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INFUSION OF INDIGENOUS KNOWLEDGE INTO ORDINARY LEVEL MATHEMATICS LEARNING ACTIVITIES: EXPERIENCES FROM ST JOSEPHS' MABURUTSE SECONDARY SCHOOL

BY

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DECLARATION

I Sauramba Melody Munyaradzi, declare that is my original work that has not been submitted for any degree or examination in any other university and that all the sources I have used or quoted here have been indicated and acknowledged.

Signature:  Date: 15.06.24

APPROVAL FORM

The undersigned certify that they have supervised, have read and recommend to the University for acceptance and examination a research project entitled: ***Infusion of Indigenous Knowledge into Ordinary Level Mathematics learning activities: Experiences from St Josephs' Maburutse Secondary School*** submitted by Sauramba Melody Munyaradzi in partial fulfilment of the requirements for the award of the Bachelor of Science Education (Honours) degree in Mathematics.

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DEDICATION

I dedicate this project to my husband Tinashe and daughter Asher Sengu for their unconditional love throughout the study. I also dedicate this piece of work to my parents and siblings who played a pivotal role in spiritual and moral support throughout my academic journey.

ABSTRACT

This research sought to gain insight into the infusion of Indigenous Knowledge into Ordinary Level Mathematics teaching and learning activities at the selected school. The researcher adopted a qualitative approach for data generation, analysis, and discussion. In this study, there were six teachers and sixteen learners who were purposively sampled to participate in this study. The researcher used an interview guide and focus group discussion in generating data. Thematic analysis was used to analyze the sourced. The study revealed that infusion of IK into Ordinary Level Mathematics enhances student engagement, motivation and critical thinking. It was revealed that various approaches (such as inquiry-based learning, problem-based learning, storytelling, traditional games, etc.) were when integrating IK into Ordinary Mathematics teaching-learning.
In addition, it was revealed that challenges like resistance to change, lack of knowledge of the community and lack of resources are being faced by teachers in infusing indigenous knowledge systems. Lastly the findings highlighted that, strategies that can be used to minimize the above challenges are, professional development for teachers, deploying teachers in communities that they are familiar with and utilizing crowd funding platforms or community fundraising initiatives to support specific IKS projects. From the findings it can be concluded that various approaches (i.e., storytelling, inquiry-based learning, project-based learning, etc.) were being used when infusing IK into Ordinary Level Mathematics teaching and learning. From the findings, it can be recommended that the need for an ongoing support and monitoring in schools so as to enhance the infusion of IK into Ordinary Level Mathematics teaching and learning.

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CHAPTER 1: PROBLEM AND ITS SETTING

1.1 Introduction

This chapter specifically focuses on the background of the study, statement of the problem, research questions, significance of the study, delimitation of the study, limitation of the study, definition of definitely key terms and chapter summary.

1.2 Background to the study

The infusion of Indigenous Knowledge (IK) in Mathematics teaching-learning has the potential to make the subject more relevant, meaningful and relatable to students in Zimbabwe (Adams et al., 2018), this can improve student's understanding and interest in the subject. IK are the ways of knowing and understanding the world that are embedded in the culture and traditions of local communities (Meyer & Brenner, 2018). This knowledge is often overlooked or dismissed in formal education settings, including in the teaching of mathematics (Bose, 2020). However, there is growing recognition of the value of integrating IK into the Mathematics curriculum. Indigenous Mathematics is a body of knowledge that has been developed and passed down through generations by indigenous peoples around the world (Smith, 2018). This knowledge is deeply rooted in cultural practices, such as storytelling, language, and traditional art. It is often connected to place and nature, and it is characterized by flexible and holistic thinking (Chaka et al., 2020).

