of this study will make contribution to the improvement of evidence-based practices that can promote more inclusive and culturally responsive in teaching and learning of Sets.

1.3 Research questions

(i) Which mathematical concepts found in the rural learners out of school mathematical practices can be integrated in the teaching and learning of Sets?

(ii) How can the mathematical concepts in the learners' daily activities be integrated in Secondary School Mathematics in Sets?

(iii) What are the challenges faced by teachers in integrating ethnomathematics?

Assumptions

The researcher assumes that the research instruments to be used are valid and reliable. We assume that the questionnaire, pretest and posttest accurately measures the variables of concern.

We assume that the sample is a true representation of the large population. The sample is assumed to adequately represent the characteristics and relevant variables of the population

The researcher assumes that teachers and learners in the sample would be cooperative, honesty and follow the given instructions in answering questionnaire, pre-test and post-test. We assume that participants would give honest and accurate responses.

We assume that the findings will be used in other settings, locations and contexts.

The researcher assumes that the manipulation of an ethnomathematics instructional method causes change the learners' academic achievement. We assume that extraneous variables are controlled in the study.

Researcher assumes that the ethical guidelines are followed in the entire research. This includes obtaining informed consent, protecting participants' privacy and confidentiality.

1.4 Significance of the study

Mathematics is very subject for Science and technology. Science and technology cannot exist without Mathematics and mathematical concepts have been adopted throughout the social, medical and physical science in recent years. In our country Zimbabwe as well as Africa at large, mathematics must be taken seriously so as to produce best scientists and engineers who can explore and utilize locally available resources effectively. Learners solve problems connected to local culture, practices and perspectives relevant to their community (Michiels, 2019). Ethnomathematics can promote world piece by embedding cultural diversity celebration into education systems (D'Ambrosio & Rosa, 2017).

. When we teach Sets using ethnomathematics every learner in the class sense valued and sense being connected to their root so that there are extra resistant to harassment and domination. This would in turn help Zimbabweans and consequently Africans to stay peaceful. Set theory and logic helps to analyze,

evaluate and formulate valid arguments, while identifying and avoiding fallacies and paradoxes (Tomer et al, 2021). Therefore Mathematics can foster learners who critical and logical thinkers who are very useful in nation building.

1.5 Limitations of the study

The participants will be from rural area at Mururi Secondary which may make it difficult to generalize the results that would be found to an urban setting. However, the researcher will be very careful in choosing the sample to ensure that all backgrounds are fully represented.

The time period for research is short which may not allow comprehensive assessment of long term effects of ethnomathematics on learners' academic achievement. There are other university modules to attend as well as planning, teaching, marking and recording amongst other duties of the full time teacher. However, the researcher will utilize every free period of time and mostly weekends and holidays in order to meet deadline as well as to come up with a reliable and valid research.

There are some contextual factors such as cultural backgrounds, socioeconomic status, prior mathematics knowledge or teaching practices. These factors have influence on academic achievement which may be challenging to control or isolate. However, the researcher will try all level best to ensure that extraneous variables are controlled.

There are ethical issues in teaching using ethnomathematics instructional method that are related to cultural appropriation due to cultural diversity.

1.6 Delimitations of the study

The sample size is not very large due to limited time, resources and accessibility.

The study focus to specific concepts in Sets like Set Notation which is atopic within a broader topic and Syllabus.

Form 3 learners are the targeted group. Other forms are not catered for in the research.

The study focuses on rural population which has different settings from urban population.

The research is limited to questionnaires, pretest and posttest only leaving other instruments like observation and focus groups which can assist in gathering more information

1.7 Definitions of terms

Sets

Sets are a collection of distinct objects forming a group (Hall, 2018).

Ethnomathematics

Ethnomathematics encompasses cultural mathematical concepts that can be used as tools to engage with the world (Rosa, 2020).

Academic performance

Academic performance refers to a learners' level of achievement and success in their educational studies measured by grades, test scores, class standing, course completion and other metrics (Duckworth et al, 2019).

Instructional approach

Instructional approach encompasses the teaching methods and techniques used by educators to enable learning and convey information to learners (Mulhearn et al, 2017).

1.8 Summary

In conclusion, chapter 1 has provided an overview of the research study investigating the effects of the ethnomathematics instructional method on learners' achievement in Sets. The chapter began by introducing the background and significance of the study, highlighting the need to explore alternative that promote cultural relevance and engage learners in teaching and learning of Sets. The research problems and research questions were clearly articulated focusing on the potential benefits of incorporating ethnomathematics instructional method for teaching Sets. A thorough review of literature will be conducted in next chapter. The researcher will be very careful in choosing the sample to ensure that all backgrounds are fully represented. The time period for research is short which may not allow comprehensive assessment of long term effects of ethnomathematics. However, the researcher will ensure that extraneous variables are controlled. Under delimitation, the sample size is not very large due to limited time, resources and accessibility. The study focus to specific concepts within a broader topic and syllabus. The form threes are the only targeted group among other leaners. A review of literature will be conducted in next chapter.

CHAPTER 2: REVIEW OF RELATED LITERATURE

2.1 Introduction

This literature review delves into the applications of mathematical concepts in real-life situations, integration of culture in Mathematics and challenges faced by teachers in teaching Mathematics. In this exploration, we aim to shed light on the relevance importance beyond the confines of classroom. By examining the integration of ethnomathematics in Sets and exploring the practical applications of mathematical concepts in different context, we can enrich learners' understanding and engagement with Mathematics while establishing meaningful connections to their everyday lives.

Extensive research has researched the integration of ethnomathematics across various ethnomathematical topics such as Geometry and Mensuration, unveiling the intricate interplay between cultural practices and formal mathematical concepts. Crucially, the inclusion of culturally diverse resources and instructional materials play a pivotal role in facilitating a deeper understanding of Mathematics. In the context of Sets, the integration of ethnomathematics can be facilitated through utilization of familiar contexts, play-based activities and interconnections with other subject areas. However, teachers face challenges such as difficulties in establishing connections between Sets and real-life situations and limited resources.

Ethnomathematics, a methodology that integrates cultural practices into Mathematics education, has gained significant attention for its potential to enhance learning outcomes and make Mathematics more relevant and engaging for learners. This literature aims to explore the integration of ethnomathematics -based teaching methods specifically in the context of Sets. Ethnomathematics has been recognized for its positive impact on teaching and learning of Mathematics Villarin et al (2024). Ethnomathematical approaches improve student engagement, learning outcomes, and the relevance of mathematics to students' lives (Adam, 2022).

The integration of ethnomathematics into Geometry Congruence, Similarity and Scale has shown promising results in simplifying teaching procedures and enriching the quality of education (Desai, 2022).

2.2 Mathematics concepts found in learners out of school context.

Mathematical concepts, such as measurement conversions, fractions and proportions are crucial in culinary endeavors specifically in recipe preparation (Rao, 2023). They enable precise ingredient quantities, effective measurement and combination of ingredients and balance in recipe development (Musina et al, 2017). The academic researches explored the application of measurement skills in Mathematics to solve real life problems. Studies have focused on connecting mathematical concepts like area measurement to daily life situations using visual tools like photography to enhance learners' understanding (Harrigan, 2017).

Mathematical concepts are essential in sports and strategy games like chess or poker (Bewersdorff, 2021). In sports, Mathematics is used for scoring, tracking statistics, determining averages and assessing probabilities (Santos-Fernandez et al, 2019). Statistics such as field percentage, rebounds and assists evaluate player performance (Sarlis & Tjortjis, 2020).

Averages like battling averages in baseball allow for the player comparisons. Probability calculations guide strategic decisions in sports (Burroughs, 2020). Chess and poker heavily rely on mathematical thinking, requiring logical reasoning, pattern recognition and probability calculations for moves and betting (Bewersdorff, 2021). Academic researches demonstrate that probability calculations guide strategic decisions in sports. Studies like Winner's work on sport betting at the University of Florida and application of distributed probability model in sports based on deep learning highlight how probability theory influences strategic choice in sports (Winner, 2023).

Efficient navigation and travel planning rely on mathematical concepts such as scale, proportions, basic geometry, distance calculations, travel times and fuel consumption (Bazzan & Klugl, 2022). Scale helps interpret maps accurately by representing real-world distances proportionally (Cao & Lam, 2023). Proportions aid in planning routes and estimating travel times by comparing distances on maps to actual distances. Basic geometry is necessary for understanding distances, angles and intersection on maps

(Pearson, 2018). Calculations involving rates, time and distance assist in planning routes and estimating arrival time. Research by Andreatta et al (2011) focused on optimizing the mix of flight times and delays at airports by considering factors like airport capacity and weather uncertainty (Jones, 2018). Their mathematical model was able to suggest which flights should be delayed to improve overall system performance (Andreatta et Al, 2011). This study highlights how incorporating calculations of rates, time and distance along with other relevant variables can enhance route planning and arrival time estimation in transportation system (Andreatta, 2011).

Various mathematical concepts are applied in tasks related to measuring spaces, calculating areas, determining material quantities and understanding angles and geometry in trades such as carpentry and tiling (Ostwald, 2021). Measuring spaces requires accurate length, width and height measurements using tools like rulers and tape measures (Williams et al, 2016). Calculating areas involves employing formulas and geometric calculations to determine precise measurements (Ghilani, 2017). Estimating material quantities in construction or renovation projects involves considering coverage rates and waste (Del Pico, 2023). There are researches on estimating material quantities in construction or renovation projects that involves considering coverage rates and waste. A study by Antoniou et al, (2023) focuses on developing cost and material quantities prediction models for construction of underground metro stations. The research emphasizes the importance of accurate estimation by incorporating factors like coverage rates and waste to enhance the precision of cost predictions in construction projects (Antoniou et al, 2023).

The research literature indicates that research shows set theory has practical applications in computer science, logic, probability, statistics, and linguistics (Zhang, 2023). Additionally, Set theory is applied in probability and statistics to define samples and events for probability calculations and data analysis (Bhardwaj, 2019). A study by Offorma shows how Set theory concepts are used in everyday organization, like sorting kitchen items, clothes, and jewelry. (Offorma, 2016). The study emphasizes that Set theory is very important and has broad applications in science, engineering, and other fields (Offorma, 2016).

2.3 How are cultural activities integrated in Mathematics?

Several studies have examined how incorporating cultural activities can enhance the learning and teaching of Mathematics. Using culturally relevant can help in teaching and learning of Mathematics. Exploring cultural mathematical practices aids in teaching and learning of Mathematics. Different cultures often have unique ways of approaching and solving mathematical problems. Research by Lowe et al, (2021) challenges traditional views, emphasizing the significance of social and cultural diversity in Mathematics. Discussing diverse cultural math practices broadens students' understanding of mathematics. (Lowe et al, 2021). Research shows Akan cultural practices can be integrated into teaching mensuration and geometry in secondary school (Owusu-Darko, et al 2023). Akan cultural practices, like artefacts and buildings were found to support teaching geometry and mensuration, integrating formal and informal math content. This helps Akan children connect school Mathematics to their cultural background (Owusu-Darko et al, 2023).

Incorporating culturally diverse resources is important in teaching and learning of Mathematics. Using diverse cultural resources is important in teaching Mathematics, to reflect learners' backgrounds. (D'Ambrosio & Rosa, 2016). Representing diverse cultures in learning materials helps students feel included and engaged (D'Ambrosio & Rosa, 2016). Ethnomathematics research shows mathematical concepts are embedded in diverse cultural practices, which should be integrated into math curriculum and teaching to reflect learner's backgrounds. (D'Ambrisio & Rosa, 2016). A study by Sunzuma and Maraji emphasized that using familiar, real-world contexts helps students connect Mathematics concepts to their own experiences, enhancing the meaningfulness of learning (Sunzuma & Maraji, 2021).

Collaborative learning must be encouraged in Mathematics in order to incorporate ethnomathematics. Collaborative learning activities that encourage peer discussion allow students to share and learn from diverse cultural perspectives in mathematics. (Gray, 2021). Gray (2021) highlighted the importance of collaborative learning activities in Mathematics to facilitate the sharing of cultural perspectives among learners. A study in Bali found that starting geometry lessons with ethnomathematics-related problems, patterns and phenomena led to effective learning of geometric transformations through student investigation and collaboration. (Lidinillah et al, 2022).

Leveraging familiar contexts can help in integrating ethnomathematics in Sets education. Teachers should take every opportunity to explain mathematical vocabulary and concepts like Sets in the context of learners' real-life experiences and familiar situations. This helps learners make significant connections between the abstract concepts of Sets and their everyday lives. Teachers can improve math learning by explaining concepts using students' real-life experiences and hands-on, play-based activities that integrate ethnomathematics in Mathematics (Anwer, 2019). Researchers emphasize on the importance of using varied play-based activities to teach mathematical concepts. Engaging students in hands-on, play-based math activities, like grouping, counting, and exploring patterns, can deepen their understanding of mathematical concepts (Anwer, 2019). However, none of the results discuss using play-based activities to teach Sets. More targeted research would be needed to determine if this approach is emphasized by researchers to teach Sets.

Using familiar prompts and vocabulary help to integrate ethnomathematics as well as teaching and learning of Mathematics. Relatable examples and everyday language helps students to understand mathematical concepts making the abstract idea more accessible and relatable for learners (Forbes, 2018). By connecting the mathematical concepts present in learners' daily activities, teachers can make teaching and learning of Sets more engaging and relevant (Forbes, 2018). However, the researchers do not specifically mention using familiar prompts and vocabulary to integrate ethnomathematics in Sets. There are also some ways that the mathematical concepts in learners' daily activities can be integrated in teaching and learning of Sets.

Use of real examples and objects can also be integrated in teaching and learning of Sets (Panda, 2023). Researchers suggest teaching sets by having students organize familiar everyday items, like favorite foods or toys, to discover relationships and make the abstract concept more relatable (Panda, 2023). Integrating sets across different subject areas helps students make connections and see the relevance of the Mathematics concepts (Gutierrez, 2019). According to Gutierrez (2019), the researches indicate that connecting Sets to other subjects helps students understand the concept's relevance beyond the math classroom (Gutierrez, 2019).

There are so many ways in which we can apply Sets in real life. Partitioning tasks into different categories or subsets can help to make comparisons between data (Vos, 2018). Real life problems can be solved by grouping them which is similar to grouping a set into subgroups (Cano et al, 2023). Learners can use Mathematics concepts to count, group and identify patterns and apply spatial reasoning (Anwer, 2019).

2.4 Challenges faced by teachers in integrating ethnomathematics

While the benefits of ethnomathematics are evident, challenges exist in integrating this approach into classroom teaching. Teachers may struggle to integrate ethnomathematics due to limited competence, experience, and resistance to changing teaching approaches (Sunzuma & Maharaj, 2019). The disconnection between cultural mathematical practices and the formal curriculum hinders teachers' ability to effectively integrate ethnomathematics into their teaching (Sunzuma & Maharaj, 2019).

Difficulty in linking Sets to real-life situations is another challenge. Teachers struggle to connect abstract math concepts like sets to real-world applications due to limited knowledge hindering their capability to design engaging, culturally-relevant lessons on Sets (Reyes et al, 2019). Inadequate content knowledge in Geometry is another challenge faced by teachers to integrate ethnomathematics. Many teachers often lack sufficient content knowledge, which is crucial for effectively integrating ethnomathematics and teaching concepts of Mathematics (Disnawati & Nahak, 2019). Limited geometry knowledge hinders teacher's ability to recognize and evaluate student's ethnomathematics-based problem-solving approaches. (Disnawati & Nahak, 2019).

Another challenge is negative beliefs about the function of culture. Some teachers believe students' cultural backgrounds do not impact their mathematical performance (Bottoms et al, 2017). This mindset can act as a barrier to embracing ethnomathematical techniques to teaching Sets. Studies emphasized the need to incorporate learners' home cultures in the classroom, as their cultural knowledge can aid ethnomathematical approaches (Bottoms et al, 2017). Dismissing the influence of students' home cultures can hinder the integration of ethnomathematics, which draws on learners' personal cultural knowledge through play-based

activities (Bottoms et al, 2017). Lack of formal training in ethnomathematics makes it difficult for teachers to effectively implement it (Machaba & Dhlamini, 2021). Providing teachers with professional development on ethnomathematics can improve their ability to integrate it into the match curriculum. (Machaba & Dhlamini, 2021).

Additionally, limited access to resources reflecting diverse cultural mathematical practices can make it difficult for teachers to incorporate ethnomathematics (Disnawati & Nahak, 2019). Resources like time are important when integrating ethnomathematics when teaching Mathematics (Sunzuma & Maharaj, 2019). Teachers may face resistance from students, parents and colleagues when integrating ethnomathematics in the mathematics curriculum (Aikenhead, 2017). The resistance may affect the integration of ethnomathematics. Language barrier can also affect the integration of ethnomathematics since learners may fail to understand the mathematical concepts (Sunzuma & Maharaj, 2019). Mathematics language should be easy to understand (Devlin, 2018).

2.5 Research gaps

The gap identified on outside school activities for teaching and learning Sets could focus on exploring how mathematical concepts like measurement, conversions and proportions are practically applied in various real-life scenarios beyond traditional academic settings. This gap could delve into the practical applications of Sets in fields like computer science, logic probability and linguistics, emphasizing hands-on experiences and connections to everyday activities such as organizing items in a closet or kitchen utensils. This research could bridge the gap between theoretical concepts and their tangible, real-world implications, enhancing understanding and engagement in Mathematics education.

There is lack of research on the use of play-based activities to teach Sets within an ethnomathematics framework. While the information mentions the importance of play-based activities in teaching Mathematics concepts and integrating ethnomathematics in Geometry there is no mention of using play-

based activities to teach Sets. Therefore, exploring how play-based activities can be incorporated into the teaching and learning of Sets from a cultural perspective could be valuable area of research. This research could investigate effectiveness of play-based activities in helping learners understand and apply Sets concepts while drawing on cultural contexts and practices. It would involve designing and implementing play-based activities related to Sets and evaluating their impact on learners' learning outcomes and engagement.

Furthermore, another gap that can be investigated is the lack of formal and exposure among teachers. This can be explored further to understand the extent to which teachers are familiar with ethnomathematics and how it affects their ability to integrate it into teaching and learning of Sets. The research can assess teachers' knowledge and understanding, explore the impact of professional development, identify barriers and challenges to professional development and investigate the impact of cultural resources. By investigating these aspects, the researcher can provide insights and recommendations on how to address the gap in teachers' training and exposure to ethnomathematics thereby facilitating the integrated of ethnomathematics-based instructional approach on learners' academic performance.

2.6 Chapter summary

Mathematical concepts are integral to a wide range of real-world applications. In culinary practices, mathematical skills facilitate precise ingredient quantities, effective ingredient combinations and recipe development. Similarly Mathematics underpins scoring, statistics, averages and probability analysis in sports and strategy games. Navigation and travel planning rely on mathematical concepts like scale, proportion, geometry, distance and fuel consumption. Constructions and trades utilize mathematics for measuring, calculating areas and determining material quantities. Even fields like computer science, logic probability, statistics and linguistics employ mathematical principles set theory to organize and analyze data. Researchers have emphasized the importance of exploring cultural mathematical practices and using culturally relevant examples in teaching. Incorporating ethnomathematics such as Akan practices in Ghana, can support the learning of like Geometry and Mensuration. Using familiar, real world contexts and

collaborative activities that draw learners' cultural perspectives can make Mathematics concepts more accessible and meaningful. However, several challenges exist in integrating ethnomathematics into classroom instruction. Teachers may lack necessary competence, experience and openness to adopt new educational paradigms. Linking abstract mathematical ideas like Set theory to real-world, culturally relevant applications can be difficult, especially when teachers have limited geometrical knowledge. Negative beliefs about the influence of cultural background on Mathematics performance can also hinder the use of ethnomathematical approaches. Addressing these gaps is crucial. Further research is needed to explore the practical applications of mathematical concepts such as Sets, in diverse fields beyond traditional academic settings. Investigation into the use of play-based activities and culturally relevant pedagogy for teaching Sets can also contribute to more engaging and inclusive mathematics education. Enhancing teachers' training and exposure to ethnomathematics is essential to facilitate the effective integration of cultural practices into the teaching and learning of Mathematics.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides an overview of the research design and methodology employed to investigate the integration of ethnomathematics-based instructional approach in Sets. The chosen approach utilizes a concurrent design. The chosen site selected for this study is Mururi Secondary School in Zvimba, with a specific focus on Form 3 learners. To ensure representativeness in participant selection, proportional stratified sampling is employed. The study aims to collect both quantitative and qualitative data through interviews and observations to examine the integration of ethnomathematics-based instructional approach in teaching and learning of Sets. Data analysis in this study involves comparing and triangulating data from various sources such as interviews, observations and questionnaires. Throughout the research process, ethical considerations and data confidentiality will be maintained throughout the study.

3.2 RESEARCH DESIGN

3.2.1 Research paradigm: Pragmatism

A paradigm is a fundamental way of perceiving and understanding the world (Hughes, 2020). Hennink et al, (2020) contend that the researchers' beliefs and feelings about the world and the manner in which it should be understood and studied guide all research. This study is pinned under pragmatism. This research is situated within a pragmatic philosophy that views reality as understood through observation and experience (Hennink et al, 2020). To utilize the pragmatism paradigm in research on effects of ethnomathematics-based instructional approach to learners' academic achievement, the researcher will integrate qualitative quantitative method based on learners' out-of-school mathematics contexts, integrating culture to teach mathematics and challenges faced by teachers to teach mathematics. The paradigm is crucial in the research since the researcher will focus on the practicality and adaptability of theories ensuring they are accessible to a wide audience. Various research methods will be incorporated without bias towards qualitative or quantitative approaches this includes questionnaires, interviews and observations, hence the importance of pragmatism paradigm. The researcher will emphasize the usability of theories in addressing learners' out-of-school mathematics contexts, cultural integration in teaching and learning of Sets as well as challenges faced by teachers to teach Sets, hence the deed for pragmatism paradigm.

3.2.2 Research method

The researcher will use the mixed method to collect data. Mixed methods combine qualitative and quantitative strengths for a more comprehensive understanding. (Dawadi et al, 2021). The researcher aims to triangulate the techniques for corroboration and validation by immediately evaluating the quantitative statistical results and qualitative findings, hence the use of mixed method.

Concurrent design

To gain a comprehensive understanding of the topic, this research will utilize the concurrent design, which is based on mixed methods (Alavi & Habek, 2016). Concurrent design involves the simultaneous collect and analysis of qualitative and quantitative data within a single survey in order to gain a comprehensive understanding of the research question and problem being investigated (Mweshi & Sakyi, 2020). The researcher wants to compare and contrast quantitative results with qualitative findings as well as to validate and expand quantitative data with qualitative data, hence the need for concurrent design.

3.3 Research methods

3.3.1 Population

In Zvimba District there are 67 Secondary Schools. For convenience sake, the researcher chose Mururi Secondary, which is located in rural area and has a population of 310 learners, and 15 teachers.

3.3.2 Sample and sampling techniques

The specific focus of this study will be on form 3 learners and the purposive sampling was used. Purposive sampling is a non-random technique in which individuals or cases are intentionally selected based on predetermined criteria or relevant characteristics that align with research objectives (Mweshi & Sakyi, 2020).

Form 3 consist of 2 classes, with total of 88 learners. Class A consist of 40 learners, while class B consist of 48 learners. Among the learners in class A, there are 19 boys and 21 girls. In class B, there are 24 boys and 23 girls. To ensure adequate representativeness, proportional stratified sampling will be utilized. Proportional stratified sampling selects participants from each stratum proportionately to represent population characteristics accurately. (Mweshi & Sakyi, 2020). Proportional stratified sampling helps to ensure that the sample accurately reflects the characteristics of the population being studied, as it takes into account variability within each stratum (Mweshi & Sakyi, 2020).

Selection criteria

To select class A we go through the following steps:

1. Determine the total number of learners in the class: 40.

2. Calculate the proportion of boys and girls in the class:

- Proportion of boys = $\frac{\text{Number of boys}}{\text{Total number of learners}} = \frac{19}{40} \approx 0.475.$

- Proportion of girls = $\frac{\text{Number of girls}}{\text{Total number of learners}} = \frac{21}{40} \approx 0.525.$

3. Calculate the number of boys and girls to select:

- Number of boys to select = (Proportion of boys) x (Total number to select) = 0.475 x 10 ≈ 5

- Number of girls to select = (Proportion of girls) x (Total number to select) = 0.525 x 10 ≈ 5

4. Create two separate strata based on gender: one for boys and one for girls.

5. Randomly select 5 boys from the stratum of boys and 5 girls from the stratum of girls. You can use a random number generator or a random sampling method to ensure the selection is unbiased.

6. Combine the selected boys and girls to form your final sample of 10 girls and 10 boys.

By following these steps, you will have selected 10 learners, with 10 boys and 10 girls, using proportional stratified sampling.

To select Class B the researcher will use proportional stratified sampling to select 10 girls and 10 boys from a class of 48 learners, follow these steps:

1. Determine the total number of learners in the class: 48.

2. Calculate the proportion of boys and girls in the class:

- Proportion of boys $= \frac{\text{Number of boys}}{\text{Total number of learners}} = \frac{25}{48} \approx 0.521.$

- Proportion of girls$= \frac{\text{Number of girls}}{\text{Total number of learners}} = \frac{23}{48} \approx 0.479.$

3. Calculate the number of boys and girls to select:

- Number of boys to select = (Proportion of boys) x (Total number to select) = 0.521 x 10 ≈ 5

- Number of girls to select = (Proportion of girls) x (Total number to select) = 0.479 x 10 ≈ 5

4. Create two separate strata based on gender: one for boys and one for girls.

5. Randomly select 5 boys from the stratum of boys and 5 girls from the stratum of girls. You can use a random number generator or a random sampling method to ensure the selection is unbiased.

6. Combine the selected boys and girls to form your final sample of 10 girls and 10 boys.

By following these steps, you will have selected 10 learners, with 10 boys and 10 girls, using proportional stratified sampling.

All 5 mathematics teachers will also be selected.

3.3.3 Data collection instruments

Questionnaires, interviews and observations will be used by the researcher.

Questionnaires

Questionnaires gather data by asking participants identical questions in a set order (Hennink, 2020). The researcher will develop questionnaires to survey learners about the mathematical concepts the use outside school. This will help identify concepts of Sets found in out-of-school contexts. The researcher will also create questionnaires for teachers to understand the challenges they face when teaching Sets. This will provide insights into the difficulties teachers encounter.

Interviews

Interviews are a valuable qualitative technique that allows researchers to obtain rich, in-depth data through direct conversations with participants (Hennink, 2020).The researcher will conduct a one-on-one interviews with learners to further explore the mathematical ideas they apply in their daily lives. This qualitative data can complement the questionnaire responses. Teachers will be interviewed by the researcher to gain deeper understanding of the challenges they face when integrating ethnomathematics into Sets lessons. The interviews can uncover specific issues teachers encounter.

Observations

Observation in research involves systematically gathering data by directly observing and recording behaviours, actions and interactions in natural settings (Anguera et al, 2018).The researcher will observe learners in their communities to see firsthand how they use mathematics concepts in out-of-school contexts. This can provide concrete examples of ethnomathematics. Sets lessons will be observed by the researcher to identify challenges teachers face when teaching the topic. Observational data can reveal issues that teachers may not mention in questionnaires or interviews.

By using a combination of questionnaires, interviews and observations, the researcher can gather both quantitative and qualitative data to comprehensively answer the research questions. The instruments will allow the researcher to identify out-of-school mathematical concepts, understand how ethnomathematics can be integrated in Sets lessons and determine the challenges teachers' face when teaching Sets.

3.3.4 Data collection method

The study will collect both quantitative and qualitative data to research on the integration of an ethnomathematics-based instructional approach in the teaching and learning of Sets. Including both quantitative and qualitative data eliminates bias and enables triangulation for a more robust, comprehensive analysis (Thompson, 2019). To validate and triangulate the data, the study will compare data from multiple sources including interviews, observations and questionnaires.

Quantitative and qualitative data will be collected through interviews and observations. Interviews are a valuable qualitative research technique that allows for obtaining rich, in-depth data through direct conservation with participants (Cresswell & Clark, 2017). Questionnaires will be designed for 5 teachers and 40 learners and participants will be given these questionnaires to complete.

Member checking will also be implemented, whereby preliminary findings will be shared with participants to verify the accuracy and interpretation of the data. This process allows participants to provide feedback and make corrections if necessary.

Quantitative data collection

For the quantitative component of parallel design, the researcher should collect data using a survey questionnaire. The questionnaire should be designed to measure variables related to research questions. It should include closed-ended questions with response options that can be easily quantified and analyzed statistically.

Qualitative data collection

For qualitative component, the researcher will collect data through semi-structured interviews and observations. Interviews allow for in-depth exploration of participants' experiences, opinions and perspectives. Observation allows the researcher to directly witness behaviors and by in context.

3.4 Data analysis

Quantitative data

To conduct data analysis for quantitative data, the researcher must first gather data from questionnaires, ensuring clear and precise questions tailored to the target population. Observation and interview must be conducted to supplement the quantitative data. Computer program like SPSS must be used to sort and clean the responses, assigning numerical values to responses and removing incomplete data. The researcher would then employ SPSS statistical analysis tools for quantitative data analysis, considering methods like factor analysis, regression analysis and analysis of variance. The researcher will then summarize key results and provide explanations and interpretations in the discussion and conclusion.

Qualitative data

To conduct data analysis of qualitative data the researcher must transcribe interview recordings and compile observation notes and open ended survey responses into a structured format. The researcher organize data by participant, data collection method and research question. Data must be red through multiple times to identify initial patterns, themes and insights. Research objectives must be revisited to determine which questions can be answered by qualitative data. The researcher would then assign codes or labels to segments of text that represent key ideas, concepts or themes. The researcher would then analyze coded data to find recurring themes, relationships. Findings would then be interpreted and the results be reported.

3.5 Data presentation and analysis

The data presentation and analysis will be divided into two main parts: quantitative data analysis and qualitative data analysis. The findings from both analyses will be integrated to provide a comprehensive understanding of the research problem.

Quantitative data analysis

The quantitative data collected through the questionnaires will be analyzed using descriptive and inferential statistics. Descriptive statistics, such as frequencies, percentages, means and standard deviations will be used to summarize and describe the characteristics of the sample population. Inferential statistics such as correlation and regression analyses, will be employed to examine the relationships between variable and test hypotheses. The quantitative data will be analyzed using Statistical Package for the Social Sciences (SPSS) software. The results will be presented in the form of tables, graphs and charts to facilitate clear and concise communication of the findings.

Qualitative Data analysis

The qualitative data collected through observation and interviews will be analyzed using thematic analysis. The data will be transcribed verbatim and the scripts will be read and re-read to familiarize the researcher with data. Initial codes will be generated based on the research questions and themes emerging from the data. These codes will be collated into potential themes, which will be reviewed and refined to ensure they accurately represent the data. The final themes will be defined and named, and representative quotes from the interviews and observations will be used to support the findings. The qualitative data analysis will be conducted using NVivo software to facilitate the organization and management of the data.

3.6 Ethical issues

To address ethical considerations the researcher must ensure that participants understand the study’s purpose, methods, risks and benefits before agreeing to participate.

On confidentiality, the research will protect participants' identities and personal information through anonymity or confidentiality unless explicitly agreed otherwise.

The researcher must prioritize participants' well-being, offering support like counseling to combat psychological harm.

On honesty and integrity, the researcher must maintain transparency in research practices ensuring data accuracy and truthfulness.

To ensure research independence, the researcher will avoid conflicts of interest and partiality, maintaining impartiality throughout the research process.

By adhering to these ethical principles, the researcher can conduct a study that respects participants' rights and ensures the validity and reliability of the research findings.

3.7 Anonymity

To maintain anonymity, the researcher must firstly ensure data confidentiality by assigning codes or numbers to participants instead of using personal identifiers. Secondly, the researcher will anonymize data during analysis by aggregating responses to prevent individual identification. Lastly, in a mixed-methods approach using questionnaires, observation and interviews, the researcher will maintain anonymity by separating qualitative and quantitative data sources to protect participants' identities. This approach safeguards privacy and confidentiality in research.

3.8 Data validation

On data validation, the research method aligns with data needed to answer questions accurately. Questions for surveys are clear and objective to avoid data quality and avoid biases. The sample size is adequate and representative of the study's objectives to maintain validity. Lastly, the researcher will address challenges like measuring complex constructs and minimizing errors during data collection to uphold the integrity of

the study. These practices are crucial for ensuring the accuracy and reliability of data in mixed-method research.

3.9 Summary of the chapter

The study is grounded in the pragmatism research paradigm which allows the researcher to use both qualitative and quantitative methods without bias towards one approach. The study will be conducted in Zvimba District in Zimbabwe, focusing 3 learners and Mathematics teachers at Mururi Secondary School. Proportional stratified sampling will be used to select a representative sample of 40 learners (20 boys and 20 girls) from the two Form 3 classes. All 5 mathematics teachers will be selected for the study. Data will be collected through questionnaires, interviews and observations. Questionnaires will be used to survey learners about mathematics concepts they use outside of school and understand challenges teachers face in teaching Sets. Interviews will provide deeper exploration of these topics. Observation will allow the researcher to see firsthand how learners apply mathematics in their daily lives and how teachers teach the topic of Sets. Both quantitative and qualitative data will be collected and analyzed. Quantitative data from the questionnaires will be analyzed using SPSS statistical software. Qualitative data from interviews and observations will be analyzed using coding and thematic analysis. Triangulation between the data sources will be used to validate the findings. Data analysis will be divided into two main parts that is quantitative and qualitative data analysis. On quantitative data analysis, descriptive statistics (frequencies, percentages, means, standard deviations) will be used to summarize the sample characteristics. The quantitative data will be analyzed using SPSS software and results presented in table, graphs and charts. On qualitative data analysis, thematic analysis will be used to analyze the observation and interview data. The data will be transcribed and coded to identify emerging themes, which then be refined and defined. NVivo software will be used to organize and manage the qualitative data. For ethical considerations, participants' informed consent, confidentiality and well-being will be prioritized. Research transparency, impartiality and avoidance of conflicts of interest will be ensured. Anonymity will be maintained by using codes or numbers instead of personal identifiers and separating qualitative and quantitative data sources. Data validation will

involve aligning methods with research questions, using clear and objective survey questions, having an adequate representative sample size and minimizing errors during data collection. The mixed-methods approach combining quantitative and qualitative analysis to provide a comprehensive understanding of the research problem.

CHAPTER 4: DATA PRESENTATION, ANALYSIS AND DISCUSSION/ INTEPRETATION

4.1 Introduction

The previous chapter discussed the methodology used to carry out the research. The purpose of this concurrent mixed method study was to explore the effects of ethnomathematics-based instructional approach on learners' academic achievement in Sets. Forty learners and 5 teachers completed the questionnaires and interviews. 5 teachers and 40 learners were observed. Consistency with the ethics in research and anonymity was observed. The research results presented below emerged from the analysis of questionnaires, interviews and observations. The quantitative and qualitative data were derived from questionnaires, interviews and observations. Data will be presented followed by analysis, then discussion and consequently the summary.

4.2 **DATA PRESENTATION, ANALYSIS AND DISCUSSION/ INTEPRETATION**

4.2.1Which mathematical concepts found in the rural learners out of school mathematical practices can be integrated in the teaching and learning of Sets?

1 Grouping and Classification

Rural learners demonstrate strong skills in grouping and classifying items in their household activities, such as sorting clothes, organizing supplies, and categorizing crops. This aligns with mathematical concepts of set theory, including defining sets, identifying set membership, and performing set operations.

Data from teachers interviews on quantitative data. On a scale of 1-5 (1 = Rarely Observed, 2 = Occasionally Observed, 3 = Sometimes Observed, 4 = Often Observed, 5 = Frequently Observed, the average ratings of common mathematical practices and concepts utilized by rural learners in their out-of-school activities.

Table 4.1

Quantitative data from teachers' interview in Table 4.1 shows that mathematical practices and concepts of grouping and classification have the rating of 5. Indicating that they are frequently observed in rural learners in their household activities like budgeting.

Grouping is very important to solve real life problems involving budgeting. This aligns with the idea that real life problems can be solved by grouping them which is similar to grouping a set into subgroups (Cano et al, 2023).

Qualitative data from learners' interview on common mathematical practices and concepts utilized by rural learners in their out-of-school activities.

Learners' reactions on common mathematical practices and concepts utilized by rural learners in their out-of-school activities n=40

Representative quotes

Learner 1: "*When l do laundry, l always sort the clothes into different piles like shirts, pants dresses and so on.*"

Learner 3: "*One of my favorite traditional games is where we have to sort different objects into categories. It is really challenging, but it is funny to see how things are related*"

Learners 5: "*When l am sorting laundry, l count number of items in each pile to know if anything is missing."*

Learner 9: "l *always sort laundry by type of clothing*."

Learner 13: *"In traditional games we sort items into categories*."

Learner 14: "*At home, we always group furniture and groceries.*"

13 learners (32.5% mentioned sorting clothes when doing laundry, such as by type of clothing (shirt, pants, dress or by colour). 8 learners (20% mentioned traditional games that involve sorting or categorizing different objects.6 learners (15%) talked about their household systems for grouping and dividing up items like kitchen supplies, school materials and toys to keep them organized. 2 learners (5%) discussed their household practice of grouping crops for storage and use.

The data shows that learners use the concept of grouping to solve real life problems at household level. This concurs with the idea that partitioning tasks into different categories or subsets can help to make comparisons between data (Vos, 2018).

Qualitative data from teachers' interview on common mathematical practices and concepts utilized by rural learners in their out-of-school activities.

Teachers' reactions on common mathematical practices and concepts utilized by rural learners in their out-of-school activities n=5

Representative's quotes

Teacher 2: "*When our learners are managing household finances and budgeting resources, they are demonstrating a deep understanding of set-related ideas like grouping, classification and cardinality.*"

Teacher 3: "*One of the most impressive things l have noticed is how rural learners utilize set-related ideas like membership and cardinality in their traditional games, puzzles and storytelling.*

Teacher 5: "*Rural learners demonstrate understanding of set-related ideas like membership in traditional games and storytelling*."

Qualitative data from teachers' interviews showed that 3 Teachers recognize the connection between learners' real-world grouping/classification practices and the learning objectives around set theory. Learners use the concepts of sets to group or classify items in their leisure time when they play games or engage in storytelling which can enable them to analyse situations or problems. This concurs with the idea that partitioning tasks into different categories or subsets can help to make comparisons between data (Vos, 2018).

From learners' interview quantitative data.

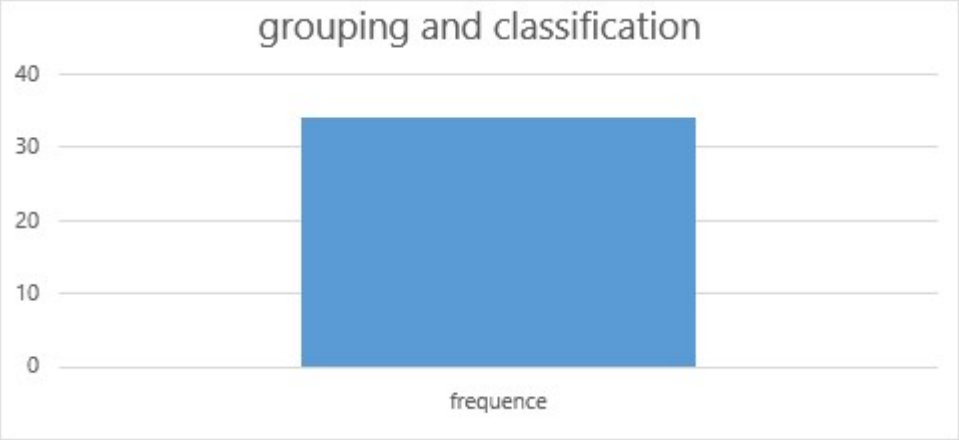


Table 4.2

34 learners said they use grouping and classification in their everyday activities. They use grouping or classification to find solutions to their household problems. This concurs with the idea that real life problems can be solved by grouping them which is similar to grouping a set into subgroups (Cano et al, 2023).

Qualitative data from learners' interview on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum.

Learners' reactions on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum n=40

Representative quotes

Learners 2: "*when washing clothes, we sort the clothes into different piles that is shirts, pants dresses and so on.*"

Learners 5: "*When l am sorting laundry, l count number of items in each pile to know if anything is missing."*

Learner 9: "l *always sort laundry by type of clothing*."

Learner 11: "*l sort clothes when doing laundry."*

Learner 15: "*When washing clothes we sort clothes separately depending on color"*

Learner 18: "*When cooking l group ingredients depending on their order when using them.*"

Learners 22: "*When we wash clothes we number items in each pile to know if anything is dirty or clean."*

Learner 26: *"Budgeting my household spending is really important to me to avoid impulse buying.*"

Learner 28: "*l sort crops when planting and harvesting."*

Learner 32: "*When putting clothes on line for drying we sort clothes separately depending on color"*

Learner 40: "*We group crops by type*."

13 learners discussed sorting clothes when doing laundry. The most common ways of sorting clothes were by type (shirts, pants, dresses) and by color. This can help to make comparison of the clothes whether they are clean or not. This concurs with the statement that partitioning tasks into different categories or subsets can help to make comparisons between data (Vos, 2018).

Qualitative data from learners' questionnaire on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum.

Learners' reactions on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum n=40

Representative quotes

Learner 2: "*Grouping together food based on their nutrients is how l use mathematics."*

Learner 6: "*Grouping together clothes based on their colour is how l use mathematics."*

Learner 15: "*I group together pesticides based on how poisonous they are."*

Learner 20: "*We group families depending on their sizes."*

Learner 26: "*We group livestock based on their type."*

Learner 28: "*I group household items which is very important to put our houses in order*"

Learner 29: "*Grouping together clothes based on their type is how l use mathematics."*

Learner 40: *Grouping household items by their intended functions or uses helps in maintaining order*."

8 learners mentioned using mathematical concept of grouping to solve household duties that involve cleaning, laundry, livestock keeping and storing food. Grouping is used by learners to solve daily problems. This concurs with the idea that real life problems can be solved by grouping them which is similar to grouping a set into subgroups (Cano et al, 2023).

Data from learners' interview on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum

Learners' reactions on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum n=40

Representative quotes

Learner 2: "*Categorization concept enables grouping things like furniture based on their use*."

Learner 3: "*Partitioning household items like food involves grouping*."

Learner 7: "*Grouping is needed to divide similar books depending on their level.*"

Learner 14: "*We use grouping to divide livestock"*

Learner 21: "*To partition livestock we use grouping."*

Learner 24: "*To partition clothes based on color when washing we use grouping."*

Learner 27: "To put food in their respective classes we make use of grouping."

Learner 29: "*To partition clothes based on its use we use grouping."*

Learner 37: "*To divide furniture to their real class we use grouping."*

9 learners said they use grouping to partition household items like clothes and furniture. This shows that they apply the concept of grouping when doing their chores. This aligns with the idea that real life problems can be solved by grouping them which is similar to grouping a set into subgroups (Cano et al, 2023).

Qualitative data from teachers' interviews showed that rural learners use Sets related concepts of grouping and classification in their out of school contexts.

Teachers' reactions on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum n=5

Representative quotes

Teacher 3*: "How rural learners use the union and intersection concepts in their everyday grouping and classification of household items aligns with Sets"*

1 out of 5 teachers (20%) explicitly connected how rural learners' grouping and classification of household items aligns with set operations like union and intersection. This shows that rural learners group their household items to solve household issues. This aligns with the notion that real life issues can be solved by grouping them which is similar to grouping a set into subgroups (Cano et al, 2023).

Qualitative data from learners' interview on key mathematical concepts and skills embedded in rural learners' out-of-school related to sets.

Learners' reactions on key mathematical concepts and skills embedded in rural learners' out-of-school related to sets n=40

Representative quotes

Learner 6: "*Grouping belongings keeps house tidy."*

Learner 11: "*We group household items by function to put order."*

Learner 16: "*Grouping properties by room makes it easier to locate your valuables."*

Learner 21: *"Grouping belongings by room makes it easier for cleaning."*

Learner 22: *"Grouping properties by their use keeps house tidy*."

Learner 25: "*Grouping kitchen utensils by colour makes the kitchen beautiful."*

Learner 27: *"Grouping ingredients by their uses makes it easier when cooking."*

Learner 28: "*Grouping clothes by their type makes it easier to locate your clothes."*

Learner 32: *"Grouping clothes by colour makes it easier for laundry."*

Learner 35: "*Grouping money by its denominations makes counting easier."*

Learner 37: *"Grouping food by its nutrients makes it easier when preparing meal*."

10 learners stated that grouping concepts help them when doing household chores like cooking, laundry, cleaning. Those household duties involving grouping assist the learners to put their homes tidy. This aligns with the idea that real life problems can be solved by grouping them which is similar to grouping a set into subgroups (Cano et al, 2023).

Qualitative data from learners' interview on key mathematical concepts and skills embedded in rural learners' out-of-school related to sets.

Learners' reactions on key mathematical concepts and skills embedded in rural learners' out-of-school related to sets n=40

Representative quotes

Learner 6: "*Grouping belongings keeps house tidy."*

Learner 11: "*Grouping household items by function to put order."*

Learner 16: "*Grouping belongings by room makes it easier for cleaning."*

Learner 21: *"Grouping belongings by room makes it easier for cleaning."*

Learner 22: *"Grouping belongings keeps house tidy*."

Learner 25: "*Grouping belongings by room makes it easier for cleaning."*

Learner 27: *"Grouping belongings keeps house tidy."*

Learner 28: "*Grouping belongings by room makes it easier for cleaning."*

Learner 32: *"Grouping belongings keeps house tidy."*

Learner 35: "*Grouping behlongings by room makes it easier for cleaning."*

Learner 37: *"Grouping belongings keeps house tidy*."

Qualitative data from learners' showed that 15 out of 40 learners (37.5%) mentioned grouping or classifying items based on function, purpose, size, material, or other attributes. The grouping can assist making decisions based on subgroups which can assist in problem solving. This concurs with the idea that partitioning tasks into different categories or subsets can help to make comparisons between data (Vos, 2018).

Qualitative data from learners' interview on key mathematical concepts and skills embedded in rural learners' out-of-school related to sets.

Learners' reactions on key mathematical concepts and skills embedded in rural learners' out-of-school related to sets n=40

Representative quotes

Learner 1: “*I group household items by function for example keeping kitchen supplies in the kitchen.”*

Learner 6: “*Grouping belongings keeps house tidy.”*

Learner 7: “*Classifying items based on their characteristics is very important for storage”*

Learner 11: “*We group household items by function to put order.”*

Learner 12: *“l classify belongings based on size shape or color to create cohesive arrangement.”*

Learner 16: “*Grouping belongings by room makes it easier for cleaning.”*

Learner 17: “*l classify items based on their function.”*

Learner 21: *“Grouping belongings by room makes it easier for cleaning.”*

Learner 22: *“Grouping belongings keeps house tidy*.”

Learner 23: “*l classify items based on their function.”*

Learner 25: “*Grouping belongings by room makes it easier for cleaning.”*

Learner 27: *“Grouping belongings keeps house tidy.”*

Learner 28: “*Grouping belongings by room makes it easier for cleaning.”*

Learner 31: *“l classify belongings based on size shape or color to create cohesive arrangement.”*

Learner 32: *“Grouping belongings keeps house tidy.”*

Learner 35: “*Grouping belongings by room makes it easier for cleaning.”*

Learner 36: “*l classify items based on their use.”*

Learner 37: *“Grouping belongings keeps house tidy*.”

Learner 39: “*l classify items based on their function.”*

Learner 40: *“Grouping belongings keeps house tidy.”*

Qualitative data from learners' showed that 20 out of 40 learners (50%) mentioned grouping or classifying items based on function, purpose, size, material, or other attributes. The grouping can assist making decisions based on certain attributes and characteristics which can assist in problem solving. This concurs with the idea that partitioning tasks into different categories or subsets can help to make comparisons between data (Vos, 2018).

Qualitative data from learners' questionnaires on key mathematical concepts and skills embedded in rural learners' out-of-school related to sets.