Indigenous Mathematics can provide a unique and valuable perspective on mathematics that can enhance students' learning and understanding (Makgakga, 2016). IK is not only found in the Shona culture, but in many other cultures around the world such as, in the Inca culture of South America, for example, the concept of zero is represented by a shell and in the Mayan culture of Meso-America, the concept of zero is represented by a snake eating its own tail (Battiste, 2016). These examples show how different cultures have developed their own unique ways of representing Mathematical concepts. They demonstrate the diversity and creativity of indigenous Mathematics and also IK can be infused into Mathematics instruction in several ways to enhance students' problem-solving skills, critical thinking and helps to promote inclusivity and representation of diverse cultures and perspectives in the curriculum (Bailey, 2020). However, there is a dearth of literature on the infusion of IK in the teaching of mathematics in Zimbabwe for example, according

to Harris et al (2019) schools may not have sufficient resources or support to effectively integrate IK into Mathematics teaching-learning, more so, there may be a risk of misrepresentation and may face resistance from educators, parents or students. Therefore, it is against this background that the researcher sought to gain insight into infusion of IK into Ordinary Level Mathematics teaching-learning.

1.3 Statement of the Problem

In recent years, there has been a developing awareness in the Ministry of Primary and Secondary Education of the value of incorporating IK into Ordinary Level Mathematics teaching-learning (Setati & Addler, 2020). However, regardless of efforts to promote inclusivity and cultural relevance in the curriculum, there are limited studies on strategies for effective infusion of IK into Ordinary Level Mathematics teaching-learning. This has created gaps in the literature concerning the infusion of IK into Ordinary Level Mathematics teaching-learning. It is in this context that this sought to contribute towards the closure of the identified gap guided by the following main research question: How IK is infused effectively into Ordinary Level Mathematics teaching-learning?

1.4 Research questions

From the above main research question the following sub-research questions were derived:

1. What is the relevance of infusing IK into Ordinary Level Mathematics teaching-learning activities?
2. What approaches are used to infuse IK into Ordinary Level Mathematics teaching-learning activities?
3. What challenges are encountered when infusing IK into Ordinary Level Mathematics teaching-learning activities?
4. What strategies can be used to minimize the challenges encountered when infusing IK into Ordinary Level Mathematics teaching-learning?

1.5 Significance of the study

1.5.1 Curriculum developers

The study findings will be beneficial to the curriculum developers in the Ministry of primary and secondary education's Curriculum development Unit to institute innovations in the curriculum that will help in the infusion of IK into Ordinary Level teaching-learning activities.

1.5.2 Mathematics teachers

The results of this study will influence teachers' methods and activities in teaching-learning. This study will bring about changes in the approaches and strategies used in Mathematics teaching-learning.

1.5.3 Learners

The significance of this study also lies in its potential to improve student outcomes. By integrating IK into Mathematics teaching-learning, learners may be better able to understand and apply mathematical concepts in real life, leading to improved problem-solving skills and critical thinking. This could have a positive impact on student performance and achievement, and may ultimately lead to improved educational outcomes for learners in Zimbabwe and other countries.

1.5.3 Bindura University of Science Education

The findings of this study could help the academic community and is going to benefit from this study and can trigger further studies.

1.5.5 Researcher

A researcher acquires a deeper grasp of the arithmetic processes. Furthermore, a researcher is helped by a precise research design to complete the objectives of the study in a given time and allows getting the best answer for the research problems. The researcher has to complete all duties even with limited asserts in a better way.

1.6 Delimitation of the study

The Ministry of Primary and Secondary Education has the following administrative districts: Buhera, Nyanga, Chipinge, Mutare Central, Mutare Rural, and Chimanimani. This study was centered on Buhera District which is made of schools offering basic education from ECD A – Advanced Level in accordance with the requirements of the new curriculum framework (2015-2023). In this study specific reference was made to St Josephs' Maburutse Secondary School with an enrolment of 150 learners and staff complement of 7 teachers. The selected school offers basic education from Form 1 - 4. At this secondary school the study delved on the infusion of IK into Ordinary Level Mathematics teaching-learning.

1.7 Limitations of the study

The findings of the study may not be generalized to all secondary school students in Zimbabwe, as the study will only include students at St Josephs' Maburutse Secondary School and also the findings of the study may not be applicable to other communities. The study is limited by the researcher's ability to access and interpret the data, and by the quality and accuracy of the data itself. The study is limited by the time and resources available for the research. These limitations are inherent to the study, and are important to consider when interpreting the findings.