Learners' reactions on key mathematical concepts and skills embedded in rural learners' out-of-school related to sets n=40

Representative quotes

Learner 1: "*When organizing my belongings, l like to sort them into groups based on their shared characteristics."*

Learner 3: *"lf l have different types of kitchen apply, l might combine them to make organization easier."*

Learner 4: *"Classifying my clothes by type makes it easier to find what l am looking for."*

Learner 6: "*I will combine related sets, like collection of books to create large reading material."*

Learner 7: "*Sorting my art supplies by medium like paints, pencils and brushes helps me maintaining a clear idea of what is available."*

Learner 9: "*If l have lots of electronic devices, l might group them into Sets like laptops, phones and tablets to stay organized."*

Learner 10: *"Combining my Sets of gardening tools into a single gardening set makes it easier to find what l need when working outside.*

Learner 11: *"When sorting my jewelry, l like to group pieces by material, such as gold, silver and gemstone to keep everything tidy."*

Learner 13: *"I might combine a set of bake ware like pans and mixing bowls, into a single baking set to streamline my kitchen organization."*

Learner 14: *"Classifying my books by genre, like fiction, non-fiction and reference makes it simpler to find what l am looking for in shelf."*

Learner 16: *"I have a variety of different sports equipment, l might group them into Sets like balls, rackets for better organization."*

Learner 17: *"Sorting my craft supplies by medium such as paints and fabrics helps me stay on top of what l have available for my projects."*

Learner 19: "*l might combine my sets of winter accessories for easy access during colder months."*

Learner 20: *"When organizing my bathroom, l like to group items by function such as hygiene and skin care for easy access."*

Learner 21: *"When sorting my jewelry, l like to group watches and group of rings and necklaces to keep everything tidy."*

Learner 22: *"lf l have different types of electrical appliances, l might combine them to make organization easier."*

Learner 23: "*If l have lots of socks, l might group them into Sets like winter socks and summer socks to stay organized."*

Learner 25: *"Classifying my movies by genre, like fiction, non-fiction and reference makes it simpler to find what l am looking for in shelf."*

Learner 26: *"lf l have different types of skirts, l might combine them to make organization easier."*

Learner 27: *"Classifying my music by genre, like gospel, rhumba and soul makes it simpler to find what l am looking for in flush."*

Learner 29: *"lf l have different types of clothes, l might combine them to make organization easier."*

Learner 32: *"When organizing my meal, l like to group items by type such as lunch and supper for easy preparation."*

Learner 33: *"lf l have different types of tools, l might combine them to make organization easier."*

Learner 35: *"lf l have different types of discs, l might combine them to make organization easier."*

Learner 36: *"When organizing my food, l like to group items by nutrients such as fats and carbohydrates for easy access."*

Learner 38: "*If l have lots of clothes, l might group them into Sets like shirts, vests and trousers to stay organized."*

Learner 39: *"I might combine a set of shirts into a single set to organize my clothes."*

Learner 40: *"lf l have different types of shoes, l might combine them to make organization easier."*

Data from learners' questionnaires on key concepts showed that 28 learners mentioned grouping or classifying items by type or category. This concurs with the idea that real life problems can be solved by grouping them which is similar to grouping a set into subgroups (Cano et al, 2023).

Qualitative data from teachers' interviews on key mathematical concepts and skills embedded in rural learners' out-of-school related to sets.

Teachers' reactions key mathematical concepts and skills embedded in rural learners' out-of-school related to sets n=5

Representative quotes

Teacher 1: *"Classification is very important. Being able to identify the common attributes that define a set and sort them into appropriate groups is a fundamental skill. Once the learners grasp classification, we can dive deeper into concepts like membership."*

Teacher 2: *"The idea of subset and cardinality are absolutely crucial for learners to understand when working with Sets. Recognizing that one set can be contained within another is a subset is key. Being able to determine the cardinality is essential for counting and comparing sets."*

Teacher 3: *"The connections between classification, membership, subset and cardinality are what really allow learners to develop robust understanding of Sets. I find that starting with classification. How we group items based on shared characteristics provide a solid foundation. Then we can explore membership, looking at whether individual item belong to a given set. From there we can investigate subset relationships and set cardinality."*

Teacher 4: "In my opinion the four key concepts-classification, membership, subset and cardinality build on each other in a logical way. That is why l make sure to give equal emphasis to each of these ideas when teaching Sets."

Teacher 5: "Areas of classification, membership, subset and cardinality are essential for the learners to master the Sets. Classifying the objects is the foundation, then being able to determine set membership leads to understanding subsets and then cardinality."

Qualitative data from teachers' interview showed that all 5 teachers (100%) mentioned the importance of classification and grouping items by common attributes. This shows that grouping is the key concept embedded in learners' out-of-school context which can allow them to solve problems. This agrees with the idea that real life problems can be solved by grouping them which is similar to grouping a set into subgroups (Cano et al, 2023).

Qualitative data from learners' questionnaires on ways in which rural learners utilize set related concepts.

Learners' reactions on ways in which rural learners utilize set related concepts n=40

Representative quotes

Learner 1: *"In vegetable garden, l organize different crops into different sets based on their type like leafy green, herbs and root vegetables."*

Learner 3: *"Group my household into Sets like cleaning and toiletries makes it easier to find what l need."*

Learner 4: *"For my craft projects, l sort the materials into Sets by type like fabrics, paints and paper, so l can quickly access what l look."*

Learner 5: When doing laundry, l sort the dirty clothes into sets based on color, fabric and washing instructions to ensure everything gets cleaned properly."

Learner 6: *"In my personal budgeting, l categorize my expenses into sets to get a clear picture of my spending."*

Learner 7: *"On the farm, l group the different livestock into Sets by species like chickens, sheep and pigs to feed them."*

Learner 8: *"When cooking a complex dish, l will organize the ingredients in sets based on when they need to be added."*

Learner 9: *"I use sets based organization to keep my craft in order, grouping things like paints, fabrics and paper by type.*

Learner 11: *"At home l classify crops based on their growing season. For example summer crops and winter crops."*

Learner 12: *"In personal budget l categorize expenses to know where money is going each month."*

Learner 13: "*I sort ingredients based on their role when cooking."*

Learner 14: *"I use sets to organize and keep craft supplies neatly, for instance keeping by project materials or by use."*

Learner 15: *"Sorting laundry by fabric ensures that everything is washed properly."*

Learner 16: *"I group livestock into Sets by their feeding requirements."*

Learner 17: *"I categorize expenses into sets to know how much l spend in each category."*

Learner 18: "*When preparing a complex dish l organize recipes depending on how they add flavor."*

Learner 19: "*To keep craft materials well stocked, l organize materials into Sets."*

Learner 20: *"Dirty laundry will be cleaned properly after sorting them using color."*

Learner 21: *"To feed livestock properly we first group them for example road set of runner and set of broilers."*

Learner 22: "*l categorize expenses into sets for example entertainment, grocery and utilities to know my spending patterns."*

Learner 23: *"We organize craft materials properly into sets to store them"*

Learner 24: *"I group expenses into categories to know my spending."*

Learner 25: *"Dirty laundry will be cleaned properly after sorting them using color."*

Learner 26: *"I group livestock into Sets by their feeding requirements."*

Learner 27: "*When preparing a good meal organize recipes depending on how they add flavor."*

Learner 28: *"Dirty laundry will be cleaned properly after sorting them using color."*

Learner 29: "*When preparing a complex meal l organize recipes depending on how they add flavor."*

Learner 30: *"I group livestock into Sets by their feeding type."*

Learner 31: "*l categorize expenses into sets for example entertainment, grocery and utilities to know my spending patterns."*

Learner 32: *"I group livestock into Sets by their feeding requirements."*

Learner 33: "*l categorize expenses into sets for example entertainment, grocery and utilities to know my spending patterns."*

Learner 34: *"I group livestock into Sets by their feeding type."*

Learner 35: *"I group expenses into categories to know my spending."*

Learner 36: *"To know my spending patterns, l categorize expenses into subgroups or subsets."*

Learner 37: *"We organize craft materials properly into sets to store them"*

Learner 38: *"I group livestock into Sets by their feeding requirements."*

Learner 39: *"I group livestock into Sets by their feeding breed."*

Learner 40: *"I categorize expenses into subgroups or sets to know my spending."*

Qualitative data from learners' questionnaires suggested that 25 out of the 40 learners (62.5%) mentioned using sets to organize and classify different types of items, such as crops, ingredients, household items, craft supplies, and expenses. 11 out of the 40 learners (27.5%) specifically referenced using sets to organize laundry by factors like color, fabric, or washing instructions. 10 out of the 40 learners (25%) talked about using sets to categorize expenses and budgeting, in order to gain better visibility into their spending patterns. 9 out of the 40 learners (22.5%) mentioned using sets to organize and plan meals, by grouping ingredients into categories like starch, protein, and fats. 8 out of the 40 learners (20%) referenced using sets to organize livestock or farm animals, typically by species or feeding requirements. 7 out of the 40 learners (17.5%) described using sets to sort and store craft supplies and materials.

6 out of the 40 learners (15%) specifically talked about using sets when preparing complex dishes, to organize recipes and ingredients.

The data shows that learners apply the concept of grouping to solve real life problems involving cooking, crafting and budgeting. This agrees with the idea that real life problems can be solved by grouping them which is similar to grouping a set into subgroups (Cano et al, 2023).

Data from teachers' interview on ways in which rural learners utilize set related concepts.

Teachers' reactions on ways in which rural learners utilize set related concepts n=5

Representative quotes

Teacher 1: *"The way rural learners categorize and group their household items demonstrate grasp of set membership and classification."*

Teacher 2: *"Rural learners have ability to partition resources in dividing firewood, cooking and heating or carefully allocating their limited funds. They understanding of Sets which is crucial in effective resource management."*

Teacher 3: *"When budgeting, the rural learners that l teach exhibit an exceptional capacity for set-related concepts. I have observed them meticulously categorizing and organizing their food items, grouping them by type, in order to maximize their limited. This skill is crucial to leverage financial literacy."*

Teacher 4: *"The rural learners possess a natural talent for identifying relationships between sets of objects. In separating kitchen tools by function or grouping household items based on common features. They demonstrate a keen grasp of set membership that is truly impressive."*

Teacher 5: *"The way rural learners apply Sets partitioning to manage their time and labor exhibit a remarkable ability to break down into manageable subsets for allocating time for roles and childcare."*

Data from teachers' interview showed that all 5 teachers (100%) highlighted the rural learners' strong grasp of set-based organization and classification. 4 out of the 5 teachers (80%) specifically mentioned the learners' ability to effectively manage and allocate limited resources, such as finances, food items, and household items, using set-based thinking. 3 out of the 5 teachers (60%) noted the learners' talent for identifying relationships between sets of objects, such as categorizing kitchen tools by function or grouping household items by common features. 2 out of the 5 teachers (40%) described the learners' skill in applying set-based partitioning to effectively manage their time and labor, such as breaking down tasks into manageable subsets.

The teachers unanimously praised the rural learners' exceptional understanding and application of set-based concepts, which they deemed crucial for effective resource management, budgeting, and problem-solving in their daily lives. This agrees with the idea that real life problems can be solved by grouping them which is similar to grouping a set into subgroups (Cano et al, 2023).

Qualitative data from learners' interview on how rural learners' informal of Set-related ideas such as membership and cardinality manifest in their traditional games, puzzles and storytelling.

Learners' reactions on how rural learners' informal of Set-related ideas such as membership and cardinality manifest in their traditional games, puzzles and story-telling

Representative quotes

Learner 1: *"In one of my favorite storybooks, the main characters are all members of a specific animal set, like a family of bears or a group of mice."*

Learner 3. *"I love playing card games that involve grouping cards into suits or ranks, which is all about identifying set membership and relationships."*

Learner 5. *"When reading folktales, I often notice the way the characters and objects are grouped into sets, like the set of magical items or the set of wise elders."*

Learner 6. *"One of my favorite logic puzzles challenges me to classify a collection of shapes into various sets based on their number of sides or other geometric properties."*

Learner *8. "In traditional storytelling, the protagonists are usually part of a specific set, like a family or a community, and understanding their relationships is key to following the plot."*

Learner 11. *"I find it really satisfying to sort a collection of objects into sets based on their common features, like grouping shells by their shape or texture."*

Learner 13. *"When playing classic word games, I have to think about how the letters in a word can be grouped into sets, like vowels and consonants, to form new words."*

Learner 14. *"One of my favorite puzzles involves classifying a set of shapes into different categories based on their number of sides or other geometric properties."*

Learner 15. *"I really enjoy traditional storytelling that features characters or objects grouped into sets, like the set of royal siblings or the set of mythical beasts."*

Learner 17. *"When reading folktales, I often notice the way the characters and objects are grouped into sets, like the set of magical helpers or the set of enchanted items."*

Learner 18. *"I find it really satisfying to sort a collection of objects into sets based on their common features, like grouping leaves by their shapes or sizes."*

Learner 20. *"One of my favorite logic puzzles challenges me to classify a collection of shapes into various sets based on their geometric properties, like the set of triangles or the set of symmetrical shapes.*

Learner 22: "*The nhodo game is so interesting whereby stones are partitioned into subsets of players who are playing"*

Learner 23: *"I really enjoy traditional storytelling that features characters or objects grouped into sets, like the set of royal siblings or the set of mythical beasts."*

Learner 27: *"I really enjoy traditional storytelling that features characters or objects grouped into sets, like the set of wild animals or the set of trees."*

Learner 30: *"Puzzles refresh the mind by sorting pieces to their respective sets to solve the puzzle."*

Learner 33: *"l enjoy playing puzzle when l make use of subsets of my pieces depending on color when solving the puzzle."*

Learner 36: *"Logic puzzles challenges me to classify a collection of shapes into various sets based on their geometric properties, like the set of triangles or the set of symmetrical shapes."*

Learner 37: *"Puzzles are really enjoyable because we make use of elements of same color to solve them"*

From learners' interview data, many learners enjoy stories, games, and puzzles that involve grouping or categorizing elements into sets based on common attributes or relationships. This was mentioned by 19 out of the 40 learners. This shows that grouping is important when solving puzzles, games and in storytelling. This concurs with the idea that partitioning tasks into different categories or subsets can help to make comparisons between data (Vos, 2018).

2. Partitioning and Division

Learners show an intuitive understanding of partitioning and dividing household resources, spaces, and items when managing their living environments and budgeting. This relates to mathematical ideas around part-whole relationships, fractions, and proportional reasoning. Teachers note how learners' partitioning of resources aligns with set theory concepts like cardinality and subsets.

Data from teachers interviews on quantitative data. On a scale of 1-5 (1 = Rarely Observed, 2 = Occasionally Observed, 3 = Sometimes Observed, 4 = Often Observed, 5 = Frequently Observed, the average ratings of common mathematical practices and concepts utilized by rural learners in their out-of-school activities.

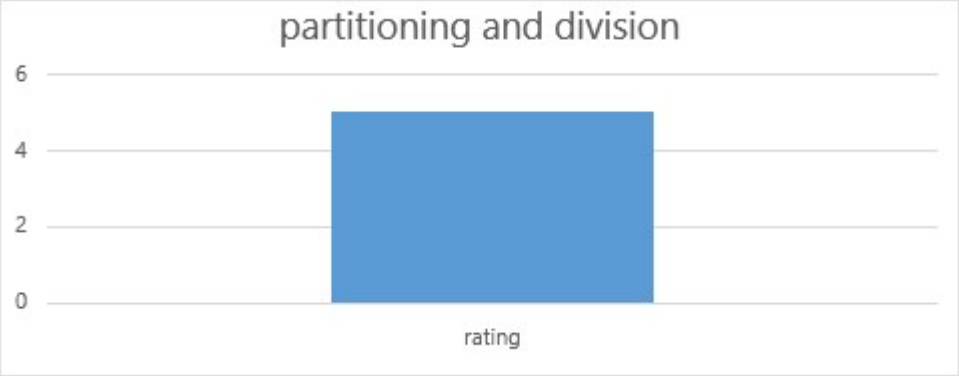


Table 4.3

Quantitative data from teachers' interview shows that mathematical practices and concepts of partitioning and division have the rating of 5. All teachers (5) said learners utilize set-related concepts like grouping and classification in household budgeting. This concurs with idea that Set theory has numerous practical applications particularly in fields like computer science, logic, probability, statistics and linguistics. (Zhang, 2023).

Quantitative data from learners' interview

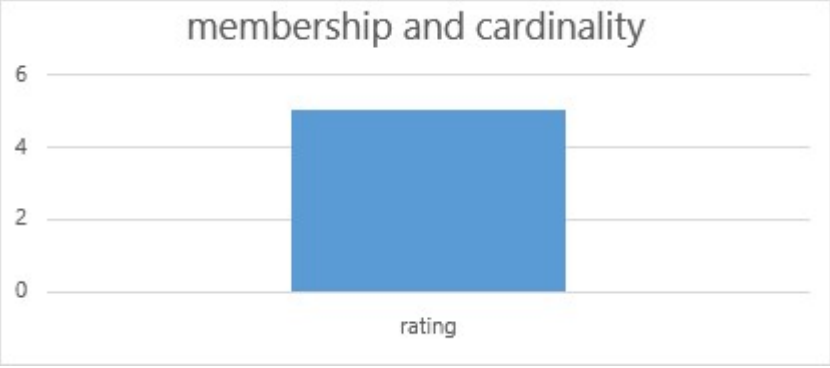


Table 4.4

25 learners said they use partitioning in their out of school contexts.

Qualitative data from learners' interview on common mathematical practices and concepts utilized by rural learners in their out-of-school activities.

Learners' reactions on common mathematical practices and concepts utilized by rural learners in their out-of-school activities n=40

Representative quotes

Learner 15: "*When washing clothes we sort clothes separately depending on color"*

Learners 17: "*When playing traditional games we sort objects into categories."*

Learner 18: "*When l do laundry l sort the clothes into different piles.*"

Learners 21: "*In our household, we always group and divide crops for storage and use"*

Learner 34: *"when farming, we divide crops into groups depending on type."*

Learner 40: *"when storing grain we divide crops into categories."*

6 learners (15%) talked about grouping and dividing up items like kitchen supplies, school materials, and toys to keep them organized.

Qualitative data from learners' interview on common mathematical practices and concepts utilized by rural learners in their out-of-school activities.

Learners' reactions on common mathematical practices and concepts utilized by rural learners in their out-of-school activities n=40

Representative quotes

Learners 4: "*In our household, we always group and divide different properties, school materials and toys to quickly find what we need."*

Learner 8: "*Our system of grouping and dividing up household items is so efficient because everyone knows where to find what they need since everything has its own place.*"

Learner 14: "*At home, we always group furniture and groceries.*"

Learners 21: "*In our household, we always group and divide crops for storage and use"*

Learners 35: "*In our household, we always group and divide crops for storage and use"*

Learner 39: "*Grouping household items is so crucial to put items in order.*"

9 learners mentioned the importance of grouping and dividing up household items, such as kitchen supplies, school materials, toys, furniture, and crops. 8 learners discussed traditional games that involve sorting and categorizing different objects. These games were described as challenging but fun ways to practice sorting and grouping skills. The main reasons cited were to quickly find what is needed and to keep everything in order. This agrees with idea that Set theory has numerous practical applications particularly in fields like computer science, logic, probability, statistics and linguistics. (Zhang, 2023).

Qualitative data from leaners' questionnaire on common mathematical practices and concepts utilized by rural learners in their out-of-school activities.

Learners' reactions on common mathematical practices and concepts utilized by rural learners in their out-of-school activities n=40

Representative quotes

Learner 6: *"One of my favorite traditional games is where we have to sort different objects into categories. It is really challenging, but it is funny to see how things are related*"

Learner 7: "*The traditional games we play often involve sorting and categorizing different objects."*

Learner 13: *"In traditional games we sort items into categories.*"

Learners 17: "*When playing traditional games we sort objects into categories."*

Learner 20: "*In traditional games we sort different objects into groups."*

Learner 30: *"In traditional games we sort items into groups*."

Learners 34: "*When playing traditional games we sort objects into different categories."*

Learner 38: "*The traditional games like tsoro we play involve sorting and categorizing different objects."*

8 learners discussed traditional games that involve sorting and categorizing different objects. These games were described as challenging but fun ways to practice sorting and grouping skills. This agrees with idea that Set theory has numerous practical applications particularly in fields like computer science, logic, probability, statistics and linguistics. (Zhang, 2023).

Qualitative data from learners' questionnaire on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum.

Learners' reactions on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum n=40

Representative quotes

Learner 3: *"We partition houses into rooms so that boys cannot sleep with girls"*

Learner 7: *"Partitioning household items based on their uses is how we use mathematics at home"*

Learner 24: "*partitioning and dividing our belongings helps to distribute resources between family members*"

Learner 30: *"Partitioning tomatoes into categories based on how ripe they are helps when storing them"*

Learner 32: "*partitioning and dividing food helps to distribute resources among household members*"

Learner 35: *"Partitioning work among family members involves mathematics thinking"*

Learner 38: "*Sharing food among family members involves partitioning.*"

7 learners mentioned partitioning as a skill they use at home. They indicated that they use partitioning to share food and resources amongst family members. This concurs with the fact that Set theory has numerous practical applications particularly in fields like computer science, logic, probability, statistics and linguistics. (Zhang, 2023).

Qualitative data from learners' questionnaire on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum.

Learners' reactions on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum n=40

Representative quotes

Learner 3: *"Partitioning household items involves mathematics thinking"*

Learner 7: *"Partitioning household items involves mathematics thinking"*

Learner 24: "*partitioning and dividing our belongings helps to distribute resources between family members*

"

Learner 30: *"Partitioning household items involves mathematics thinking"*

Learner 32: "*partitioning and dividing food helps to distribute resources among household members*"

Learner 35: *"Partitioning household items involves mathematics thinking"*

Learner 38: "*To share food among family members involves partitioning.*"

Qualitative data from learners' questionnaire on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum.

Data from learners' interview on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum

Learners' reactions on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum n=40

Representative quotes

Learner 3: "*Partitioning household items involves grouping*."

Learner 21: "*To partition items we use grouping."*

Learner 24: "*To partition clothes based on color when washing we use grouping."*

Learner 29: "*To partition clothes based its use we use grouping."*

Learner 31: *"To separate rooms we use partitioning"*

Learner 32: "*To separate fruits from vegetables we use partitioning."*

Learner 34: *"To separate dining from bedroom we use partitioning"*

7 learners discussed using categorization/grouping/classification to organize and partition household items, clothing, livestock, and other belongings. This agrees with idea that Set theory has numerous practical applications particularly in fields like computer science, logic, probability, statistics and linguistics. (Zhang, 2023).

Qualitative data from teachers' interview showed that partitioning is very important in everyday activities.

Teachers' reactions on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum n=5

Representative quotes

Teacher 5: "*partitioning resources when sharing and organize their living spaces map closely with Sets"*

1 out of 5 teachers (20%) discussed how learners' partitioning of resources when sharing and organizing living spaces relates to set theory. This agrees with idea that Set theory has numerous practical applications particularly in fields like computer science, logic, probability, statistics and linguistics. (Zhang, 2023).

Qualitative data from learners' interview on key mathematical concepts and skills embedded in rural learners' out-of-school related to sets.

Learners' reactions on key mathematical concepts and skills embedded in rural learners' out-of-school related to sets n=40

Representative quotes

Learner 3: *"Partitioning rooms in house helps to effectively allocate resources for different activities."*

Learner 8: "*Partitioning house for easy management."*

Learner 13: "*Partitioning rooms in my house allows me to designate specific areas for different activities like studying and entertainment."*

Learner 18: "*Partitioning house into different zones allows me to better allocate my time and energy when completing household tasks."*

4 out of 40 learners (10%) discussed how partitioning their house or rooms allows them to better manage and allocate resources. They partition items for household tasks, management, study and entertainment.

This concurs with fact that Set theory has numerous practical applications particularly in fields like computer science, logic, probability, statistics and linguistics. (Zhang, 2023).

Qualitative data from learners' questionnaires on ways in which rural learners utilize set related concepts.

Learners' reactions on ways in which rural learners utilize set related concepts n=40

Representative quotes

Learner 2: *"When planning my meal l like to divide ingredients into subgroups of ingredients for example starch, protein and fats."*

Learner 10: *"Dividing my household tasks into sets like cleaning laundry and meal prep, helps me stay on top of everything."*

The learners indicated that they divide ingredients when planning to cook as well as dividing household tasks. Dividing ingredients is very crucial when planning to cook. This agrees with the idea that mathematical concepts, such as measurement conversions, fractions and proportions are crucial in culinary endeavors specifically in recipe preparation (Rao, 2023).

Qualitative data from learners' interview on how rural learners' informal of Set-related ideas such as membership and cardinality manifest in their traditional games, puzzles and story-telling.

Learners' reactions on how rural learners' informal of Set-related ideas such as membership and cardinality manifest in their traditional games, puzzles and story-telling

Representative quotes

Learner *4. "In a classic board game, the game pieces are divided into different colored sets, and part of the strategy is understanding how many pieces are in each set."*

Learner 10. *"One of my favorite board games has us divide the game pieces into different sets based on their attributes, like size or color, to strategize our moves."*

Learner 16. *"In a classic board game, the game pieces are divided into different colored sets, and part of the strategy is understanding the cardinality, or number, of each set."*

Learner 19. *"In traditional card games, the cards are often divided into different suits or ranks, which is all about identifying set membership and relationships."*

Learner 24: *"In traditional card games, the cards are often divided into different suits or ranks, which is all about identifying set membership and relationships."*

Learner 29: “Nhodo game is enjoyable when we divide stones into subsets of players who play the game and we move stones to different positions when playing.”

Learner 35: *"In traditional card games, the cards are often divided into different suits or ranks, which is all about identifying set membership and relationships."*

Learner 38: *"In traditional card games, the cards are often divided into different suits like shrubs and spades, which similar to identifying set membership."*

Traditional games like draughts/checkers and nhodo, which involve dividing game pieces into subsets were mentioned by 8 learners. This shows that learners use partitioning to play games. This agrees with idea that Set theory has numerous practical applications particularly in fields like computer science, logic, probability, statistics and linguistics. (Zhang, 2023).

3. Counting and Cardinality

Learners frequently use counting skills in their out-of-school activities, such as keeping track of household items, livestock, and harvest yields. This directly connects to the mathematical concept of cardinality, understanding the number of elements in a set.

Table 4.5

Quantitative data from teachers' interview shows the average response for demonstrating understanding of set-related concepts like counting and cardinality is 5 out of 5 indicating "very frequent" usage. This shows that counting is very important in their real life. This agrees with idea that engaging students in hands-on, play-based math activities, like grouping, counting, and exploring patterns, can deepen their understanding of mathematical concepts (Anwer, 2019).

Quantitative data from learners' interview

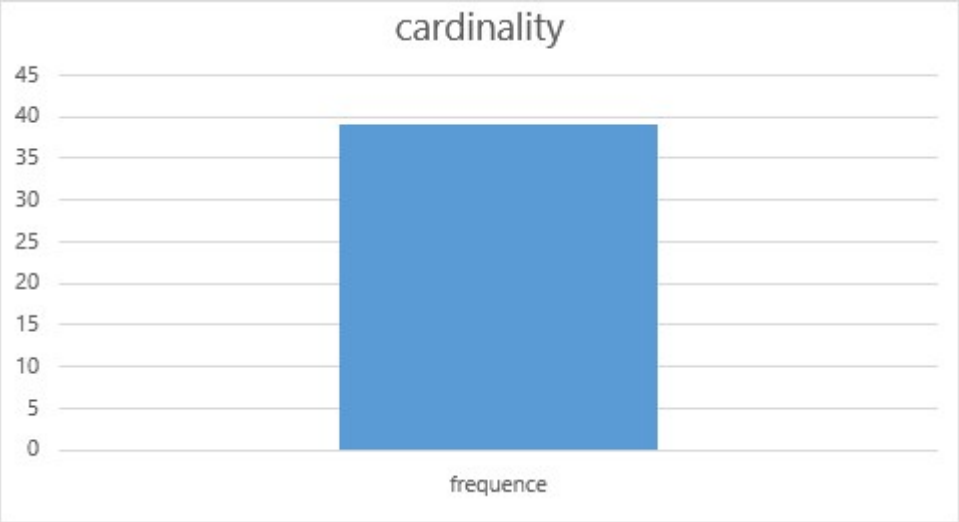


Table 4.6

The data showed that 39 learners use counting and cardinality concepts in their everyday lives. This shows that counting and cardinality is frequently used in their daily activities. This agrees with idea that Set theory has numerous practical applications particularly in fields like computer science, logic, probability, statistics and linguistics. (Zhang, 2023).

Teachers' reactions on common mathematical practices and concepts utilized by rural learners in their out-of-school activities n=5

Representative's quotes

Teacher 1: "*Our rural are constantly applying mathematical skills and concepts in their everyday lives, often without realizing it. Whether they are counting livestock, measuring farm plots, or tracking harvest yields, they are engaging in important numeracy practices.*"

Teacher 2: "*When our learners are managing household finances and budgeting resources, they are demonstrating a deep understanding of set-related ideas like grouping, classification and cardinality.*"

Teacher 3: "*One of the most impressive things l have noticed is how rural learners utilize set-related ideas like grouping, membership and cardinality in their traditional games, puzzles and storytelling. The spatial reasoning and logical thinking in activities like construction and organizing crops is incredibly valuable mathematical practice*."

Teacher 4: "*In building shelters, organizing their living spaces or sharing resources, our learners are constantly demonstrating an intuitive grasp of spatial concepts and set operations like union and intersection*."

Teacher 5: "*Rural learners demonstrate understanding of set-related ideas like membership in traditional games and storytelling*."

Qualitative data from teachers' interview show that learners demonstrating understanding of set-related concepts like counting and cardinality in planning, budgeting and playing games. This shows that they have a deep understanding of Sets and can apply them in games and other household activities. This agrees with idea that engaging students in hands-on, play-based math activities, like grouping, counting, and exploring patterns, can deepen their understanding of mathematical concepts (Anwer, 2019).

Table 4.7

3 teachers recognize the link between learners' real-world counting practices and the set theory learning objectives around cardinality. This shows that learners use cardinality in real life situations to solve problems and to make decisions using statistics. This agrees with idea that learners can use Mathematics concepts to count, group and identify patterns and apply spatial reasoning (Anwer, 2019).

Qualitative data from leaners' questionnaire on common mathematical practices and concepts utilized by rural learners in their out-of-school activities.

Learners' reactions on common mathematical practices and concepts utilized by rural learners in their out-of-school activities n=40

Representative quotes

Learners 5: "*When l am sorting laundry, l count number of items in each pile to know if anything is missing."*

Learners 22: "*When we wash clothes we number items in each pile to know if anything is dirty or clean."*

2 learners (5 and 22) mentioned counting items in each pile to ensure nothing is missing. This shows that learners use counting to solve household problems. This concurs with fact that learners can use Mathematics concepts to count, group and identify patterns and apply spatial reasoning (Anwer, 2019).

Qualitative data from learners' questionnaire on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum.

Learners' reactions on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum n=40

Representative quotes

Learner 1: "*l use mathematics at home to count the number of household items l have*."

Learner 4: "*l use mathematics at home to count the number of goods that l have*."

Learner 5: "*Counting is crucial to keep tracking of what we have*."

Learner 9: "*Counting is very important to record our property*"

Learner 10: "*l use mathematics at home to count the number of household items l have*."

Learner 11: "*Counting is crucial to keep tracking of the livestock*."

Learner 12: "*l use mathematics at home to count the number of household items l have*."

Learner 13: "To count number of puppies in the kennel we use mathematics."

Learner 16: "*Counting is crucial to keep tracking of our grocery in stock*."

Learner 17: "*l use mathematics at home to count the number of household items l have*."

Learner 18: "When playing traditional games like tsoro we use counting."

Learner 21: "*To play traditional game like nhodo we use counting"*

Learner 22: "*To count number of clothes in wardrobe l use mathematics*"

Learner 23: "*l use mathematics at home to count the number of household items l have*."

Learner 25: "*l use mathematics at home to count the number chicken in the field run*."

Learner 31: "*I use mathematics at home to count the number of plates in the kitchen*."

Learner 34: "*l use mathematics at home to count the number of household items l have*."

Learner 39: "*Counting is the skill we use in tallying number of books in shelf*."

Qualitative data from learners' questionnaire show that 18 learners mentioned using mathematics to count household items. They use the counting to determine number of livestock, domestic pets, kitchen utensils, clothes and books. That can allow them to have a record of their possessions. This agrees with idea that learners can use Mathematics concepts to count, group and identify patterns and apply spatial reasoning (Anwer, 2019).

Qualitative data from learners' questionnaire on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum.

Learners' reactions on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum n=40

Representative quotes

Learner 1: "*l use mathematics at home to count the number of household items l have*."

Learner 4: "*l use mathematics at home to count the number of household items l have*."

Learner 5: "*Counting is crucial to keep tracking of what we have*."

Learner 9: "*Counting is very important to record our property*"

Learner 10: "*l use mathematics at home to count the number of household items l have*."

Learner 11: "*Counting is crucial to keep tracking of the livestock*."

Learner 12: "*l use mathematics at home to count the number of household items l have*."

Learner 13: "To count number of puppies in the kennel we use mathematics."

Learner 16: "*Counting is crucial to keep tracking of our grocery usage*."

Learner 17: "*l use mathematics at home to count the number of household items l have*."

Learner 18: "When playing traditional games like tsoro we use counting."

Learner 21: "*To play traditional game like nhodo we use counting"*

Learner 22: "*To count number of clothes in wardrobe l use mathematics*"

Learner 23: "*l use mathematics at home to count the number of household items l have*."

Learner 25: "*l use mathematics at home to count the number chicken in the field run*."

Learner 31: "*l use mathematics at home to count the number of plates in the kitchen*."

Learner 34: "*l use mathematics at home to count the number of household items l have*."

Learner 37: "*l use mathematics at home to count the number of household items l have*."

Learner 39: "*Counting is the skill we use in tallying number of books in shelf*."

19 learners said they use mathematics for counting in their everyday activities. Most of them mentioned they count to keep a track of spending and for stock tacking.

Data from learners' interview on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum

Learners' reactions on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum n=40

Representative quotes

Learner 1: *"l use Mathematics to count the number of clothes in my closet."*

Learner 4: "*Counting is crucial to verify the grocery used and that which is left*."

Learner 5: *"l use Mathematics to count the number of dishes in the kitchen."*

Learner 6: "*We use counting to calculate the money in the purse*."

Learner 8: "*To determine the quantity of meat in refrigerator we use counting*."

Learner 9: "*We use counting to calculate the money in the wallet*."

Learner 10: *"l use Mathematics to count the stock of fruits in the refrigerator."*

Learner 15: "*To take stock of grain in storage we use counting*."

Learner 18: "*To take stock of grocery in the pantry we use counting*."

Learner 19: *"To calculate items on a receipt we use counting."*

Learner 20: "*To calculate number of plates on an electric stove we use counting."*

Learner 40: *"l use Mathematics to count the number of clothes in my closet."*

From learners' interview 12 learners mentioned using mathematics counting to keep track of household items like clothes, dishes, groceries, fruits and meat. Household items can be managed through use of

counting. This concurs with fact that learners can use Mathematics concepts to count, group and identify patterns and apply spatial reasoning (Anwer, 2019).

Teachers' reactions on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum n=5

Representative quotes

Teacher 1: "*The way learners group and classify household items, partition resources and use spatial reasoning are directly related to Sets union, intersection and cardinality.*

The teacher mentioned the importance cardinality concept is used when classifying, partitioning and reasoning.

Qualitative data from teachers' interviews showed that partitioning resources is similar to Sets.

Teachers' reactions on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum n=5

Representative quotes

Teacher 5: "*partitioning resources when sharing and organize their living spaces map closely with Sets"*

1 out of 5 teachers (20%) discussed how learners' partitioning of resources when sharing and organizing living spaces relates to set theory.

Qualitative data from learners' interview on key mathematical concepts and skills embedded in rural learners' out-of-school related to sets.

Learners' reactions on key mathematical concepts and skills embedded in rural learners' out-of-school related to sets n=40

Representative quotes

Learner 5: “*Counting the number of items in each room, or the set cardinality helps me keep track of my household possessions.”*

Learner 15: “*Counting number of items in each room helps in stocktaking.”*

Learner 24: “*Counting the number of items in each room, or the set cardinality helps me keep track of my household possessions.”*

Learner 26: “*Counting number of items in each room helps in stocktaking.”*

Learner 29: “*Counting the number of items in each room, or the set cardinality helps me keep track of my household possessions.”*

Learner 34: “*Counting number of items in each room helps in stocktaking.”*

Learner 38: “*Counting the number of items in each room, or the set cardinality helps me keep track of my household possessions.”*

7 out of 40 learners (17.5%) mentioned counting the number of items in each room or space, relating this to the concept of set cardinality. Learners use counting to solve household issues. This aligns with idea that learners can use Mathematics concepts to count, group and identify patterns and apply spatial reasoning (Anwer, 2019).

Qualitative data from learners’ questionnaires on key mathematical concepts and skills embedded in rural learners’ out-of-school related to sets.

Learners’ reactions on key mathematical concepts and skills embedded in rural learners’ out-of-school related to sets n=40

Representative quotes

Learner 2: “*Counting the number of items in each group, help me keep track of my possessions.”*

Learner 5: “*Knowing quantity of items in the pantry helps me plan my grocery shopping.”*

Learner 8: *"Counting the number of items in each group help me to track my inventory and identify gaps."*

Learner 12: *"Knowing the Set cardinality helps me maintain a well-stocked supply and avoid running out unexpectedly."*

Learner 15: "*Counting number of items in each Set allows me to keep stock of my belongings."*

Learner 18: *"Knowing quantity of items in my fridge helps me to plan my meal."*

Learner 24: *"Counting the number of cattle in my herd help me to track the missing beast."*

Learner 28: *"Counting the number of chicken in each fowl run p help me to identify an increase or decrease"*

Learner 30: *"Knowing quantity of items in my wardrobe helps me to plan my dressing."*

Learner 31: *"Counting the number of clothes in my wardrobe help me to track the missing"*

Learner 34: *"Knowing quantity of money in my pocket helps me to plan my journey."*

Learner 37: *"Knowing quantity of items in my pantry helps me to plan my meal."*

12 learners mentioned counting or knowing the quantity of items in each group or set. The learners apply the concept of counting for planning and tracking the missing objects which can enable them to make a decision. This concurs with fact that learners can use Mathematics concepts to count, group and identify patterns and apply spatial reasoning (Anwer, 2019).

Qualitative data from teachers' interviews on key mathematical concepts and skills embedded in rural learners' out-of-school related to sets.

Teachers' reactions key mathematical concepts and skills embedded in rural learners' out-of-school related to sets n=5

Representative quotes

Teacher 2: *"The idea of subset and cardinality are absolutely crucial for learners to understand when working with Sets. Recognizing that one set can be contained within another is a subset is key. Being able to determine the cardinality is essential for counting and comparing sets."*

Teacher 3: *"The connections between classification, membership, subset and cardinality are what really allow learners to develop robust understanding of Sets. I find that starting with classification. How we group items based on shared characteristics provide a solid foundation. Then we can explore membership, looking at whether individual item belong to a given set. From there we can investigate subset relationships and set cardinality."*

Teacher 4: "In my opinion the four key concepts-classification, membership, subset and cardinality build on each other in a logical way. That is why l make sure to give equal emphasis to each of these ideas when teaching Sets."

Teacher 5: "Areas of classification, membership, subset and cardinality are essential for the learners to master the Sets. Classifying the objects is the foundation, then being able to determine set membership leads to understanding subsets and then cardinality."

4 out of the 5 teachers (80%) specifically highlighted the concepts of subset and cardinality as crucial for learners to understand when working with sets. This shows that counting is very useful in everyday life. This agrees with idea that Set theory has numerous practical applications particularly in fields like computer science, logic, probability, statistics and linguistics. (Zhang, 2023).

4. Spatial Reasoning and Logical Thinking

Learners demonstrate strong spatial reasoning and logical thinking abilities in activities like building shelters, organizing living spaces, and playing traditional games. These skills are important mathematical practices that underlie concepts like patterns, relationships, and problem-solving.

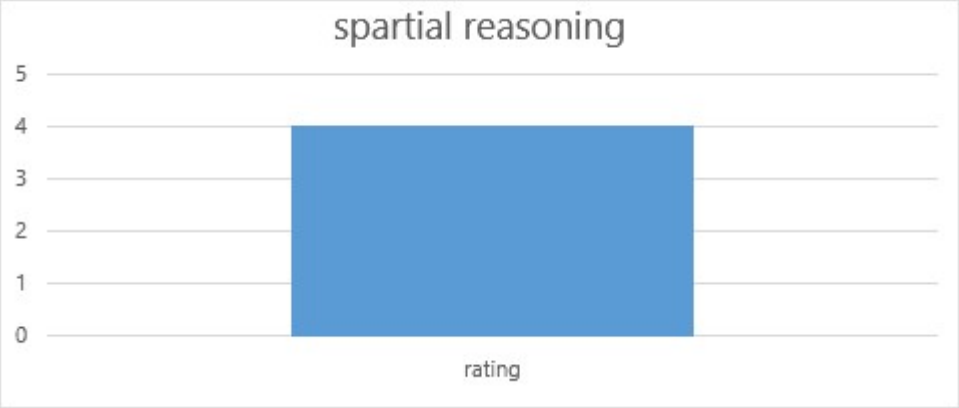


Table 4.8

Quantitative data from teachers' interviews showed spatial reasoning has rating of 4 which shows they are often observed in rural learners out of school activities. This shows that spatial reasoning is applied by learners to solve problems. This concurs with the statement that logic studies patterns and principles of valid reasoning and argumentation (Devlin, 2018).

Qualitative data from teachers' interviews showed one teacher said learners use sets for spatial reasoning and logical thinking.

Teachers' reactions on common mathematical practices and concepts utilized by rural learners in their out-of-school activities n=5

Representative's quotes

Teacher 3: "*The spatial reasoning and logical thinking in activities like construction and organizing crops is incredibly valuable mathematical practice*."

Teachers highlight how learners' spatial and logical thinking align with key mathematical learning goals. The learners use logic in construction and farming activities. This concurs with fact that learners can use Mathematics concepts to count, group and identify patterns and apply spatial reasoning (Anwer, 2019).

Qualitative data from learners' questionnaire on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum.

Learners' reactions on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum n=40

Representative quotes

Learner 8: *"To arrange property at home, l make use of logic."*

Learner 14: *"When preparing budgets, l use logical concept of Sets."*

Learner 27: "*l use logic to store goods at home."*

Learner 33: "*l use logic to arrange furniture at home."*

Learner 36: "*l use logic to manage goods at home."*

5 leaners mentioned using logic in their everyday activities to prepare budget, arrange property. They are applying logic to make decisions on household budgeting, arranging furniture and storing goods. This concurs with fact that learners can use Mathematics concepts to count, group and identify patterns and apply spatial reasoning (Anwer, 2019).

Data from learners' interview on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum

Learners' reactions on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum n=40

Representative quotes

Learner 11: "*Logic is crucial to solve problems."*

Learner 13: "*Logic is used to make good decisions."*

Learner 17: "*To solve life problems we use logic."*

Learner 30: "*Problems can be solved by applying logic.*"

Learner 38: "*Logic enables problems to be solved amicably.*"

5 learners mentioned using logic to solve problems and make decisions. They are using logic to find real solutions to their everyday problems. This agrees with idea that Set theory has numerous practical applications particularly in fields like computer science, logic, probability, statistics and linguistics. (Zhang, 2023).

Qualitative data from teachers' interview showed that learners apply logic to solve problems.

Teachers' reactions on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum n=5

Representative quotes

Teacher 2: "*The logical reasoning skills that learners apply to solve problems involving Sets, such as determining the relative size of livestock population in different fields are incredibly valuable."*

1 out of 5 teachers (20%) discussed how the logical reasoning skills applied by learners in household tasks relate to solving problems involving sets. Learners are applying logic to solve household problems involving farming. This concurs with fact that learners can use Mathematics concepts to count, group and identify patterns and apply spatial reasoning (Anwer, 2019).

Qualitative data from learners' interview on how rural learners' informal of Set-related ideas such as membership and cardinality manifest in their traditional games, puzzles and story-telling.

Learners' reactions on how rural learners' informal of Set-related ideas such as membership and cardinality manifest in their traditional games, puzzles and story-telling

Learner 6. *"One of my favorite logic puzzles challenges me to classify a collection of shapes into various sets based on their number of sides or other geometric properties."*

Learner 9. *"When playing classic memory games, I have to carefully observe the sets of matching symbols or images in order to successfully find and remember their locations."*

Learner 21: *"I find jigsaw puzzles really interesting because l analyze the shapes and patterns of the pieces to determine which set they belong to in order to complete the picture."*

Learner 25: *"Draughts game is so interesting when we apply logic to capture the opponent."*

Learner 26: *"Through the use of logic the game of draughts allows me to capture my opponent which is very interesting."*

Learner 28: *"The draughts game is so interesting because we use two different sets of pieces and we apply logic to attack the opponent's elements."*

Learner 31: *"We refresh our minds by playing draughts when players try to reduce elements of the opponents."*

Learner 34: "*l love to apply logic when playing traditional games like tsoro."*

Learner 37: *"Puzzles are really enjoyable because we make use of elements of same color to solve them"*

Learner 39: *"Jigsaw puzzles are very interesting because they require me to analyze the shapes and patterns of the pieces to determine which set they belong to in order to complete the picture."*

Learner 40: *"In traditional fairy tales, the magical items or enchanted creatures often belong to specific sets, and understanding those relationships is important for following the story."*

Logic puzzles that challenge learners to classify collections of shapes or objects into various sets based on geometric or other properties were mentioned by 7 learners. Jigsaw puzzles, where analyzing the shapes and patterns of pieces to determine set membership is important, were mentioned by 5 learners. These puzzles require logic to be classified and analyzed when solving them. This agrees with idea that Set theory has numerous practical applications particularly in fields like computer science, logic, probability, statistics and linguistics. (Zhang, 2023).

5. Intuitive understanding of Set-related concepts

The teachers emphasize that the rural learners demonstrate an incredible grasp or "innate understanding" of set-related concepts through their traditional games and activities. Examples include learners organizing stones by color, displaying an intuitive ability to recognize sets and set relationships, and exhibiting a "deep, almost instinctual understanding of foundational mathematical ideas" related to sets.

Qualitative data from teachers' interviews showed one teacher said learners demonstrate intuitive grasp of Sets concepts.

Teachers' reactions on common mathematical practices and concepts utilized by rural learners in their out-of-school activities n=5

Representative's quotes

Teacher 4: "*In building shelters, organizing their living spaces or sharing resources, our learners are constantly demonstrating an intuitive grasp of spatial concepts and set operations like union and intersection*."

The data suggests that the rural learners have a strong, intuitive understanding of set-based organization, classification, and reasoning, which represents a valuable asset that can be leveraged in their education.

This concurs with fact that Set theory has numerous practical applications particularly in fields like computer science, logic, probability, statistics and linguistics. (Zhang, 2023).

Qualitative data from teachers' interview showed that learners apply familiarity with Sets to formulate smaller groups from larger groups when solving problems.

Teachers' reactions on how these out-of-school mathematical practices and concepts be mapped to the learning objectives and content of the Sets topic in the curriculum n=5

Representative quotes

Teacher 4: "*Familiarity with concepts like subset and superset is similar to recognizing subsets from universal sets for example tea spoon is a subset of larger cutlery set."*

1 out of 5 teachers (20%) discussed how the logical reasoning skills applied by learners in household tasks relate to solving problems involving sets.

Qualitative data from learners' interview on key mathematical concepts and skills embedded in rural learners' out-of-school related to sets.

Learners' reactions on key mathematical concepts and skills embedded in rural learners' out-of-school related to sets n=40

Representative quotes

Learner 4: "*Understanding which items belong in each room is important for maintaining order and ensuring everything has a designated place."*

Learner 14: "*Understanding which utensil belong in each category in kitchen is important for maintaining sense of order in the house."*

Learner 19: *"Knowing which items is needed by customers is crucial in business."*

Learner 33: “*Understanding which colour code belong in each socket is important for fixing electrical appliances.”*

Learner 35: *“Knowing which clothing is needed by is crucial for an occasion.”*

Learner 36: “*Understanding which colour code belong in each socket is important for fixing electrical appliances.”*

6 out of 40 learners (15%) highlighted the importance of understanding which items belong in each room or space for maintaining order and organization. When putting order and organizing household items there is involvement of Sets. This concurs with the idea that Set theory concepts are used in everyday organization, like sorting kitchen items, clothes, and jewelry. (Offorma, 2016).