1.8 Definitions of key terms

In this section the following terms are defined contextually:

1.8.1 Indigenous Knowledge It refers to the unique knowledge, skills, beliefs, practices and technologies that have been developed by various indigenous communities over generations (Posey, 2015). These systems are deeply rooted in the cultural traditions, values and experiences of a particular group of people and are typically passed down orally from one generation to another (Warren et al., 2015). Learning activities refer to the specific tasks, exercises or assignment that students engage in to acquire or develop various skills (Setati & Addler, 2020). In the context of mathematics education, learning activities can take various forms, including problem solving tasks, group discussions, hands-on experiments, investigations, real-world applications and computer simulations (Bobis, 2017).

1.8.2 Ordinary Level Mathematics teaching-learning

Is a level of mathematics education typically taught in secondary schools around the world (Bostock and Shephard, 2018). This level of Mathematics usually covers topics such as algebra, geometry, trigonometry, calculus statistics, and probability (Council for the Indian School, 2019).

1.8.3 Infusion

Infusion refers to the process of integrating or incorporating a particular element or concept into a larger context or system (Merriam, 2021). In the context of education, infusion implies to blending or merging difference different knowledge systems, typically incorporating a more traditional or dominant knowledge system with other diverse knowledge systems (Oxford Languages, 2021). For example, in the case of indigenous knowledge infusion in the teaching of mathematics, it involves incorporating indigenous ways of understanding and solving mathematical problems into the existing curriculum or teaching methodologies.

1.9 Chapters layout

Chapter 1: Problem and its setting was put into context.

Chapter 2: Theoretical framework that forms the lens through which the study will be observed. In addition, the gaps to be filled by this study will be identified.

Chapter 3: Research methodology outlines the strategy through which data for this study will be generated, presented, analysed and interpreted.

Chapter 4: Generated data will be presented, analysed and interpreted with the view to provide answers to sub-questions raised in chapter one.

Chapter 5: Overview of the study will be articulated, resulting in the conclusion and recommendations.

1.10 Chapter summary

This chapter targeted on the background of the study, statement of the problem, research questions, significance of the study, limitations of the study and the delimitations of the study in a big way. The researcher additionally defined phrases that may also decorate the understanding of this study, which specially is fairly significant. In the following chapter the researcher dwells on the literature related to the research problem.

CHAPTER 2: REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter will explore the theoretical framework surrounding indigenous knowledge systems, discuss the conceptualization of IK, highlight the benefits of infusing IK into Mathematics teaching-learning, strategies used to infuse IK into Mathematics teaching-learning and challenges encountered when infusing IK into Mathematics teaching-learning.

2.2 Theoretical framework

This study is grounded in a framework comprised of the following theories:

2.2.1 Culturally Relevant Pedagogy

This theory argues that learners learn better when the content and pedagogy is culturally relevant and relatable to their own experiences and backgrounds (Villegas and Lucas, 2022). When applied to the teaching of mathematics, culturally responsive teaching can involve integrating indigenous ways of knowing and doing Mathematics, such as using traditional storytelling, songs, and symbols to explain mathematical concepts (Nieto, 2022). By incorporating IKS and perspectives into the teaching of mathematics, educators can make the subject more accessible and engaging for indigenous students, leading to improved academic outcomes (Ladson-Billings, 2018).

The key tenets of culturally relevant pedagogy include: valuing students cultural backgrounds and identities, creating meaningful and relevant learning experiences, developing students' critical consciousness and fostering positive relationships between students and teachers (Smith et al., 2016). Firstly, diving a little deeper on valuing students' cultural backgrounds and identities, the tenet is based on the recognition that students come from diverse cultural backgrounds and have unique experiences and perspectives (Cajete, 2020). Arzarello and Pedemonte (2017) highlighted that it is important to acknowledge and celebrate these differences, rather than trying to erase them.