Qualitative data from learners’ interview on how rural learners’ informal of Set-related ideas such as membership and cardinality manifest in their traditional games, puzzles and story-telling.

Learners’ reactions on how rural learners’ informal of Set-related ideas such as membership and cardinality manifest in their traditional games, puzzles and story-telling

Representative quotes

Learner *4. "In a classic board game, the game pieces are divided into different colored sets, and part of the strategy is understanding how many pieces are in each set."*

Learner *8. "In traditional storytelling, the protagonists are usually part of a specific set, like a family or a community, and understanding their relationships is key to following the plot."*

Learner 12. *"In traditional fairy tales, the magical items or enchanted creatures often belong to specific sets, and understanding those relationships is important for following the story."*

Learner 16. *"In a classic board game, the game pieces are divided into different colored sets, and part of the strategy is understanding the cardinality, or number, of each set."*

Learner 32: *"In traditional fairy tales, the items often belong to specific sets, and understanding those relationships is important for following the story."*

Learner 40: *"In traditional fairy tales, the magical items or enchanted creatures often belong to specific sets, and understanding those relationships is important for following the story."*

6 learners said they use set related ideas in classic board games and in traditional fairy tales.

Qualitative data from teachers' interview on how rural learners' informal of Set-related ideas such as membership and cardinality manifest in their traditional games, puzzles and story-telling. This concurs with idea that Set theory has numerous practical applications particularly in fields like computer science, logic, probability, statistics and linguistics. (Zhang, 2023).

Teachers' reactions on how rural learners' informal of Set-related ideas such as membership and cardinality manifest in their traditional games, puzzles and story-telling

Representative quotes

Teacher 1: "I have been really impressed by the way rural learners demonstrate an innate understanding of set-related concepts through their traditional games and activities. In one game I observed, the learners were collecting stones of different colors, and they were able to intuitively grasp the idea of sets and subset relationships. They could easily recognize patterns, organize the stones into groups based on their attributes, and understand the hierarchical relationships between the different collections."

Teacher 2: "What I find most fascinating is how rural learners' engagement with traditional storytelling and games seems to cultivate this robust, intuitive understanding of set-related ideas like membership and cardinality. Even without formal mathematical instruction, these learners display an innate ability to recognize sets, identify their members, and reason about the relationships between different sets."

Teacher 3: "Rural learners demonstrate an incredible grasp of set-related concepts through their traditional games and activities. For example, in one game where they collect stones of different colors,

they're not just randomly accumulating objects - they're actively organizing them into sets and reasoning about the subset relationships. This suggests a deep, almost instinctual understanding of foundational mathematical ideas. I think tapping into this existing knowledge is crucial for designing learning experiences that are meaningful and empowering for rural learners."

Teacher 4: "I was really struck by the learners' ability to comprehend the hierarchical relationships between sets and subsets. This speaks to a level of mathematical sophistication that is often overlooked or undervalued in rural contexts. By recognizing and validating this intuitive understanding, we can build upon it to develop even more advanced mathematical thinking and problem-solving skills. As educators, we should seek to integrate these cultural assets into our instructional practices to create more accessible and empowering learning environments."

Teacher 5: Rural learners display an intuitive grasp of set-related ideas like membership and cardinality. This aligns perfectly with what I've observed in my own classroom. In the context of traditional games and activities, these learners demonstrate a natural facility for recognizing sets, identifying their constituent elements, and reasoning about the relationships between different collections. This innate mathematical ability is a tremendous asset that we should leverage in the classroom.

From teachers' interview all 5 teachers independently noted that rural learners demonstrate an "incredible grasp" or "innate understanding" of set-related concepts through their traditional games and activities. Specific examples highlighted include Learners collecting stones of different colors and organizing them into groups/sets based on attributes, Learners displaying an intuitive ability to recognize sets, identify set members, and reason about set relationships (e.g., subsets) and Learners exhibiting a deep, almost instinctual understanding of foundational mathematical ideas" related to sets. The teachers emphasized that this intuitive mathematical understanding is often "overlooked or undervalued" in rural contexts, and represents a "tremendous asset" that can be built upon. The teachers noted that traditional games, storytelling, and other culturally-grounded learning experiences seem to cultivate this robust understanding of set-related concepts, even without formal mathematical instruction.

The teachers unanimously agreed that tapping into rural learners' existing knowledge and validating their intuitive grasp of foundational mathematical ideas is crucial for designing more meaningful, accessible, and empowering learning experiences. By connecting the mathematical concepts present in learners' daily activities, teachers can make teaching and learning of Sets more engaging and relevant (Forbes, 2018).

Learners' observations

The researcher observed on learners' informal understanding of set-related ideas, such as membership and cardinality, was observed in their traditional games, puzzles, and storytelling.

Traditional games

Tsoro

Fig 4.1

The game tsoro, can be thought of as a representation of a universal set, with the occupied and unoccupied regions corresponding to different subsets. The capturing and defending of territories in tsoro mirrors set operations like union, intersection and compliment as players strategize to grow, shrink or protect their controlled regions. The relative positions and connections between a player's controlled territories on the board can be analyzed in terms of set relationships such as disjointness, containment and overlaps. This concurs with the idea that mathematical ideas are essential in sports and strategy games (Bewersdorff, 2021).

Nhodo

Fig 4.2

The universal game in the context of nhodo game can be represented as the entire collection of stones used to play the game. During the nhodo game the stones are typically divided into two or more subsets which represent the different players or teams participating in the game. The subsets of stones belonging to different players or teams are typically disjoint sets, meaning they have no common elements (no stones shared between players). The subsets of stones belonging to different players form a partition of the universal set. When playing the game, the player selects a subset of their stones and moves them to a different position on the playing area. We can identify intersection that is common stones between the subsets of different players which could indicate potential capturing opportunities.

Draughts

Fig 4.3

The draughts board can be represented as a set, with the squares on the board being the elements of the set. The entire game of draughts can be viewed as a sequence of sets, where each set represents the game state at a particular turn. Effective draughts strategies can be formulated in terms of set operations, such as taking

the union of potential moves, intersecting sets of squares to control or complementing the opponent's piece positions. Set theory can provide a formal framework for describing and reasoning about draughts strategies and decision-making processes. This concurs with the idea that mathematical ideas are essential in sports and strategy games (Bewersdorff, 2021).

Puzzle

Fig 4.4

In puzzle, the entire collection of puzzle pieces can be thought of as the universal set. The completed puzzle represents the full set of elements that make up the final solution. As you work on a puzzle, the pieces you have already placed can be considered as a subset of the universal set of all puzzle pieces. Solving a puzzle often involves performing set operations such as union, intersection and complement. For example, when you try to match two puzzle pieces together, you are effectively performing an intersection operation to find the common elements that fit. Removing a piece that does not fit can be seen as a complement operation, where you exclude that element from the subset of placed pieces. Puzzles often involve sorting and categorizing pieces based on color. Solving puzzles requires the use of logical reasoning and problems solving skills which are also fundamental to set theory. This concurs with the idea that mathematical ideas are essential in sports and strategy games (Bewersdorff, 2021).

Storytelling

Fig 4.5

The characters, locations, objects and events in a story can be viewed as elements of different sets, each with its own defining characteristics. The relationships between the sets of elements in a story such as unions, intersections and complements can be used to drive the plot, reveal connections and create contrast. Concepts like subsets, supersets and partitions can be applied to understand hierarchical or nested structure of a story, the grouping of related elements and the way the narrative is divided into distinct sections or chapters. Scholars and critics can use set theory to analyze thematic, symbolic and structural elements of narratives, uncovering deeper insights and patterns. This concurs with idea that set theory has practical applications in computer science, logic, probability, statistics, and linguistics (Zhang, 2023).

Comparing cows and bulls

Fig 4.6

Conclusions and inferences about the composition of the herd based on the relative sizes of the cow and bull set can be drawn using logic. For example, if you know that the number of cows is greater than the

number of bulls, you can logically conclude that the set of cows is a proper superset of the set of bulls and that there are elements in set of cows not in bulls. This concurs with idea that partitioning tasks into different categories or subsets can help to make comparisons between data (Vos, 2018).

Household stock taking

Fig 4.7

The universal set can be represented as the entire collection of grocery items in the household. When conducting grocery stock taking, we can create subsets based on categories of grocery items. For example fruits, vegetables, dairy, meat. The subsets created are typically disjoint sets. When stocktaking we use the concept of cardinality to count element of subsets. We can identify common grocery items shared between different categories. We can apply set operation to find items that are present in one subset but not in another, which could indicate missing low-stock items that need to be replenished. This concurs with researches that Set theory concepts are used in everyday organization, like sorting kitchen items, clothes, and jewelry. (Offorma, 2016).

Household budget

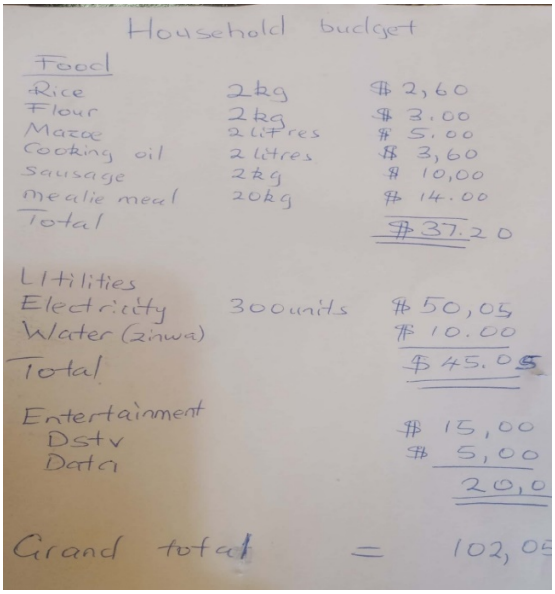


Fig 4.8

The different expense categories in a budget, such as food, utilities, and entertainment can be represented as sets. Each set would contain the specific expenses that fall under that category, allowing for better organization and analysis of budget. This categorization can help in prioritizing spending and making informed decisions about budget allocation. This concurs with researches that Set theory concepts are used in everyday organization, like sorting kitchen items, clothes, and jewelry. (Offorma, 2016).

Laundry

Fig 4.9

The universal set can be represented as the entire collection of clothes that need to be dried. When classifying clothes by color or brightness, we create subsets based on color or brightness. The subsets of

clothes classified by color or brightness are typically disjoint sets. This concurs with researches Set theory concepts are used in everyday organization, like sorting kitchen items, clothes, and jewelry. (Offorma, 2016).

Partitioning the house

Fig 4.10

The union of all rooms represents the entire house. The intersection of any two rooms represents the common elements (if any) between those rooms. For example, the intersection of the living room and the kitchen would be an empty set, as there are no common elements between these two rooms. The rooms in the house are typically disjoint sets, meaning they have no common elements. The rooms in the house can be seen as a partition of the universal set (the house). This concurs with researches that partitioning tasks into different categories or subsets can help to make comparisons between data (Vos, 2018).

Craft making

Basket making

Fig 4.11

The different types and styles of baskets made by various cultures could be viewed as forming sets of related objects, which could be studied and classified using set theory. The design and construction of baskets may involve optimizing the use of materials, space and techniques which could potentially draw on mathematical ideas from set theory, such as optimization and resource allocation. This concurs with researches that connecting Sets to other subjects helps students understand the concept's relevance beyond the math classroom (Gutierrez, 2019).

The arrangement and placement of pottery items

Fig 4.12

The arrangement and placement of pottery items either during production process or in a display/ storage setting, could be analyzed using spatial reasoning and Sets concepts such as proximity, containment and partitioning. For instance the efficient packing and stacking of pottery pieces in kiln or a display case could be viewed as an optimization problem involving set operations. The intricate patterns and symmetries often found in pottery designs could be analyzed using Set theory. This concurs with researches that Learners can use Mathematics concepts to count, group and identify patterns and apply spatial reasoning (Anwer, 2019).

Teachers' lessons observations

Play-based activities

Fig 4.13

The teachers used play-based activities, learners were asked to search the classroom/school for objects that can be grouped into sets, then identified the sets and set operations. Some learners found skin creams and perfumes from their bags and they could identify universal set of personal care products and they could identify subset of skin creams and other subset of perfumes It allowed learners to actively explore set concepts in a fun, hands-on way that connected them to their out-of-school mathematical skills and concepts. This concurs with the statement that by connecting the mathematical concepts present in learners' daily activities, teachers can make teaching and learning of Sets more engaging and relevant (Forbes, 2018).

Ethnomathematics materials

Fig 4.14

The teacher brought balls (universal set) into the classroom and gave learners opportunity to classify the balls into subsets based on their use that is volleyball, football, handball amongst many categories. The learners would formulate disjoint sets and complements under the guidance of the teacher. The participation was very overwhelming and learners were engaged throughout the lesson since they could relate their

everyday mathematical concepts and skills to the formal classroom learning. This aligns with the fact that the integration of ethnomathematics into Mathematics simplifies teaching procedures and enriches the quality of education (Desai, 2022).

4.2 How can the mathematical concepts in the learners' daily activities be integrated in Secondary School Mathematics in Sets?

4.2.1 Increased Relevance and Meaningfulness

From teachers interview (quantitative data) the rating was 5, all teachers strongly agree that incorporating learners' daily activities and experiences increase relevance and meaningful of mathematics.

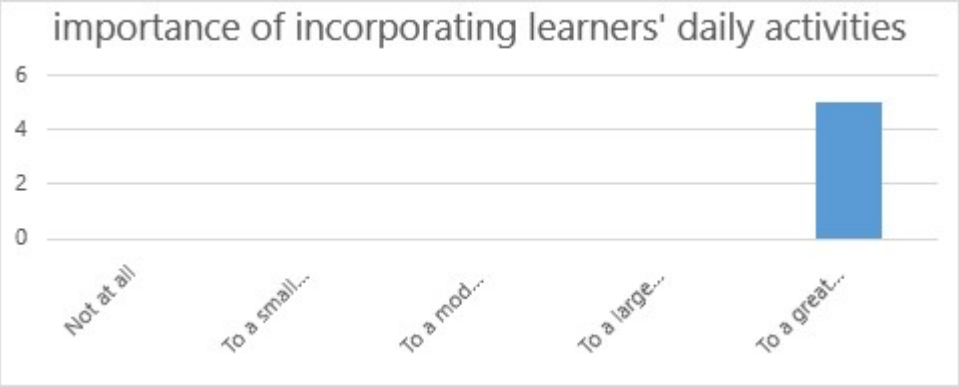


Fig 5.19

The data indicates that (100%) rated incorporating learners' daily activities and experiences increase relevance and meaningful of Mathematics learning as a 5 on the scale. Since all the teachers rated the importance as 5, the percentage of teachers who strongly agree with this approach is 100%. The mean, median and mode of the teachers' responses are all 5, indicating a strong consensus among the teachers. The range of the response is 0, as all teachers provided the same rating of 5. This suggests a complete lack of variability in the teachers' perspectives.

The data clearly shows that all teachers strongly agree that incorporating learners' daily activities and experiences increase relevance and meaningful of mathematics when teaching Sets. The unanimous rating of 5 indicates that the teachers place a high value on this approach and believe it is essential for improving the teaching and learning of Sets. This concurs with the idea that exploring and discussing cultural mathematical practices with learners in Mathematics enhances understanding (Lowe et al, 2021).

Quantitative data from learners questionnaires on the extent at which incorporating learners' daily activities increase relevance and meaningful of mathematics lesson on scale 1-5, (1 = Not at all, 2 = To a small extent, 3 = To a moderate extent, 4 = To a large extent, 5 = To a greater

extent)

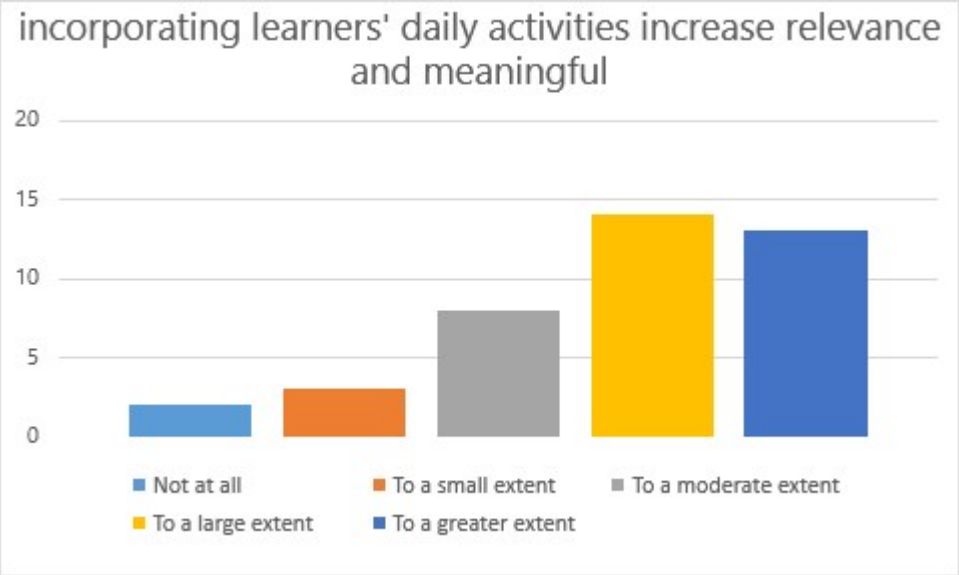


Table 4.9

The data shows the distribution of learners' responses on how incorporating their daily activities increase relevance and meaningful of Mathematics lesson on Sets. By analyzing the frequency or percentage of responses for each scale point, we can gain insights into learners' perceptions and attitudes towards this approach. Majority of learners (70%) responded with a 4 or 5, showing that they believe incorporating their daily activities into Mathematics lesson of Sets increase relevance and meaningful of Sets to their learning.

18% responded with a 3, it suggested that they see moderate importance in this approach, recognizing its potential value but not considering it as essential. A minority (12.5%) of learners responded with a 2, it would imply that they do not see much value in incorporating their daily activities into the Mathematics lesson on Sets, potentially preferring a more traditional, textbook driven approach.

The majority of learners indicated that incorporating ethnomathematics increase relevance and meaningful of Mathematics making the work easier for the teacher and enhances learners' understanding. This agrees with the idea that ethnomathematics simplifies teaching and enriches the quality of education (Adam, 2022).

Quantitative data from learners' interview on the extent at which incorporating learners' daily activities increase relevance and meaningful in mathematics lesson using scale the 1-5. (1 = Not at all, 2 = To a small extent, 3 = To a moderate extent, 4 = To a large extent, 5 = To a greater extent).

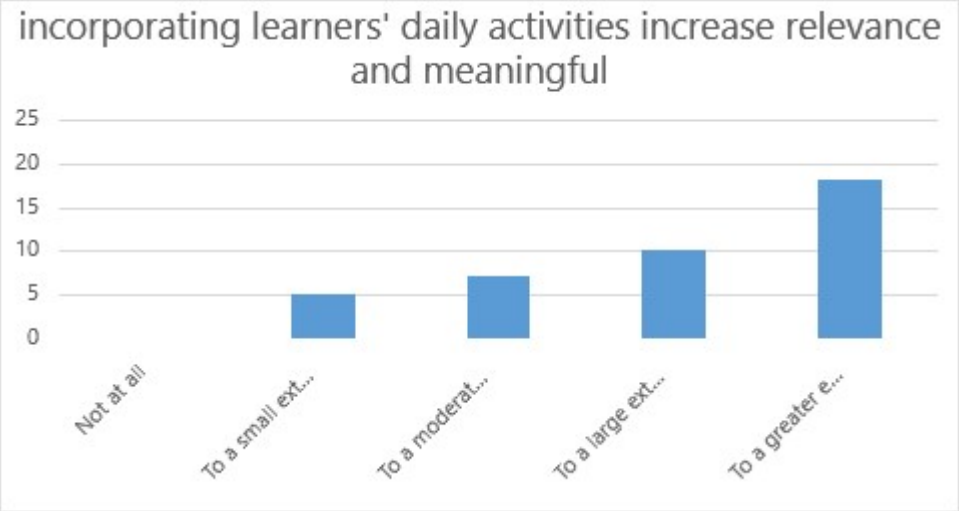


Table 4.10

The data shows the distribution of the learners' responses on how incorporating their daily activities increase relevance and meaningful of Sets. By analyzing the frequency or percentages of responses for each scale point, we can gain insights into the learners' perceptions and attitudes towards this approach. Majority of learners (67.5%) responded with a 4 or 5, indicated that they believe incorporating their daily activities into the Mathematics lesson on Sets increase relevance and meaningful of Sets. 20% responded

with a 3, it suggested that they see moderate increase relevance and meaningful in this approach, recognizing it's potential value, but not considering it as essential. A minority (12.5%) of learners responded with a 1 or 2, it would imply that they do not see much value in incorporating their daily activities into the Mathematics lesson on Sets, potentially preferring a more traditional, textbook driven approach.

Many learners said that incorporating ethnomathematics increase relevance and meaningful of Mathematics lessening the burden to the teacher. The majority of learners indicated that incorporating ethnomathematics increase relevance and meaningful of Mathematics making the work easier for the teacher and enhances learners' understanding. This agrees with the idea that ethnomathematics simplifies teaching and enriches the quality of education (Adam, 2022).

4.2.2 Enhanced Engagement and Understanding

Qualitative data from teachers' interview on how mathematical concepts from learners' daily activities align with the learning objectives and content covered in the Sets topic in the secondary school mathematics curriculum.

Teachers' reactions on how mathematical concepts from learners' daily activities align with the learning objectives and content covered in the Sets topic in the secondary school mathematics curriculum n=5

Representative quotes

Teacher 1: "*In household management, rural learners group similar items together based on their properties, such as categorizing household expenses into food, housing and utilities. This aligns with Sets operations of union and intersection. Marrying the two when teaching enhances engagement and understanding"*

Teacher 2: "*Rural learners classify household properties into categories like furniture, appliances and tools. This aligns with Sets concept of classification and can assist the teacher to enhance engagement and understanding when teaching."*

Teacher 3: "*In the households, learners often tally items such as the number of items in their household inventory. This aligns well with cardinality which requires counting and we can enhance engagement and understanding when teaching Sets while incorporating daily activities.*

Teacher 4: *"The way rural learners group similar items together based on their properties is connected to union and intersection in Sets. Enhanced engagement and understanding can be fostered when we teach Sets incorporating out of school contexts*."

Teacher 5: *"The categorization of household items that learners engage in at home maps well onto formal concept of classification in Sets. There is enhanced engagement and understanding when we bring the learners' out of school environment in the classroom."*

Qualitative data from teachers' interview showed that all 5 out of 5 teachers agree that incorporating out of school activities in lesson enhances engagement and understanding. 2 out of 5 teachers stated that the way rural learners group similar household items together based on their properties is connected to the Sets operations of union and intersection. 2 out of 5 teachers expressed that the way rural learners classify household items into categories aligns with Sets concept of classification. 1 out of 5 teachers stated that the way rural learners tally items in their household inventory aligns with Sets concept of cardinality. 3 out of 5 teachers explicitly stated that the way rural learners engage in household management activities aligns with the formal concepts of Sets engage in household management activities aligns with the Sets covered in the curriculum.

The data showed that allowing learners to view the practical application of Sets in their out-of-school activities makes the learning activities more engaging and meaningful, and can improve their overall understanding. This agrees with the idea that connecting mathematical concepts to daily life situations enhance learners' understanding (Harrigan, 2017).

4.2.3 Accessibility and Applicability

Qualitative data from teachers' interview on how the integration of learners' Set-related daily experiences enhance learners' understanding and application of Set -Theory concepts.