The tenet also recognizes that students' cultural backgrounds can have a significant impact on their learning, for example, students may have different approaches to learning and different ways of making sense of the world (Bishop et al., 2015). Incorporating indigenous knowledge into

mathematics learning activities can help to make the content more relevant and meaningful for students. Sibanda and Franklin (2016), asserts that valuing students' cultural backgrounds and identities, is important to create a classroom environment that is welcoming and inclusive for students. Barwell and Barwell (2018), acknowledged the need for teachers to learn about their students' cultures and backgrounds. This enables them to incorporate diverse perspectives into the curriculum, promoting respect and understanding between students and creating a sense of community in the classroom. By creating a welcoming and inclusive environment, teachers can help to ensure that all students feel valued and supported in their learning (Hoyles & Chandra, 2017).

2.2.2 Social constructivist

Social constructivism posits that knowledge is actively constructed by individuals through social interactions and experiences (Banks, 2017). By integrating indigenous into the teaching of mathematics, educators can provide students with diverse perspectives and alternative ways of understanding mathematical concepts, fostering a deeper understanding of the subject and encouraging critical thinking skills (Vygotsky, 2015). Social constructivism is theory that emphasizes the role of social interaction and collaboration in the construction knowledge. According to Sena (2016), knowledge is simply transmitted from teacher to student, but is actively constructed and negotiated by learners as they interact with one another and with their environment. The theory is particularly relevant to the incorporation of indigenous knowledge, as it recognizes the importance of learners' lived experiences and perspectives in the learning process (Chandra, 2017). Sibanda and Franklin (2016), supports that it also emphasizes the importance of creating learning environments that foster collaboration and peer learning. One key aspect of social constructivism is the idea of ''situated cognition'', this concept emphasizes on the importance of learning in a context that is relevant and meaningful to the learner (Chakaipa, 2019). For example, when incorporating indigenous knowledge into mathematics learning activities, it is important to consider the social, cultural, and historical context of the knowledge being shared (Carlson, 2016). This can help to ensure that the knowledge is relevant and meaningful to learners, and that is not divorced from its cultural context.

2.3 Conceptualization of Indigenous Knowledge

IK refers to the collective body of knowledge, beliefs, practices and traditions that have been developed over generations by indigenous communities (Scott & Thornton, 2017). These systems are based on the unique experiences, observations, values and cultural beliefs of a particular group of people (Goos & Comri, 2019). IK encompasses a wide range of topics including traditional medicine, agriculture, hunting, fishing, arts and crafts, ceremonies, storytelling and spirituality (Berkes, 2016). The conceptualization of IK involves several key aspects explained below:

2.3.1 Recognition of diverse

IK vary greatly among different indigenous communities in the world (Hardy, 2020). It is important to recognize and respect the diversity of indigenous knowledge systems and the unique perspectives and practices that each community brings to the table (Smith et al., 2018). The incorporation of indigenous knowledge systems into Mathematics learning activities, based on the recognition of diversity, can be conceptualized as a process that aims to create a culturally-relevant and meaningful learning experience for all students (Törner & Yaski, 2016). This process involves acknowledging and valuing the diverse perspectives and experiences of students, and using this diversity as a resource for learning (Arzarello & Pedemonte, 2017). The goal is to create a learning environment that is inclusive and supportive, and that allows all students to achieve their full potential.

One benefit is that it can help to close the achievement gap between indigenous and non-indigenous learners (Lowrie & Logan, 2021). By acknowledging indigenous knowledge systems into Mathematics learning activities, teachers can make the content more accessible and relevant for students, and can provide them with the support they need to succeed (Grieshaber, 2018). Another benefit is that it can help to promote cultural pride and self-identity among students (Scott & Tacchi, 2016). By validating and incorporating indigenous knowledge systems, the teacher can help to create a sense of belonging and empowerment among students (La Franiere & Kervin, 2020).

2.3.2 Understanding of interconnections

IK holistic in nature, often emphasizing the interconnectedness of all living beings and the environment (Bishop, 2022), this interconnectedness is reflected in the way indigenous communities interact with and care for the natural world. This refers to the interconnectedness of IK, and the way in which they are embedded within a broader cultural context (Boyd et al., 2018). In the context of Mathematics learning activities, understanding these interconnections can help to create a more holistic and culturally-relevant learning experience (Greer & Mukhopadhyay, 2016). Teachers can achieve this by exploring the relationships between indigenous knowledge systems and other areas of knowledge, such as science, history, and language (Wilson & Wilson, 2019), this can help to foster a deeper understanding of the material. For example, in a Mathematics learning activity, teachers could explore the relationship between traditional Agricultural practices and Mathematics (Atikinson & Biddle, 2017).

This looks at how indigenous farmers use mathematics to plan and manage their crops, and how these practices are informed by cultural beliefs and values (Bose, 2020). This can help students to see how mathematics is connected to the real world, and can help to make the material more relevant and meaningful to students (Bowers & Stephens, 2020). One area where this approach could be particularly useful is in the teaching of geometry. In many indigenous cultures, geometry is deeply connected to the natural world and is used to express cultural values and beliefs (Bishop & Berryman, 2015). For example, in Navajo culture, the circle is a symbol of wholeness and balance, and is used in many traditional art forms (Chaka et al., 2019). By exploring these connections, teachers can help students to understand geometry in a more meaningful way and to appreciate the richness and diversity of indigenous cultures (Mueller & Strutchens, 2021).

2.3.3 Emphasis on oral tradition

Indigenous Mathematics is grounded in real-world problems and experiences (Hopper, 2016). Indigenous mathematics if often based on observation of nature and the environment (Nieto, 2022). IK is transmitted orally from one generation to the next through storytelling, songs, ceremonies and other forms of oral communication (Sutinen & Way, 2021). Masingila (2021) highlighted that; oral tradition is a key aspect of preserving and passing on IK. In many indigenous cultures, oral tradition is a central part of their knowledge systems (Wheeler, 2021). Stories, songs, and other forms of oral communication are used to transmit knowledge from generation to generation

(Young & Carlson, 2016). This can be a powerful way to teach mathematics, as it can make the material more accessible and engaging, also teachers could use this approach by incorporating traditional stories and songs into mathematics learning activities (Thornton & Vaughan, 2018). This could help students to understand mathematical concepts in a new light and to gain a deeper appreciation for the role of oral tradition in indigenous cultures (Eberhardt et al., 2022).

In addition to emphasizing oral tradition, teachers can also use a 'place-based' approach to teach Mathematics (Barwell & Barwell, 2018). This can help students to see how Mathematics is connected to the world around them, and can make the material more relevant and meaningful (Klenowski et al., 2020). This approach can also help students to develop a sense of place and belonging, and to feel connected to their community (Jorgensen et al., 2018). In addition to emphasizing oral tradition and place-based learning, teachers can also use a practice-based approach to teaching Mathematics (Baeza et al., 2017). Chakaipa (2019) highlighted that, teachers focus on the ways in which Mathematics is practiced in everyday life and teachers can also look at how indigenous people use Mathematics to solve problems and make decisions in their daily lives. This can help students to see Mathematics as something that is practical and useful, rather than abstract and theoretical (Bussi & Dimitriadis, 2015).

This approach can also help students to develop important skills like problem-solving and critical thinking (Swan, 2018). Teachers could use storytelling and place-based learning to teach topics like measurement, shapes, and patterns (Panel & Finkle, 2020). Teachers could also use practice-based learning to teach topics like counting, money, and time and they could use a combination of these approaches to teach more complex topics like Geometry and Algebraic lessons (Grieshaber, 2018). Teachers could start by telling a traditional story about shapes and patterns in nature, then the teacher could take a walk outside and have students observe and identify different shapes in the environment (Lowrie & Logan, 2021). Finally, the teacher could come back to the classroom and have students create their own drawings or models of shapes based on what they observed (Santos, 2021).