Teachers' reactions on how the integration of learners' Set-related daily experiences enhance learners' understanding and application of Set -Theory concepts n=5

Representative quotes

Teacher 1: "*By connecting the concepts of Sets to the learners' daily experiences, the Sets content becomes more relatable and relevant for them"*

Teacher 2: *"When learners can view the practical application of Sets in their out-of-school activities, the learning activities become more applicable and meaningful, which can enhance their understanding of Sets."*

Teacher 3: "*Integrating the learners' set-related daily experiences into the curriculum makes the content more accessible and helps them see its real-world relevance."*

Teacher 4: *"Contextualizing the learning of Sets by drawing connections to the ways learners use set-related ideas in their everyday lives can make the subject matter more accessible and applicable and can improve their overall understanding."*

Teacher 5: "*Creating opportunities for learners to apply to concepts of Sets to their out-of-school activities helps them see the practical value of what they are learning, which in turn makes the learning more accessible and applicable."*

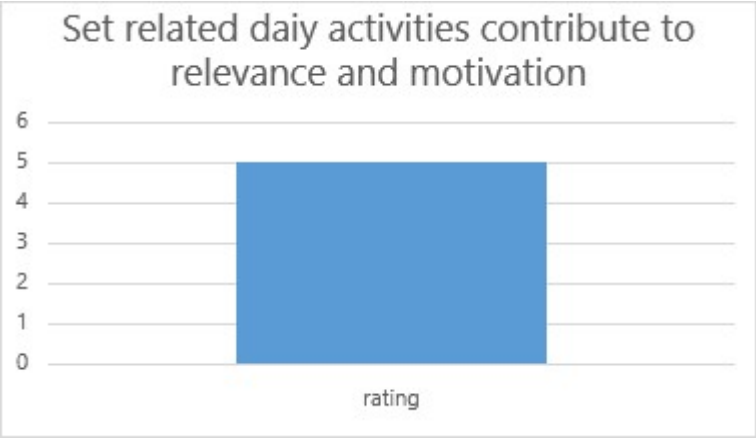
From teachers' interviews, all 5 teachers stated that connecting the concepts of sets to the learners' daily experiences makes the content more relatable, relevant and meaningful for them. 4 out of 5 teachers emphasized that when learners can view the practical application of Sets in their out-of-school activities, the learning activities become more engaging and meaningful and helps them see the real-world relevance of Sets.

3 out of 5 teachers suggested that contextualizing the learning of Sets related ideas in their everyday lives can improve their overall understanding of the subject matter. 3 out of 5 teachers stated that integrating the learners' set-related daily experiences into the curriculum makes the content more accessible and engaging for them.

These statistics highlight the key points made by the teachers regarding the benefits of connecting the concepts of Sets to the learners' daily experiences and out-of-school activities, such as increased relevance, engagement, understanding and accessibility of the subject matter. Integrating the learners' set-related daily experiences into the curriculum makes the content more accessible and engaging. Allowing learners to contribute their own perspectives and real-world examples moves beyond just memorizing definitions and procedures, hence the learning would become meaningful. This agrees with the idea that that using familiar, real-world contexts helps students connect Mathematics concepts to their own experiences, enhancing the meaningfulness of learning (Sunzuma & Maraji, 2021).

4.2.4 Increased Motivation and Relevance

From teachers interviews on quantitative data, 5 is the average rating from the scale (1-5) to indicate how they find integration of learners' Set-related daily contribute to the relevance, motivation and contextualization of set theory curriculum.



From teachers' interviews on quantitative data, 5 is the average rating from the scale (1-5) to indicate how they find the integration of learners' Set-related daily contribute to the relevance, motivation and contextualization of set theory curriculum. This agrees with the idea that representing diverse cultures in learning materials helps students feel included and engaged (D'Ambrosio & Rosa, 2016).

Qualitative data from teachers' interview on how the integration of learners' Set-related daily contribute to the relevance, engagement and contextualization of set theory curriculum.

Teachers' reactions on how the integration of learners' Set-related daily contribute to the relevance, engagement and contextualization of set theory curriculum n=5

Representative quotes

Teacher 1: *"Incorporating the learners' set-related daily activities into the Sets curriculum could make the content more relevant, meaningful and interactive for them."*

Teacher 2: *"If we allow learners to contribute their own perspectives and real-world examples when learning about sets, it can move the instruction beyond just memorizing definitions and procedures and it motivates them"*

Teacher 3: *"Connecting the Sets curriculum to the learners' set-related experiences outside of school increases the relevance and meaningfulness of the material which can boost their motivation."*

Teacher 4: *"Drawing on the learners' own set-related daily activities makes the Sets curriculum more interactive and relevant, rather than just relying on abstract definitions."*

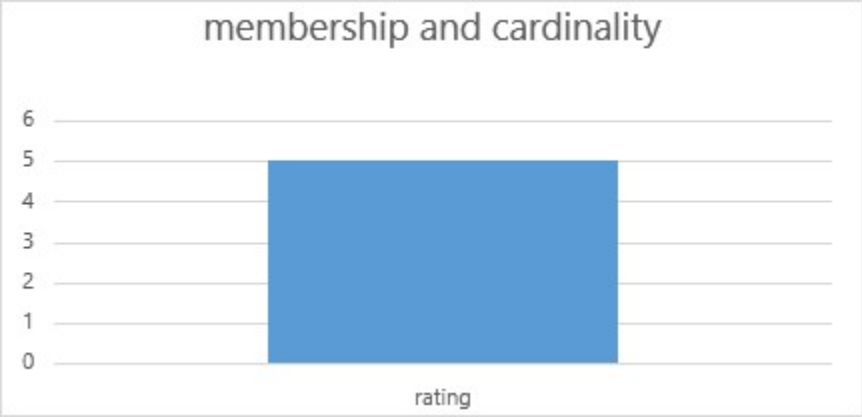
Teacher 5: *"Letting learners share their own examples and perspectives from the real-world experiences can make the learning of Sets relevant and it motivates them."*

Qualitative data from teachers' interview showed 4 out of 5 teachers stated that incorporating the learners' set-related daily activities into the Sets curriculum could make the content more relevant, meaningful and interactive for them. 2 out of 5 teachers expressed that allowing learners to contribute their own perspectives

and real-world examples when learning about Sets can move the instruction beyond just memorizing definitions and procedures. 3 out of 5 teachers stated that connecting the Sets curriculum to the learners' set-related experiences outside of school increases the relevance and meaningfulness of the material, which can boost their motivation. This agrees with the idea that representing diverse cultures in learning materials helps students feel included and engaged (D'Ambrosio & Rosa, 2016).

4.2.5 Play-based activities are engaging

Quantitative data from teachers' interviews rating from the scale (1-5) to indicate how they find the play-based instructional strategies they employ to be engaging.



From teachers' interviews on quantitative data, 5 is the average rating from the scale (1-5) to indicate how they find the play-based instructional strategies they employ to be very engaging and effective in bridging the gap between everyday mathematical concepts and the formal treatment of Sets in the secondary school curriculum.

The data shows that teachers find play-based activities to be very engaging and effective when teaching Sets since the learners would be involved throughout the lesson and they help one another to connect the outside world into the classroom. This agrees with the fact that collaborative learning activities in Mathematics to facilitate the sharing of cultural perspectives among learners (Grey, 2021).

Qualitative data from teachers' interviews on specific examples, strategies/approaches of play-based activities and how it helps bridge the gap between daily life and the formal mathematics.

Teachers' reactions on specific examples, strategies/approaches of play-based activities and how it helps bridge the gap between daily life and the formal mathematics n=5

Representative quotes

Teacher 1: *"The Set-themed scavenger hunt is a great way to get learners actively exploring Sets concepts in a funny way, hands-on manner that connects directly to their immediate environment. It allows them to see set operations at work in the real world."*

Teacher 2: *"Having learners create their own Set-themed card games using operations like union, intersection and complement is a fantastic way to encourage them to think creatively about applying Sets ideas. It helps to bridge the gap between the formal Mathematics and the personal experiences."*

Teacher 3: *"l really like the set scavenger hunt activity because it allows learners to actively discover set concepts within their classroom and surroundings. It makes the abstract ideas of Sets much more concrete and relatable for them."*

Teacher 4: "*The sets card game is such a clever way to get learners thinking about how set operations can be applied in a game context. It makes the learning more interactive and encourages them to explore sets in an imaginative way."*

Teacher 5: "*Both the scavenger hunt and set card game strike me as excellent ways to connect the formal Sets to the learners' immediate environment and personal interests. These hands-on, game based activities really bring the concepts to life in an engaging manner."*

Qualitative data from teachers' interviews showed 3 out of 5 teachers stated that the Set-themed scavenger hunt is a great way to get learners actively exploring set concepts in a fun, hands-on manner that connects directly to their immediate environment, making the abstract ideas of Sets much more concrete and

engaging. 3 out of 5 teachers expressed that having learners create their own Set-themed card games using operations like union, intersection and complement in a fantastic way encourage them to think creatively about applying Sets, bridging the gap between formal Mathematics and their personal experiences. 4 out of 5 teachers highlighted that both the scavenger hunt and set card game activities are excellent ways to connect the formal Mathematics of Sets to the learners' immediate environment and personal interests, bringing the concepts to life in an engaging manner. 3 out of 5 teachers mentioned that these hands-on, game based activities make the learning more interactive and encourage learners to explore Sets in an imaginative way.

Set-themed activities like scavenger hunts and card games allow learners to actively explore set concepts in a fun, hands-on manner that connects to their immediate environment, making the abstract ideas more concrete and relatable. This agrees with the idea that using familiar, real-world contexts helps students connect Mathematics concepts to their own experiences, enhancing the meaningfulness of learning (Sunzuma & Maraji, 2021).

4.3 What are the challenges faced by Mathematics teachers in integrating ethnomathematics?

4.3.1 Bridging the Gap between Informal and Formal Mathematical Knowledge

Qualitative data from teachers' questionnaire on challenges that teachers face in bridging the gap between informal contextualized Mathematics used by leaners in their communities and the formal, decontextualized taught in the classroom.

Teachers' reactions on challenges that teachers face in bridging the gap between informal contextualized Mathematics used by leaners in their communities and the formal, decontextualized taught in the classroom

n=5

Representative quotes

Teacher 1: *"Learners often develop rich mathematical knowledge and skills through their everyday activities at home and in their communities. But this informal, contextualized Mathematics can look different from the formal, abstract Mathematics we teach in the curriculum."*

Teacher 2: "*Disconnection between the learners' informal, practical mathematical knowledge and the formal academic content we cover in school can be a real challenge for teachers. It is not always easy to recognize and validate the mathematical ideas that arise from their experiences."*

Teacher 3: *"Leveraging the learners' informal mathematical knowledge that develops through their daily activities and interactions is so valuable. But bridging that to the formal curriculum we are expected to teach can be more difficult and we need support in making those connections effectively."*

Teacher 4: *"Learners are constantly engaging with Mathematics at home and community environments we teach is not straight forward. We need strategies to better integrate those two domains.*

Teacher 5: *"The mathematical knowledge and skills that learners build through their everyday experiences are so important, but they often look quite different from the formal Mathematics we teach. Findings ways to validate that informal knowledge and link it to the curriculum is an ongoing challenge for teachers."*

Qualitative data from teachers' questionnaires suggests that all 5 teachers acknowledged the disconnection between the learners' informal, practical mathematical knowledge developed through everyday activities at home and in their communities and the formal, abstract Mathematics taught in the curriculum. 4 out of 5 teachers stated that it can be difficult for teachers to recognize and validate the mathematical ideas that arise from the learners' lived experiences, as the informal, contextualized knowledge may look quite different from the formal academic content. 4 out of 5 teachers emphasized the value of leveraging the learners' informal mathematical knowledge that develops through their daily activities and interactions, as it can provide a strong foundation for the formal curriculum. All 5 teachers expressed the need for strategies and support to help teachers to effectively bridge the gap between learners' informal contextualized mathematical understanding and the formal academic content they are expected to teach.

These statistics highlight the widespread recognition among the teachers of the challenge in reconciling the learners' informal mathematical knowledge with the formal curriculum and the importance of finding ways to validate and integrate these two domains to support more effective and meaningful learning. Teachers may struggle to integrate ethnomathematics due to limited competence, experience, and resistance to changing teaching approaches (Sunzuma & Maharaj, 2019).

Quantitative data from teachers' interview On a scale of 1 to 5 (1 = Not at All, 2 = To a Small Extent, 3 = To a Moderate Extent, 4 = To a Large Extent, 5 = To a Greater Extent) the extent at which bridging the gap between informal contextualized Mathematics used by leaners in their communities and the formal, decontextualized taught in the classroom showed the following results

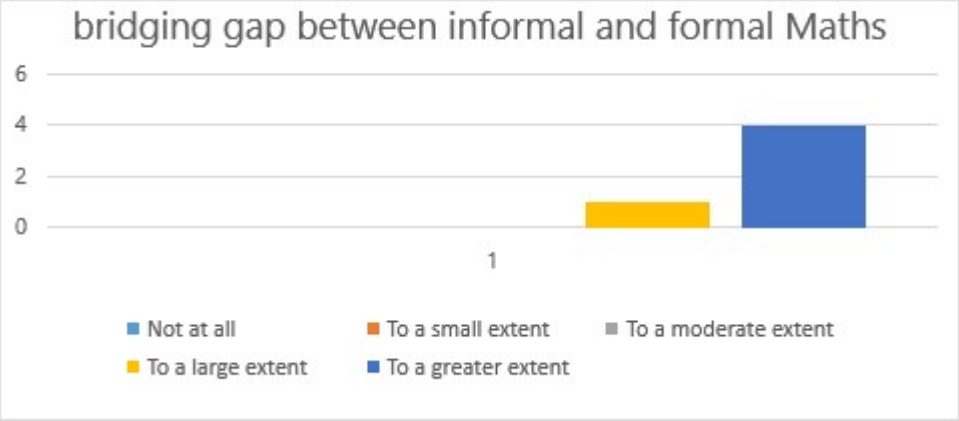


Table 4.11

Based on quantitative data from the teachers' interview, the majority of teachers (4 out of 5) indicated that bridging the gap between informal and formal Mathematics is a challenge to a greater extent. Only 1 teacher reported to a large extent and none of the teachers reported to a small or not at all.

The quantitative data strongly suggests that the challenge of bridging the gap between informal, contextualized Mathematics and formal, decontextualized Mathematics is a significant and widespread issue faced by teachers. The fact that 5 out of 5 of teachers reported the challenge to a large or greater

extent highlights the critical need for addressing this issue in teacher education, professional development and curriculum design.

The quantitative data aligns with and reinforces qualitative findings where teachers mentioned difficulties in identifying, validating and effectively incorporating learners' informal mathematical knowledge into the formal curriculum. The combination of qualitative and quantitative data provides a comprehensive understanding of the magnitude and nature of the challenges faced by teachers in incorporating learners' informal mathematical knowledge into the formal curriculum. This agrees with the fact that teachers face challenges of poor knowledge and struggle to connect the abstract concept of Sets to relevant, real-world applications limiting their potential to identify and assess diverse problem-solving methods that learners may present from an ethnomathematics perspective (Disnawati & Nahak, 2019; Reyes et al, 2019).

4.3.2 Need for Guidance, Resources, and Flexibility

Quantitative data from the teachers' interview on the extent at which resource limitations such as lack of ethnomathematical teaching materials or professional development opportunities that hinder teachers' efforts to integrate ethnomathematics

Table 4.12

The majority of teachers (5 out of 5) indicated that resource limitations such as lack of ethnomathematical teaching materials or professional development opportunities hinder teachers' efforts to integrate ethnomathematics. This aligns with information that limited access to resources reflecting diverse cultural

mathematical practices can make it difficult for teachers to incorporate ethnomathematics (Disnawati & Nahak, 2019).

Qualitative data from teachers' interviews on resource limitations such as lack of ethnomathematical teaching materials or professional development opportunities that hinder teachers' efforts to integrate ethnomathematics.

Teachers' reactions on resource limitations such as lack of ethnomathematical teaching materials or professional development opportunities, that hinder teachers' efforts to integrate ethnomathematics n=5

Representative quotes

Teacher 1: *"I would love to give my learners more opportunities to explore mathematical concepts using their own culturally influenced methods and strategies, bi the rapid pace of the quite challenging. I feel like l am constantly having to choose between covering the mandated content allowing for more open-ended, exploratory learning, l need better resources to help me strike the balance effectively."*

Teacher 2: *"The wide range of informal math skills and strategies that my diverse learners bring poses a significant challenge. Trying to accommodate all of that in my instruction takes a lot of time and can be overwhelming. II want to honor their existing, knowledge, but the fast pace of the curriculum makes it difficult to explore those real-world approaches in depth."*

Teacher 3: *"One of my biggest challenges is the inability to effectively integrate the culturally influenced mathematical methods and ways of thinking that my learners bring with them. The standardized curriculum and assessment system we work within is so rigid and focused on Western-centric approaches that it leaves little room for exploration of alternative problem solving strategies or pedagogical techniques. I feel like l am constantly having to choose between honouring my learners' cultural identities and meetings that mandated learning objectives."*

Teacher 5: *"Integrating ethnomathematical concepts into my teaching of standard topics has been a real struggle. The pedagogical approaches associated with these cultural math traditions do not always align well with the more formal, Western-centric curriculum l am expected to follow. I want to create a more inclusive learning environment, but the systemic barriers make it very difficult to do so in a sustainable way."*

Qualitative data from teachers' interviews showed that 1 out of 5 teachers highlighted language barriers as a hindrance to effectively communicate and integrate ethnomathematics in the classroom, requiring the use of creative strategies such as visual aids, hands-on activities and making the mathematical ideas more accessible and intuitive for the learners. 2 out of 5 teachers noted that teaching styles associated with ethnomathematics often do not align well with more traditional, formal curriculum they are expected to follow, making it challenging to seamlessly incorporate ethnomathematical concepts in a way that feels natural and relevant for their learners. 2 out of 5 teachers emphasized the significant effort they have had to put in and build bridges and help their learners to see the value and relevance of the mathematical ideas being explored, in the face of cultural divisions between the learners' home environments and the school context. 2 out of 5 teachers identified the cultural disconnection between the learners' home environments and the more formal school context as a significant challenge leading to misunderstandings and lack of mathematical content. 1 out of 5 teachers highlighted the challenge of aligning ethnomathematical concepts with the standardized rigid curriculum that is typically focused on Western-centric mathematical content and teaching methods, requiring a delicate balancing act to integrate more culturally-relevant hands-on approaches while still meeting all the required learning outcomes.

The qualitative and quantitative data from teachers' interviews provide a comprehensive understanding of the resource limitations that hinder teachers' efforts to integrate ethnomathematics in their lessons.

The majority of the teachers mentioned the lack of access to ethnomathematical teaching materials, resources and curricula as a significant challenge. This scarcity makes it difficult for teachers to effectively integrate Ethnomathematics into their lessons. Many teachers highlighted the limited professional

development opportunities available to learn about ethnomathematics and how to incorporate it into their teaching practices. The lack of training and support can hinder teachers' ability to develop the necessary knowledge, skills and strategies to integrate ethnomathematics effectively. All the teachers stated that the lack of adequate funding and institutional support for ethnomathematical initiatives and teacher training programs poses a significant barrier to integrate ethnomathematics in the classroom.

From quantitative data, many teachers expressed that they seem to be a disconnection between the Mathematics skills learners demonstrate in the classroom versus what they use in their day to day lives. Teachers would like more opportunities to observe and interact with learners in their home and community context to better understand the Mathematics skills they employ outside the classroom.

The absence of sufficient resources and institutional backing can limit the time, attention and effort that teachers can devote to exploring and implementing ethnomathematical approaches. This agrees with the idea that limited access to resources reflecting diverse cultural mathematical practices can make it difficult for teachers to incorporate ethnomathematics (Disnawati & Nahak, 2019).

By addressing these resource limitations and challenges, educational systems can empower teachers to more effectively integrate ethnomathematics into their teaching, ultimately enhancing the relevance and effectiveness of Mathematics education for diverse learners.

From teachers' questionnaire teachers are lacking guidance and professional development opportunities to effectively integrate ethnomathematics when teaching Sets

Teachers' reactions on lack of ethnomathematical and professional development opportunities teaching materials n=5

Representative quotes

Teacher 1: *"l really struggle to get insight into the Mathematics skills and knowledge that my learners are developing through their home and community experiences. It would be do helpful to have more opportunities to observe and interact with them in those real-world contexts."*

Teacher 2: *"l have noticed a real world disconnection between the Mathematics skills and strategies my learners demonstrate in the classroom versus what they are using in their day-to-day lives. I would really appreciate more training and support on how to effectively bridge the gap."*

Teacher 3: *"I am not alone in struggling to gain insight into the Mathematics my learners use outside of school and connect it to my classroom instruction."*

Teacher 4: *"Many teachers feel there is a disconnection between the academic Mathematics we see in the classroom and the practical, contextual Mathematics our learners employing their everyday lives. I would love more guidance on how to better align those two domains."*

Teacher 5: *"It is reassuring to know l am not the only one who has difficulty getting a window into the Mathematics skills and knowledge my learners are developing outside of school. And a desire for more ethnomathematical teaching materials and professional learning opportunities is clearly a widespread need among my fellow teachers."*

From the teachers' questionnaire 3 out of 5 teachers expressed a struggle to gain insight into the Mathematics skills and knowledge that their learners are developing through their home and community experiences and a desire for more opportunities to observe and interact with learners in those real-world contexts.

4 out of 5 teachers noted a disconnection between the Mathematics skills and strategies their learners demonstrate in the classroom versus what they are using in their day-to-day lives, and the challenge in bridging the gap. 3 out of 5 indicated that lack of ethnomathematical teaching materials and professional development opportunities is a widespread challenge faced by many teachers in their efforts to gain insight into the Mathematics used by learners outside of school and connect it to classroom instruction.

4 out of 5 teachers expressed a need for guidance and support on how to effectively bridge the disconnection between the academic Mathematics skills seen in the classroom and the practical, contextual Mathematics employed by learners in their everyday lives.

These statistics highlight the common struggles that teachers face in gaining insight into their learners' real world mathematical knowledge, experiences and widespread desire for more resources and professional development to help them better align the academic content with the practical, contextual Mathematics used by learners outside of the classroom. Lack of formal training in ethnomathematics makes it difficult for teachers to effectively implement it (Machaba & Dhlamini, 2021).

Qualitative data from teachers' questionnaire reactions on how factors such as school policies, curriculum demands, assessment structures, and resource limitations impact teachers' ability to effectively integrate ethnomathematics in their mathematics lessons.

Teachers' reactions on how factors such as school policies, curriculum demands, assessment structures, and resource limitations impact teachers' ability to effectively integrate ethnomathematics in their mathematics lessons n=5

Representative quotes

Teacher 2: *"Resource limitations have been a major hindrance in my efforts to incorporate more ethnomathematical elements into my lessons. The lack of funding for teaching materials, professional development opportunities and other essential support makes it really difficult to explore alternative pedagogical approaches. I want to give my learners the chance to learn Mathematics in ways that are more aligned with their cultural backgrounds, but without proper tools and training, it is an uphill battle."*

Teacher 4: *"One of the biggest barriers l face is trying to strike a balance between maintaining rigor and content requirements of the prescribed curriculum while also incorporating more culturally relevant mathematical approaches. I am always worried that if l stray too far from the standard lesson plans and assessment formats. I will end up failing to adequately prepare my learners for the high stakes tests they*

will need to pass. It is a delicate dance, and l wish l had more support and flexibility to truly integrate ethnomathematics in a meaningful way.

From the above mentioned information, teachers indicated they lack teaching materials, professional development opportunities and they do not have support and flexibility to integrate ethnomathematics effectively due to the curriculum which is rigid. This aligns with the fact that lack of formal training in ethnomathematics makes it difficult for teachers to effectively implement it (Machaba & Dhlamini, 2021).

Qualitative data from teachers' interview on how factors such as school policies, curriculum demands, assessment structures, and resource limitations impact teachers' ability to effectively integrate ethnomathematics in their mathematics lessons

Teachers' reactions on how factors such as school policies, curriculum demands, assessment structures, and resource limitations impact teachers' ability to effectively integrate ethnomathematics in their mathematics lessons n=5

Representative quotes

Teacher 5: *"One of the biggest hurdles l face is bridging the gap between the informal, contextualized mathematics skills and strategies that my learners use and the more formal, decontextualized concepts outlined in the curriculum. I spend a lot of time translating between the two, and it can be really time consuming and challenging. I wish l had more guidance and resources to help me integrate those informal approaches more effectively and make the connections between the two more explicit for my learners."*

The teacher expressed lack of guidance and resources to effectively integrate ethnomathematics in Mathematics lesson. This indicates that resources and guidance are very crucial when integrating out of school activities and classroom activities. Lack of cultural resources and guidance can hinder the learners' understanding. This agrees with the notion that limited access to resources reflecting diverse cultural mathematical practices can make it difficult for teachers to incorporate ethnomathematics (Disnawati & Nahak, 2019).

4.3.3. Curriculum Constraints and Misalignment

Qualitative data from teachers' questionnaires on cultural, linguistic and pedagogical barriers that teachers encounter when trying to integrate ethnomathematical concepts into the teaching of standard mathematical topics like Sets.

Teachers' reactions on cultural, linguistic, and pedagogical barriers that teachers encounter when trying to integrate ethnomathematical concepts into the teaching of standard mathematical topics like Sets n=5

Representative quotes

Teacher 1: *"One of the biggest challenges l have faced is the cultural disconnection between the learners' home environments and the more formal school context. This can lead to misunderstandings and lack of connection with mathematical content. I have really had to make an effort to bridge the gap and help my learners to see the relevance of what we are learning to their own lived experiences."*

Teacher 2: *"Language barriers have definitely been a hindrance when it comes to effectively communicating and integrating ethnomathematical concepts in my classroom. Since the language of instruction differs from the learners' home languages, l have had to get creative visual aids, hands on activities and finding ways to make mathematical ideas more accessible and intuitive for learners."*

Teacher 3: *"The teaching and learning styles associated with ethnomathematics do not always align well with more traditional, formal curriculum we are expected to follow. This disconnection can make it challenging to incorporate ethnomathematical concepts that feels natural and relevant for leaners. I have had to do a lot of adapting and bridging between these different pedagogical approaches."*

Teacher 4: *"Navigating the cultural divisions between the learners' home environments and the school context has been one of the biggest hurdles l have faced. There are often misunderstandings and lack of connection, which can create barriers to effective learning. I have had to put in a lot of effort to build*

cultural bridges and help my learners to see the value and relevance of the mathematical ideas we are exploring."

Teacher 5: "*Aligning ethnomathematical concepts with the standardized curriculum has been a real challenge. The curriculum tends to be very rigid and focused on traditional, Western-centric mathematical content and teaching methods. Trying to integrate more culturally-relevant, hands-on approaches while still meeting all the required learning outcomes has been a delicate balancing act."*

Qualitative data from teachers' questionnaires suggests 2 out of 5 teachers identified the cultural disconnection between the learners' home environments and the more formal school context as a significant challenge leading to misunderstandings and a lack of connection with the mathematical content.

1 out of 5 teachers highlighted language barriers as a hindrance to effectively communicate and integrate mathematical concepts in the classroom, requiring the use of creative strategies such as visual aids, hands-on activities and making the mathematical ideas more accessible and intuitive for the learners.

2 out of 5 teachers noted that the teaching and learning styles associated with ethnomathematics often do not align well with the more traditional, formal curriculum they are expected to follow, making it challenging to incorporate ethnomathematics in a way that feels natural and relevant for their learners.

2 out of 5 teachers emphasized the significant effort they have had to put in to build cultural bridges and help their learners to see the value and relevance of the mathematical being explored in the face of the cultural divisions between the learners' home environments and the school contexts.

1 out of 5 teachers highlighted the challenge of aligning ethnomathematical concepts with the standardized, rigid curriculum that is typically focused on traditional, Western-centric mathematical content and teaching methods, requiring a delicate balancing act to integrate more culturally-relevant hands-on approaches while still meeting all the required learning outcomes.

These statistics demonstrate the various cultural, linguistic and pedagogical challenges that teachers face in their efforts to effectively incorporate ethnomathematical concepts and approaches in their classroom practices, particularly in the context of more traditional, standardized educational systems and curricula. The learners' culture and language must be incorporated to simplify the Sets concepts. This concurs with the emphasis that mathematics language should be easy to understand (Devlin, 2018).

Qualitative data from teachers' interviews on cultural, linguistic, and pedagogical barriers that teachers encounter when trying to integrate ethnomathematical concepts into the teaching of standard mathematical topics like Sets.

Teachers' reactions on cultural, linguistic, and pedagogical barriers that teachers encounter when trying to integrate ethnomathematical concepts into the teaching of standard mathematical topics like Sets n=5

Representative quotes

Teacher 1: *"One of the biggest challenges l face is the wide range of informal mathematics skills and strategies my learners bring with them from their diverse cultural backgrounds. Trying to accommodate all that in my instruction is really time consuming and can be quiet overwhelming. I want to honour their existing knowledge, but the placing of the curriculum makes it difficult to dive as deep as l would like into those real-world approaches."*

Teacher 2: "*while l would love to spend more time letting my learners explore mathematical concepts using their own culturally influenced methods and strategies. The fast pace of the mandated curriculum makes that quite challenging. I feel like l am constantly having to choose between covering the required content and allowing for more open-ended, exploratory learning. I need better tools and resources to help me strike that balance effective learning. I need better tools and resources to help me strike that balance effectively."*

Teacher 3: "*Integrating ethnomathematical concepts into my teaching of Mathematics topics like Sets has been a real struggle. The pedagogical approaches associated with these cultural mathematics traditions do not always align well with the more formal, Western-centric curriculum l am expected to follow. I want to create a more inclusive learning environment, but the systemic barriers make it difficult to do so in a meaningful and sustainable way."*

Teacher 4: *"My learners come from such diverse backgrounds, and all have their own unique ways of thinking and engaging with mathematical ideas. Trying to accommodate all of those informal skills and strategies in my instruction is incredibly time consuming and at times, feels practically impossible given the pace at which l am expected to cover the required content. I wish l had more flexibility and support to really dive into these culturally influenced approaches."*

Teacher 5: *"One of the biggest challenges l face is the inability to effectively integrate the culturally influenced mathematical methods and ways of thinking that my learners bring with them. The standardized curriculum and assessment system we are working within is so rigid and focused on Western-centric approaches that lives little room for the exploration of alternative problem solving strategies or pedagogical techniques. I feel like l am constantly having to choose between honouring my learners' cultural identities and meetings the mandated learning objectives."*

Qualitative data from teachers' interviews stated that 3 out of 5 teachers identified the challenge of accommodating the wide range of informal Mathematics skills and strategies that their learners bring from their diverse cultural backgrounds. This was described as time consuming and overwhelming, as they want to honour the learners' existing knowledge but the pacing of the curriculum made it difficult to dive deeper into those real-world approaches. 3 out of 5 teachers expressed the desire to spend more time allowing learners to explore mathematical concepts using their own culturally influenced methods and strategies but felt constrained by the fast pace of the mandated curriculum. This created a constant tension between covering the required content and allowing for more open-ended, exploratory learning. 2 out of 5 teachers specifically highlighted the struggle of integrating ethnomathematical concepts into their teaching of

standard topics into their teaching of standard topics, as the pedagogical approaches associated with these cultural mathematics traditions often did not align with the more formal, Western-centric curriculum they were expected to follow. 2 out of 5 teachers acknowledged the systemic barriers that made it very difficult to create a more inclusive by meaningful and sustainable integrating ethnomathematical concepts and approaches into their teaching. 2 out of 5 teachers expressed a need for more flexibility and support to really dive deep into the culturally influenced approaches and ways of thinking that their learners bring to the classroom, as they felt constrained by the rigid standardized curriculum and assessment system.

These statistics demonstrate the significant challenges that teachers face in their efforts to honour and integrate the diverse cultural backgrounds and informal mathematics skills of their learners, while also navigating the demands of standardized curriculum requirements and assessment systems that often prioritize Western-centric approaches over more inclusive, ethnomathematical practices. This concurs with the emphasis that we need to incorporate learners' home cultures in the classroom, as their cultural knowledge can aid ethnomathematical approaches (Bottoms et al, 2017).

By addressing these challenges related to accommodating diverse informal mathematics skills, the pace of the curriculum and integration of culturally influenced mathematics methods, teachers can be better equipped to bridge the gap between learners' home mathematical practices and the formal mathematics curriculum, ultimately enhancing the relevance, engagement and learning outcomes for all learners.

Quantitative data from teachers' interviews on the extent at which the cultural, linguistic, and pedagogical are barriers that teachers encounter when trying to integrate ethnomathematical concepts into the teaching of standard Mathematics.

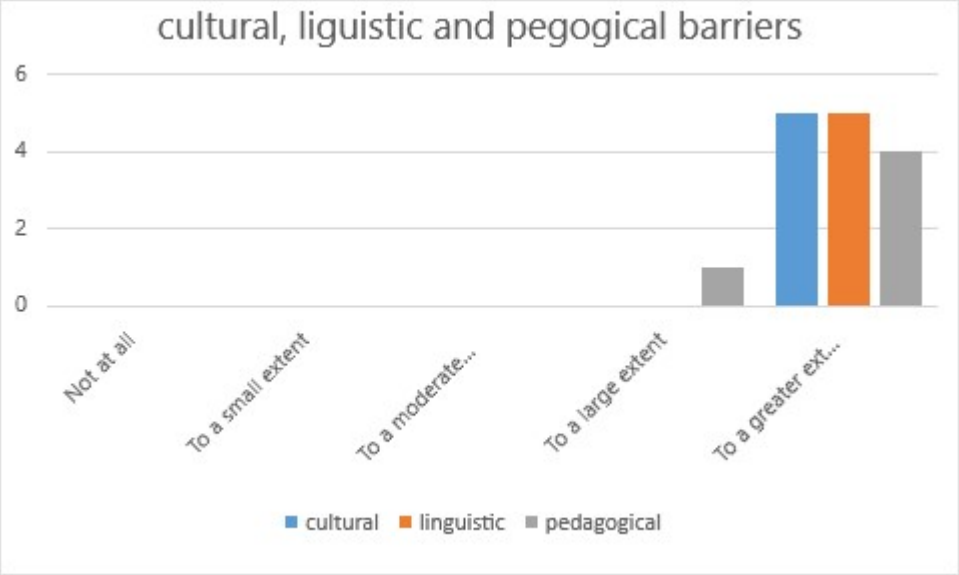


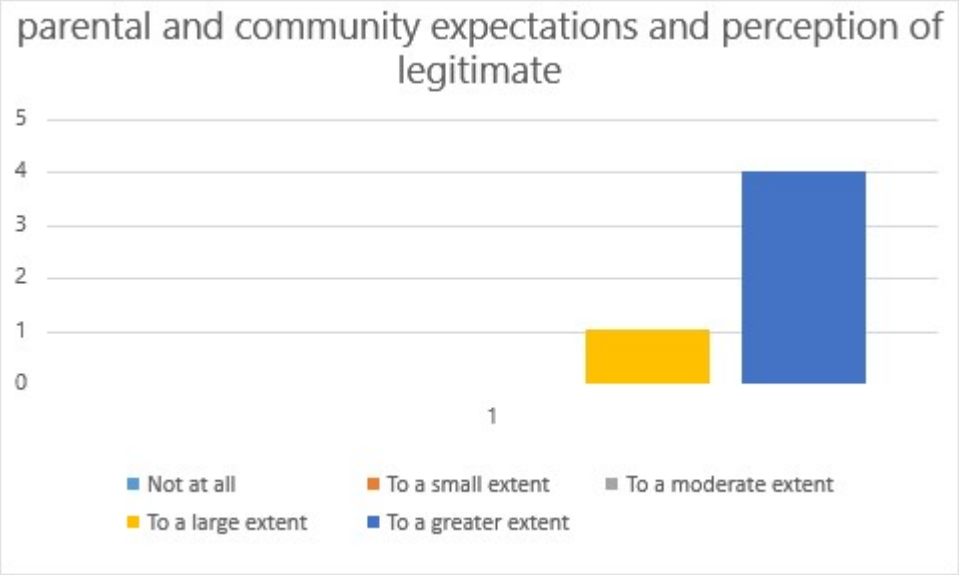
Table 4.13

Results above showed that many teachers (5) agreed to a greater extent that cultural and linguistic barrier affect integration of ethnomathematics. 4 teachers agreed to a greater extent while 1 teacher agreed to a large extent that pedagogical approach can be a barrier to integration of ethnomathematics.

The data indicates that culture, language and pedagogical approaches can affect the integration of ethnomathematics when teaching Sets. The teachers must not ignore learners' culture, language when delivering lessons for the learners to easily understand the concepts. This concurs with the emphasis that we need to incorporate learners' home cultures in the classroom, as their cultural knowledge can aid ethnomathematical approaches (Bottoms et al, 2017).

3.4.4. Systemic Barriers and External Pressures

Quantitative data from teachers' interview on parental and community expectations and perceptions of "legitimate" pose challenges for teachers



The data shows that many teachers (4) agree to a greater while 1 teacher agreed to a large extent that parents and community pose challenges to the integration of ethnomathematics in classroom. Learners come from different cultures and their expectations vary which can affect the integration of teacher when trying to meet all their expectations. This agrees with the emphasis teachers may face resistance from students, parents and colleagues when integrating ethnomathematics in the mathematics curriculum (Aikenhead, 2017).

Qualitative data from teachers' interviews on ways that parental and community expectations and perceptions of "legitimate" pose challenges for teachers.

Representative quotes

The data shows that many teachers (4) agreed a greater extent while 1 teacher agreed to a large extent that parents and community pose challenges to the integration of ethnomathematics in classroom.

Teachers should be careful not to deviate much to the community's expectations when integrating ethnomathematics in classroom. Learners come from different cultures and their expectations vary.

Teacher 1: *"The pressure from parents to constantly improve our pass rates puts a huge strain on us as teachers. They have such high and often unrealistic expectations that it becomes really difficult to focus on*

developing the deeper cultural skills and strategies that are so important for our learners. I know integrating ethnomathematics approaches would benefit them immensely, but the relentless drive for results often takes precedence, making it hard to try new things."

Teacher 2: *"The sociocultural and economic diversity in our community leads to a wide range of expectations when it comes to mathematics education. This can create real conflicts between what we as teachers are trying to do, like incorporating more culturally relevant practices and what some parents and community members see as legitimate learning. It is an ongoing challenge to try and bridge those divisions and demonstrate the value of a more holistic, ethnomathematical approach."*

Teacher 3: *"The high and sometimes unrealistic expectations from parents to constantly improve our pass rates puts a tremendous pressure on us as teachers. We end up feeling like we have to prioritize results over truly engaging our learners in a meaningful, culturally grounded mathematics. Integrating ethnomathematical approaches would be so beneficial, but the relentless focus on test scores makes it really difficult to devote the time and energy required."*

Teacher 4: *"The sociocultural and economic diversity in our community means that there are varied expectations when it comes to what legitimate mathematics education should look like. This can create real conflicts between the teachers who are trying to incorporate more ethnomathematical practices and parents or community members who may not see the value in those approaches. It is an ongoing challenge to try and bridge that gap and demonstrate the educational benefits of a more holistic, culturally responsive curriculum."*

Teacher 5: *"The pressure from parents to continuously improve our pass rates is intense, and often comes at the expense of our ability to focus on developing the deeper cultural skills and strategies that are so important for our learners. I know integrating ethnomathematical approaches would be hugely beneficial, but the relentless drive for results oriented metrics makes it really difficult to try new things and step outside the boundaries of the prescribed curriculum."*

The qualitative data suggests that some parents and community members may not see the value in integrating informal mathematical practices into the formal curriculum. This points to a potential disconnection between the teachers' efforts to incorporate ethnomathematical approaches and the perceptions of the parents and community regarding what constitutes legitimate mathematics education. Teachers reported that they try to engage with parents and the community to demonstrate the educational benefits of incorporating ethnomathematical practices, but this can be an ongoing challenge.

The qualitative indicates that all teachers interviewed reported that high and unrealistic expectations from parents to improve pass rates put significant pressure on them. This pressure causes teachers to focus more on achieving desired results, rather than prioritizing the integration of cultural skills and strategies through ethnomathematical approaches. The need to meet these high expectations can create a tension between the teachers' pedagogical goals and demands of parents.

Many teachers reported that the socioeconomic and cultural differences within the community can lead to varied expectations, which may create conflicts between teachers and the community. This diversity of perspectives and expectations within the community can make it challenging for teachers to find a balanced approach that resonates with all stakeholders. The varied expectations can also contribute to the perceived lack of support or understanding for the integration of ethnomathematics.

These qualitative findings highlight the complex dynamics involved in the integration of ethnomathematics, where teachers must navigate the expectations and perceptions of parents and the community, in addition to the systemic factors such as curriculum demands and assessment structures. This agrees with the emphasis teachers may face resistance from students, parents and colleagues when integrating ethnomathematics in the mathematics curriculum (Aikenhead, 2017).

By addressing the parental and community expectations and perceptions and aligning those with the teacher's efforts to integrate ethnomathematics a more inclusive and equitable mathematics education can be achieved, benefiting all learners.

Qualitative from teachers' questionnaire on ways that parental and community expectations and perceptions of "legitimate" pose challenges for teachers.

Teachers' reactions on ways that parental and community expectations and perceptions of "legitimate" pose challenges for teachers n=5

Representative quotes

Teacher 1: *"One of the biggest hurdles l face is the preconceived notions that parents and community members have about what constitutes real or legitimate mathematics. There is often a perception that the formal, academic mathematics taught in schools is the only valid approach, and that incorporating more ethnomathematical practices is somehow less rigorous or valuable. It can be really challenging to push back against those entrenched beliefs and demonstrate the educational benefits of a more culturally responsive curriculum."*

Teacher 2: *"The pressure from parents and the community to focus solely on the traditional mathematics curriculum and teaching methods is a constant challenge. There is a perception that anything outside of the dominant, decontextualized approach to Mathematics is somehow less valuable or legitimate. As a teacher, l would love to be able to explore more ethnomathematical strategies and connect the curriculum to my learners' experiences, but the expectations from the community make that really difficult."*

Teacher 3: *"One of the biggest issues l face is the preconceived notions that parents and community members have about what real mathematics should look like. There is often a belief that the formal, academic approach taught in schools is the only valid way, and that incorporating more ethnomathematical practices is less rigorous or valuable. It can be a real uphill battle trying to change those deeply-rooted perceptions and demonstrate the educational benefits of a more culturally responsive curriculum."*

Teacher 4: *"The perception that ethnomathematical approaches are less valuable than the dominant, formal mathematics curriculum is a constant challenge. Parents and community members often have very fixed ideas about what constitutes legitimate mathematics learning, and they put a lot of pressure on us as*

teachers to focus solely on the traditional methods and content. It makes it really difficult to explore more culturally relevant strategies and connect the Mathematics to my learners' experiences."

Teacher 5: *"One of the biggest obstacles l face is the preconceived notions that parents and community members have about what real mathematics should look like. There is a strong belief that formal academic approach taught in schools is the only valid way and that incorporating more ethnomathematical practices is somehow less rigorous or valuable. As a teacher, l would love to be able to explore those culturally responsive strategies more but the pressure from the community to stick to the traditional curriculum and teaching methods is constant."*

From teachers' questionnaires all 5 out of 5 teachers reported that parents and community members may have preconceived notions about what constitutes legitimate or real mathematics, which may not align with the principles of ethnomathematics. This disconnection between the teachers' efforts to incorporate ethnomathematical approaches and the parents' and community's understanding of what real mathematics can create significant challenges.

Many teachers reported that they may face pressure from parents and community to focus solely on traditional mathematics curriculum and teaching methods, limiting their ability to explore and incorporate ethnomathematical approaches. This pressure to adhere to the dominant decontextualized mathematical knowledge can create significant challenges for teachers who are trying to create a more inclusive and culturally responsive mathematics education. This agrees with the emphasis teachers may face resistance from students, parents and colleagues when integrating ethnomathematics in the mathematics curriculum (Aikenhead, 2017).

The qualitative data from teachers' questionnaire highlights the critical role that parental and community expectations and perceptions play in shaping the integration of ethnomathematics in the classroom.

4.3 Summary

The data provides valuable insights into the interplay between learners' intuitive understanding of set-related concepts and the formal Sets curriculum. Several key findings emerge from qualitative and quantitative data points. Qualitative data indicates that learners frequently apply Sets concepts such as grouping, partitioning and classification in a variety of out-of-school activities like farming, cooking and budgeting. Quantitative data further with a significant number of learners reporting the use of set-related ideas. Qualitative data reveals that teachers consistently observe learners demonstrating proficiency in applying set-related concepts like grouping and partitioning in everyday tasks. Quantitative data shows that all 5 teachers noted learners' ability in partitioning resources while teachers observed learners' natural use of set-related ideas. Qualitative data suggests that learners frequently apply set-related mathematical concepts like grouping, classifying and identifying membership in traditional games, puzzles and budgeting. Quantitative data corroborates this, showing that learners were observed using set-related concepts. Qualitative data reveals that both learners and teachers recognize the presence of set-related concepts in traditional games, puzzles and storytelling. Quantitative data indicates that a majority of learners highlighted these set-related concepts, and all 5 teachers noted an innate grasp of set ideas. Qualitative and quantitative data strongly suggest that both learners and teachers value the importance of incorporating learners' daily activities and experiences into Mathematics lessons of Sets. Quantitative shows mean ratings from 4.2 to 4.6 on a 5 point scale, indicating a high level of consensus on the benefits of this approach. The data indicates that rural learners demonstrate a strong understanding of set-related concepts through their everyday practices and that leveraging these experiences could enhance their learning of formal Sets concepts in the curriculum.

Many learners felt their existing experiences and intuitive understanding of set-related concepts aligned well with formal Sets curriculum and could be leveraged to make the learning more relevant. However few learners struggled to clearly articulate these connections between their daily activities and Sets content. All teachers recognized the alignment between learners' household practices (grouping, classifying, counting) and the formal Sets.

Integrating learners' set-related daily experiences can provide relevant and meaningful contexts for applying set-related ideas, bridge the gap between informal intuition and formal concepts as well as increase learner engagement, motivation and understanding. Many teachers said it would make the Sets content more relatable, accessible engaging and applicable to learners' lives. It allows learners to contribute their own perspectives and real world examples. On play-based instructional strategies, teachers found various Set-themed games and activities effective in connecting Sets to learners' everyday mathematical experiences. These hands-on, contextual

These hands-on, contextual activities helped bridge the gap between intuitive set-related concepts and the formal curriculum. In summary, the data suggests that intentionally connecting the Sets curriculum to learners' existing set-related experiences and intuitions, through both instructional approaches and play-based activities, can significantly enhance learners' engagement, understanding and application of formal Set Theory concepts. However, the limited implementation of these strategies in the observed classrooms indicates an opportunity for further professional development and integration of ethnomathematics-based teaching methods. Challenges faced bet teachers to integrate ethnomathematics include bridging the gap between informal, contextualized mathematics and formal, decontextualized mathematics. Teachers struggle to connect learners' informal, practical mathematical knowledge to the formal academic curriculum. There is a mismatch between the ways of thinking, problem-solving strategies, and representations used in learners' communities and those emphasized in formal school mathematics. Quantitative data shows teachers' rate this challenge as a 4 out of 5, indicating they face it to a large extent. Resource limitations hindering integration of ethnomathematics is another challenge. Lack of access to ethnomathematical teaching materials and professional development opportunities. Quantitative data shows 4 out of 5 teachers cited resource limitations like lack of funding and materials as hindering their efforts. Another challenge is cultural, linguistic, and pedagogical barriers. Cultural differences between learners' home environments and the school context create misunderstandings. Language barriers hinder effective

communication and integration of ethnomathematical concepts. Pedagogical approaches in the traditional mathematics curriculum may not align with ethnomathematics. Quantitative data indicates 5 teachers mentioned the challenge of balancing mathematics grounded in culture with curriculum content. Other challenges include school policies, curriculum demands, and assessment structures may not support integration of ethnomathematics. Time constraints and heavy workloads make it difficult for teachers to devote time to ethnomathematical lessons. Teachers fear straying from prescribed standards and lesson plans, worried about losing rigor or failing to prepare students for standardized assessments.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This research study has provided valuable insights into the potential benefits and challenges of incorporating ethnomathematics-based instructional strategies for teaching Sets to secondary school learners in Zimbabwe. The findings from the preceding chapters offer a comprehensive understanding of how intentionally connecting the formal Set Theory curriculum to learners' existing set-related experiences and intuitions can enhance engagement, understanding, and application of these mathematical concepts.

The study employed a mixed-methods approach, gathering both qualitative and quantitative data to investigate the research questions. Chapter 1 established the theoretical and practical rationale for exploring alternative approaches, such as ethnomathematics, to make mathematics instruction more culturally relevant and engaging for diverse learners. Chapters 2 reviewed literature on wide range applications of Mathematics concept in various real-world domain, challenges in integrating ethnomathematics in classroom and gaps that need to be addressed were identified. Chapter 3 detailed the research design, methods, and data collection and analysis procedures used to examine the implementation and impacts of ethnomathematics-based teaching strategies in the Set Theory classroom.

The results presented in Chapters 4 and 5 demonstrate that when teachers deliberately integrate learners' informal, set-related experiences and real-world examples into their instructional approaches and supplement them with play-based activities, it can significantly improve learners' understanding and application of formal Set Theory concepts. Learners reported feeling more motivated and able to connect the academic content to their everyday lives. Teachers also noted increased learner engagement and the ability to bridge the gap between intuitive set-related knowledge and the decontextualized formal curriculum.

However, the data also revealed several key challenges that hinder the widespread integration of ethnomathematics-based teaching methods. These include the difficulty of bridging the divide between informal, contextualized mathematics and formal, decontextualized mathematics; limited access to appropriate resources and professional development opportunities; cultural, linguistic, and pedagogical barriers; and structural constraints within the education system, such as inflexible curricula and high-stakes assessments.

This concluding chapter will synthesize the key findings, draw overarching conclusions, and provide recommendations for addressing the identified challenges and further incorporating ethnomathematics into mathematics education. By highlighting the benefits of this pedagogical approach and providing guidance on how to overcome the barriers, this research aims to inform and support teachers, curriculum developers, and policymakers in their efforts to create more culturally responsive and engaging mathematics instruction.

5.2 Summary of the study

This study investigates the effects of the ethnomathematics-based instructional method on learners' achievement in Sets at Mururi Secondary in Zvimba District. Chapter 1 introduces the background and significance of the study, highlighting the need to explore alternative approaches that promote cultural relevance and engage learners in the teaching and learning of Set Theory. The research problems and questions focus on the potential benefits of incorporating ethnomathematics instructional methods for teaching Set Theory.

The study is grounded in the pragmatism research paradigm, allowing for the use of both qualitative and quantitative methods. It will be conducted in Zvimba District, Zimbabwe, focusing on 3 learners and 5 Mathematics teachers at Mururi Secondary School. Proportional stratified sampling will be used to select a representative sample of 40 learners (20 boys and 20 girls) from the two Form 3 classes. Data was

collected through questionnaires, interviews, and observations, and analyzed using both quantitative and qualitative methods.

Rural learners demonstrate strong skills in grouping and classifying items in their household activities. This aligns with mathematical concepts of Sets, including defining Sets, identifying set membership and performing sets operations. Teachers can recognize the connection between learners' real world grouping or classification practices and the learning objectives around Sets.

Learners show an intuitive understanding of partitioning and dividing household resources, spaces and items when managing their living environment and budgeting. This relates to mathematical ideas around part-whole relationships, fractions and proportional reasoning. Teachers can noted how learners' partitioning of resources aligns with Sets concepts like cardinality and subsets. Learners frequently used counting skills in their out-of-school activities. This directly connect to the mathematical concept of cardinality, understanding the number of elements in a Set. Teachers can recognize the link between learners' real world counting and Sets learning objectives around cardinality.

Learners demonstrate strong spatial reasoning and logical thinking abilities. These skills are important mathematical practices that underlie concepts like patterns, relationships and problem solving. Teachers can highlight how learners' spatial and logical thinking align with key mathematical learning goals. The teachers emphasize that rural demonstrate a grasp or understanding of set-related concepts through their traditional games and activities. Examples include learners organizing stones and colour, displaying an intuitive ability to recognize Sets and sets relationships and exhibiting a deep understanding of foundational mathematical ideas related to Sets. Connecting the concepts of Sets to the learners' daily experiences makes the content more relatable, relevant and meaningful. Using familiar objects, materials and contexts from learners' lives and designing activities that mirror their traditional sorting, classifying and partitioning practices helps them to connect Sets to their everyday experiences. Allowing learners to view the practical

application of Sets in their out-of-school activities makes the learning activities more engaging and meaningful. This can improve the learners' overall understanding of set-related concepts. Integrating the learners' set-related daily experiences into the curriculum makes the content more engaging and accessible.

Allowing learners to contribute their own perspectives and real world examples moves beyond just memorizing definitions and procedures. Connecting the Sets curriculum to the learners' set-related experiences outside of school increases the relevance and meaningfulness of the material. This can boost the learners' motivation to engage with and learn the Sets related concepts.

Set-themed activities like Scavenger hunts and card games allow learners to actively explore set concepts in a fun, hands-on manner. These activities connect to the learners' immediate environment, making the abstract ideas more concrete and relatable.

Teachers face challenges in bridging the gap between informal and formal mathematical knowledge. Teachers struggle to effectively connect the learners' informal, practical mathematical understanding developed through everyday activities with the formal, abstract mathematical concepts in the curriculum. Educators lack guidance, resources and flexibility. Teachers express a strong desire for more support, teaching materials and flexibility to adapt lessons inorder to better integrate the informal mathematical knowledge of their learners into their instruction. A few teachers highlighted language barriers as a hindrance to effectively communicating and integrating ethnomathematical concepts with their learners, requiring creative strategies. Curriculum constraints and misalignment is another barrier faced by teachers. Many teachers find the formal curriculum to be disconnected real-world applications and not well aligned with the more contextual, culturally relevant approaches of ethnomathematics creating challenges in seamlessly incorporating these concepts.

Systemic barriers and external pressures are some of the challenges encountered by educators. Teachers face systemic barriers such as cultural divisions and pressures from parents and the education system which make it difficult to prioritize the integration of ethnomathematical approaches in their teaching.

5.3 Conclusions

5.3.1 Which mathematical concepts found in the rural learners out of school mathematical practices can be integrated in the teaching and learning of Sets?

5.3.1.1 Grouping and classification

Rural learners demonstrate skills in grouping and classifying items in their household activities. This aligns with mathematical concepts of Sets, including defining a set, identifying membership and performing set operations. Teachers recognize the connection between learners' real world grouping/ classification practices and the learning objectives around Sets.

5.3.1.2 Partitioning and division

Learners show an intuitive understanding of partitioning and dividing household resources, spaces and items when managing their living environments and budgeting. This relates to mathematical ideas around part-whole relationships, fractions and proportional reasoning. Teachers note how learners' partitioning of resources aligns with Sets concepts like cardinality and subsets.

5.3.1.3 Counting or cardinality

Leaners frequently used counting skills in their out-of-school activities. This directly connects to mathematical concept of cardinality, understanding number in a set. Teachers recognize the link between learners' real-world counting practices and Sets learning objectives around cardinality.

5.3.1.4 Spatial reasoning and logical

Logical thinking demonstrate strong spatial reasoning and logical thinking abilities in their daily activities. These skills are important mathematical practices that underlie concepts like patterns, relationships and problem solving. Teachers highlight how learners' spatial and logical thinking align with key mathematical goals.

5.3.1.5 Intuitive understanding of set-related concepts

The teachers emphasize that rural learners demonstrate grasp or understanding of set-related concepts through their traditional games and activities. Examples include learners organizing stones by colour, displaying an intuitive ability to recognize Sets and set relationships and exhibiting a deep understanding of foundational mathematical ideas related to Sets.

5.3.2 How can the mathematical concepts in the learners' daily activities in Secondary School Mathematics in Sets?

5.3.2.1 Increased relevance and meaningfulness

Connecting the concepts of Sets to the learners' daily experiences makes the content more relatable, relevant and meaningful. Using objects, materials and contexts that are familiar to the rural learners and designing activities that mirror their traditional sorting classifying and partitioning helps them to connect the Set-related concepts to their everyday lives and experiences.

5.3.2.2 Enhanced engagement and understanding

Allowing learners to view the practical application of Sets in their out-of-school activities makes the learning activities more engaging and meaningful and can improve their overall understanding.

4.3.2.3 Accessibility and applicability

Integrating the learners' set-related daily activities into the curriculum makes the content more accessible and engaging. Allowing learners to contribute their own perspectives and real-world examples moves beyond just memorizing definitions and procedures.

5.3.2.4 Increased motivation and relevance

Connecting the Sets curriculum to the learners' set-related experiences outside of school increases the relevance and meaningfulness of the material which can boost their motivation.

5.3.2.5 Play-based activities are engaging

Set-themed activities like Scavenger hunts and card games allow learners to actively explore Sets concepts in a fun, hands on manner that connects to their immediate environment, making the abstract ideas more concrete and relatable.

5.3.3 What are challenges faced by Mathematics teachers in integrating ethnomathematics?

5.3.3.1 Bridging the gap between informal and formal Mathematical knowledge

This is the primary challenge identified by all teachers who struggle to find effective ways to connect the learners' informal practical mathematical understanding developed through everyday activities with the formal, abstract mathematical in the curriculum.

5.3.3.2 Need for guidance, resources and flexibility

Teachers express a strong desire for more support, teaching materials and flexibility to adapt lessons inorder to better integrate the informal mathematical knowledge of their learners into their instruction. A few teachers highlighted language barriers as a hindrance to effectively communicating and integrating ethnomathematical concepts with their learners, requiring creative strategies.

5.3.3.3 Curriculum constraints and misalignment

Many teachers find the formal curriculum to be disconnected from real-world applications and not well aligned with the more contextual culturally relevant approaches of ethnomathematics, creating challenges in seamlessly incorporating these concepts.

5.3.3.4 Systemic barriers and external pressures

Teachers face systemic barriers such as cultural divisions and pressures from parents and the education which make it difficult to prioritize. The integration of ethnomathematical approaches in teaching.

5.4 Recommendations

Leveraging learners' existing knowledge and experiences is needed. We should actively engage learners in recognizing and articulating the connections between their daily activities and the formal Set Theory concepts. Learners must be encouraged to share their intuitive understanding of set-related ideas from their everyday lives, and use these as a foundation for building deeper comprehension (Owusu-Darko et al, 2023). The use of play-based instructional strategies must be encouraged to give learners opportunities to actively engage with Sets concepts. We must design lessons that incorporate familiar, contextual examples and applications of set-related concepts from learners' households and communities (D'Ambrosio & Rosa, 2016).

Professional development and resources for teachers must be provided. We should advocate for increased access to ethnomathematics-based teaching materials and professional development opportunities for teachers. We should assist in developing or curating a repository of ethnomathematical resources, lesson plans, and instructional strategies that teachers can readily utilize (Gray, 2022). Workshops and training sessions to help teachers learn how to effectively integrate learners' cultural and linguistic knowledge into their mathematics instruction must be organized.

Cultural, linguistic, and pedagogical barriers must be addressed. Collaboration with teachers to identify and address the specific cultural, linguistic, and pedagogical challenges they face in their classrooms must be implemented (Forbes, 2018). We should explore ways to adapt the formal curriculum and teaching approaches to be more inclusive of diverse mathematical practices and representations. Discussions and workshops with teachers, parents, and community members to build understanding and acceptance of ethnomathematical approaches should be encouraged.

We must advocate for systemic and institutional changes. School administrators and policymakers must advocate for the inclusion of ethnomathematics in the curriculum, assessment frameworks, and teacher

training programs. Adjustments to school policies, schedules, and resource allocation to better support the integration of ethnomathematics-based teaching and learning must be proposed. Engagement with parents and the broader community to build support and understanding for the value of incorporating learners' cultural and contextual mathematical knowledge in the classroom should be made (Forbes, 2018).

Action research and dissemination of its findings should be conducted. Initiation or participation in action research projects that explore the implementation and impact of ethnomathematics-based teaching strategies in Sets and other mathematics topics should be made. Dissemination of the research findings through publications, presentations, and collaborations with educators, researchers, and policymakers to promote the adoption of ethnomathematics in mathematics education should be made (Owusu-Darko et al, 2023).

By implementing these recommendations, we can help to bridge the gap between learners' informal mathematical knowledge and the formal Set Theory curriculum, making the content more engaging, relevant, and accessible for diverse learners.

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APPENDICES

Face to face interview for teachers

Thank you for agreeing to participate in this interview. The purpose of this interview is to gain deeper understanding mathematical concepts and ideas you apply in your everyday life outside of classroom. Your responses will provide valuable qualitative data to supplement the information gathered from the previous surveys.

Your responses will be kept completely confidential. Please feel free to share your thoughts and experiences.

Interview will take approximately 30-45 minutes.

Are there any questions before we begin?

Section A Demographic information

1. Age……
2. Sex…….
3. Highest qualification…….
4. Teaching experience……..

Section B: Rural Learners' Out-of-School Mathematical Practices and Concepts

1. On a scale of 1 to 5 (1= rarely observed, 2= Occasionally observed, 3 = sometimes Observed, 4 = Often Observed, 5 = frequently observed), how common are the following

mathematical practices and concepts utilized by rural learners in their out-of-school activities?

a) Grouping and classification 1 2 3 4 5
b) Partitioning and division 1 2 3 4 5
c) Spatial reasoning 1 2 3 4 5
d) Patterns and relationships 1 2 3 4 5
e) Probability and chance 1 2 3 4 5

2. Can you provide specific examples of how these out-of-school mathematical practices and concepts could be mapped to the learning objectives and content of the sets topic in the curriculum?
3. What are the key mathematical concepts and skills embedded in rural learners' out-of-school activities related to sets?
4. Can you describe in detail how you have observed rural learners utilizing set related concepts (e.g., grouping, classification, partitioning) in the management of their households and budgeting?
5. How have you observed rural learners' informal understanding of set-related ideas, such as membership and cardinality, manifesting in their traditional games, puzzles, and storytelling? Please provide specific examples.

Section B: Integrating Learners' Daily Mathematical Experiences

1. On a scale of 1 to 5 (1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly Agree), to what extent do you agree that incorporating learners' daily activities and experience into Mathematical lessons is important.

2. Can you provide specific examples of how these mathematical concepts from learners' daily activities align with the learning objectives and covered in the sets topic in the secondary school mathematics curriculum?

   i)The strategy/approach

   ii) How it helps bridge the gap between daily life and the formal mathematics

Section C: Challenges and Barriers to Integrating Ethnomathematics

To what extent do the following factors hinder your teachers' efforts to integrate ethomathematics into their mathematics lessons? On a scale of 1 to 5 (1 = Not at all, 2 = To a Small Extent, 3 = to a moderate Extent, 4 = To a large Extent, 5 = To a greater Extent)

1 2 3 4 5

a) Lack of ethnomathematical teaching materials and professional development opportunities

1 2 3 4 5

b) Cultural/linguistics barriers

1 2 3 4 5

c) School policies and curriculum demands

1 2 3 4 5

d) Parental/community perceptions of “legitimate’’ mathematics

1 2 3 4 5

e) Resource limitations (e.g. funding, technology)

1 2 3 4 5

1. On a scale of 1 to 5 (1 = Not significant, 2= somewhat significant, 3 = moderately significant, 4 = highly significant, 5 extremely significant), how significant are the following challenges you face in bridging the gap between the informal, contextualized mathematics used by learners in their communities and the formal, decontextualized mathematics taught in the classroom?

    a) Lack of understanding of learners’ out of school
    b) Difficulty in aligning learners’ informal knowledge with curriculum objectives
    c) Integrating culturally relevant content within the formal curriculum
    d) Adapting teaching methods to accommodate diverse mathematical practices

2. What specific resource limitations (e.g. lack of ethnomathematical teaching materials, limited professional development opportunities)

3. Can you describe any cultural, linguistic and pedagogical barriers you have encountered when trying to integrate ethnomathematical concepts into the teaching of standard mathematical topics like Sets? What strategies have you used to overcome these barriers?

4. How do factors such as school policies, curriculum demands, assessment structures, and resource limitations impact your ability to effectively integrate ethnomathematics in your mathematics lessons? Please provide specific examples.

5. In what ways do parental and community expectations and perceptions of "legitimate'' mathematics pose challenges for you when attempting to integrate ethnomathematics? How have you addressed these challenges?

   Thank you

Learners' interview

Thank you for agreeing to participate in this interview. The purpose of this interview is to gain a deeper understanding of mathematical concepts and ideas you apply in your everyday life outside of classroom. Your responses will provide valuable qualitative data to supplement the information gathered from the previous surveys.

Your responses will be kept completely confidential. Please feel free to share your thoughts and experiences.

Interview will take approximately 30-45 minutes.

Section A: demographic Information

Age ……

Form ……

Sex……

Section B:

1. Quantitative: On a scale of 1-5 (1 = Least Frequent, 2 = Slightly Frequent, 3 = Moderately Frequent, 4 = Very Frequent, 5 = Most Frequent), how often do you use the following mathematical practices and concepts in your out-of-school activities:

a) Grouping

b) Classification

c) Partitioning

d) Intuitive understanding of set related concepts

e) Set cardinality

Qualitative: Can you provide some specific examples of how you use these mathematical ideas in your daily life outside of school?

2. Qualitative: In what ways do you think the mathematical practices and concepts you use in your daily life relate to the learning objectives and content covered in the Sets topic in your school curriculum? Can you provide some examples that illustrate these connections?

3. Qualitative: what are the key mathematical concepts and skills embedded in rural learners' out-of-school activities related to sets?

4. Qualitative: Can you describe how you utilize set-related concepts like grouping, classification, and partitioning when managing your household chores or budgeting your personal expenses?

5. Qualitative: Can you share some examples of how your informal understanding of set-related ideas such as membership and cardinality are reflected in the traditional games, puzzles, or storytelling you engage with outside of school?

Section C:

2. Qualitative: In what ways do you think the mathematical concepts you use in your daily activities align with the learning objectives and content covered in the Sets topic in your school mathematics curriculum? Can you give some examples that illustrate these connections?

Teachers Lesson Observation Tool

Section A: Demographics

Teacher's highest qualifications_____ Teaching experience……

School……Age……..

Section B: Integrating Learners' Daily Mathematical Experiences

1. On a scale of 1 to 5 (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree), to what extent do you agree that incorporating learners' daily activities and experience was important in the observed Mathematics lessons.

- Observe and record examples provided by the teacher and learners.

2. How well did daily mathematical practices and concepts used by the learners align with the learning objectives and content covered in the observed lesson of Sets?

Scale from 1-5 with (1 = Not at All, 2 = Slightly, 3 = Moderately, 4 = Well, 5 = Very Well)

- Circle the appropriate number: 1 2 3 4 5

3. In what ways do you think integrating learners' set-related daily experiences enhanced their understanding and application of set theory concepts in the observed lesson?

- Observe and record the teacher's response.

4. How did incorporating learners' set-related daily activities contribute to the relevance, engagement, and contextualization of the Sets in observed lesson.

- Observe and record the teacher's response.

5. What play-based instructional strategies or pedagogical approaches have you found effective in bridging the gap between the mathematical concepts used in learners' daily lives and the formal treatment of Sets in the curriculum?

- Observe and record the response.

Section C: Challenges in Integrating Ethnomathematics

6. To what extent do the observed teachers face challenges in bridging the gap between the informal, contextualized mathematics used by their learners in their communities and the formal, decontextualized

mathematics taught in their classroom? scale from 1-5 with (1 = Not at All, 2 = To a Small Extent, 3 = To a Moderate Extent, 4 = To a Large Extent, 5 = To a Greater Extent)

- Circle the appropriate number: (1) (2) (3) (4) (5)

72. What resource limitations, such as lack of ethnomathematical teaching materials or professional development opportunities, have hindered your efforts to integrate ethnomathematics?

- Observe and record the response.

Teacher questionnaire

Introduction:

This questionnaire is part of a research study exploring the integration of rural learners' out-of-school mathematical practices and concepts into the teaching and learning of Sets. Your responses will help us better understand how your daily mathematical experiences can be leveraged to enhance your understanding of Set theory.

Your responses will be kept completely confidential. Please feel free to share your thoughts and experiences.

Section A: Demographic Information

1. Age: _____

2. Gender: _____

3. Education Level: _____

4. Teaching experience _____

Section B: Exploring Rural Learners' Out-of-School Mathematical Practices

1. What are some common mathematical practices you observe your rural learners engaging in outside of the classroom?

2. To what extent do you see your rural learners utilizing concepts related to Sets (e.g. grouping, classification, partitioning) in the management of their households and budgeting? (Scale from 1-5, 1= Not at All, 2 = To a Small Extent, 3 = To a Moderate Extent, 4 = To a Large Extent, 5 = To a Greater Extent)

3. How frequently do your rural learners demonstrate understanding of set-related ideas like membership and cardinality in their traditional games, puzzles, and storytelling? (use the scale from 1-5, 1 = Least Frequent, 2 = Slightly Frequent, 3 = Moderately Frequent, 4 = Very Frequent, 5 = Most Frequent)

4. Please describe some specific examples of how your rural learners apply set-related mathematical concepts in their out-of-school activities.

5. How does rural learners' informal understanding of set-related ideas, such as membership and cardinality, manifesting in their traditional games, puzzles, and storytelling? Please provide specific examples.

Section B: Integrating Learners' Daily Mathematical Experiences

6. On a scale of 1 to 5 (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree), to what extent do you agree that incorporating learners' daily activities and experience into Mathematics lessons is important.

7. How well do these daily mathematical practices and concepts used by your learners align with the learning objectives and content covered in the Sets topic of the secondary school mathematics curriculum? Use scale from 1-5 with (1 = Not at All, 2 = Slightly, 3 = Moderately, 4 = Well, 5 = Very Well)

8. In what ways do you think integrating learners' set-related daily experiences could enhance their understanding and application of set theory concepts?

9. How can incorporating learners' set-related daily activities contribute to the relevance, engagement, and contextualization of the set theory curriculum?

10. What play-based instructional strategies or pedagogical approaches have you found effective in bridging the gap between the mathematical concepts used in learners' daily lives and the formal treatment of Sets in the curriculum?

Section C: Challenges in Integrating Ethnomathematics

11. To what extent do you face challenges in bridging the gap between the informal, contextualized mathematics used by your learners in their communities and the formal, decontextualized mathematics taught in your classroom? (Scale from 1-5, 1= Not at All, 2 = To a Small Extent, 3 = To a Moderate Extent, 4 = To a Large Extent, 5 = To a Greater Extent)

12. What resource limitations, such as lack of ethnomathematical teaching materials or professional development opportunities, have hindered your efforts to integrate ethnomathematics?

13. What cultural, linguistic, and pedagogical barriers do you encounter when trying to integrate ethnomathematical concepts into your teaching of standard mathematical topics like Sets? 14. How do factors such as school policies, curriculum demands, assessment structures, and resource limitations impact your ability to effectively integrate ethnomathematics in your mathematics lessons?

15. In what ways do parental and community expectations and perceptions of "legitimate" mathematics pose challenges for you in integrating ethnomathematics?

Questionnaire for Rural Learners

Introduction:

This questionnaire is part of a research study exploring the integration of rural learners' out-of-school mathematical practices and concepts into the teaching and learning of Sets. Your responses will help us better understand how your daily mathematical experiences can be leveraged to enhance your understanding of Set theory.

Your responses will be kept completely confidential. Please feel free to share your thoughts and experiences.

Section 1: Demographic Information

1. Age: _____

2. Gender: _____

3. Grade Level: _____

4. Name of School: _____

5. Location of Home (Village/Town): _____

Section 2: Out-of-School Mathematical Practices and Concepts

6. What are some of the common mathematical activities or tasks you engage in outside of school?

a. _____

b. _____

c. _____

d. _____

7. In the activities you mentioned, what specific Sets concepts or skills do you use

a. _____

b. _____

c. _____

d. _____

8. Rank the following potential benefit of set-related mathematical concepts in your out-of-school activities Use the scale from 1-5 with (1 = Not Beneficial, 2 = Somewhat Beneficial, 3 = Moderately Beneficial, 4 = Highly Beneficial, 5 = Very Beneficial):

a. Grouping/Classification 1 2 3 4 5

b. Partitioning 1 2 3 4 5

c. Membership 1 2 3 4 5

d. Cardinality (counting/quantifying) 1 2 3 4 5

e. Set operations (union, intersection) 1 2 3 4 5

9. Describe how you use the concept of sets (groups, collections, categories) in your daily out-of-school activities. Provide specific examples.

_____

_____

_____ _____

10. In what ways do you utilize set-related ideas like membership, cardinality, and partitioning in your traditional games, puzzles, or storytelling?

_____

_____

_____

11. How do you use set-related concepts (e.g., grouping, classification, partitioning) in the management of your household resources and budgeting?

_____

_____

_____

Thank you for your participation!