2.3.4 Relationship with the environment

Kral (2021) highlighted that, indigenous knowledge is closely tied to the natural world, and many indigenous cultures view the environment as an integral part of their identity. This relationship is reflected in the way that mathematics is taught and learned in indigenous communities (Berkes, 2015). For example, many mathematics concepts are based on stories and observations of the natural world (Bishop et al., 2020). In addition, mathematics activities may be designed to teach students about the importance of respect for the environment (Kimmeter, 2022). One approach is to use stories that are based on traditional knowledge for example; a teacher might tell a story about how a community learned to count by observing the phases of the moon (Bishop et al., 2020). Another approach is to use mathematics problems that are based on the environment for example; a teacher might ask students to count the number of birds in a flock or estimate the size of a lake (Jones & Te Haara, 2019). In addition, students might be asked to measure the circumference of a tree or the width of a river (Roberts & Gere, 2021).

2.4 Relevance of infusing IK into Mathematics teaching-learning

Infusing IK into Mathematics teaching-learning activities can have various benefits for learners. Some of these benefits include:

2.4.1 Increased cultural relevance

Mueller and Strutchens (2021) highlighted that, when students see themselves and their culture reflected in the curriculum, they are more likely to be engaged and motivated to learn. This can be done by using materials and activities that are specific to indigenous cultures, for example; teachers can use mathematics activities that are that are based on traditional stories, myths and legends from different indigenous cultures (D'Ambrosio & Furinghetti, 2016). This can make mathematics more meaningful and interesting for students, and it can also help to preserve and promote indigenous cultures (Hopper, 2016). This approach has several benefits, including increased engagement, improved self-esteem, build a sense of community and sense within the classroom, greater appreciation for indigenous cultures and foster a positive attitude towards mathematics, which can lead to improved learning outcomes (Bonner & Aikenhead, 2017).

2.4.2 Enhanced understanding of Mathematical concepts

One way that incorporating indigenous knowledge systems into mathematics activities can enhance understanding of mathematical concepts is by using hands on activities and manipulative (Santana, 2017). For example, teachers can use Aboriginal counting sticks, which are traditional tools used by indigenous groups to count and measure (Bussi & Dimitriadis, 2015). This allows students to physically interact with the materials and can help to bring abstract concepts to life (Santos, 2021). It can also help to develop critical thinking and problem-solving skills (Martin & Burridge, 2015). In addition to increased understanding of Mathematical concepts, this approach can also help to develop students' mathematical literacy (Patricio, 2021), this includes, the ability to read, write and communicate about mathematics in real-life. For example, teachers can use story problems that are based on traditional knowledge to help students understand the context and meaning of mathematical concepts (Nakata et al., 2017), this can lead to a deeper understanding of how Mathematics is used in the real world

2.4.3 Improved critical thinking skills

Engaging with IK can help learners develop critical thinking skills as they analyze and interpret mathematical problems for multiple perspectives (Cajete, 2020). One way that infusion of indigenous knowledge systems can improve critical thinking skills is by providing students with opportunities to think critically about how their knowledge relates to the knowledge of others (Aguirre & Ortiz, 2019). For example, students could be asked to compare and contrast their own indigenous knowledge with the knowledge of other indigenous groups or cultures. This can help students to develop their critical thinking skills and to gain a deeper understanding of the knowledge systems of others (Smith & Stevens, 2017). Another way that this approach can improve critical thinking skills is by challenging students to consider how their own knowledge systems relate to the broader world of Mathematics (Weaver, 2020). For example, students could be asked to consider how their IK compare to more formalized systems of mathematics, such as Euclidean geometry or the Pythagorean Theorem (Yang, 2019).

2.4.4 Valuing diversity

Incorporating indigenous knowledge systems into mathematics learning activities promotes the value of diverse ways of knowing and thinking, fostering a sense of inclusion and respect for different cultural perspectives (Medin, 2019). By valuing diversity, teachers can create a more welcoming and inclusive learning environment for all students, regardless of their background or cultural identity (Ernest, 2016). In addition, valuing diversity can help students to appreciate the unique perspectives and experiences of others, which can in turn lead to a more nuanced understanding of mathematics (Weaver, 2020). Valuing diversity is not only important for the learning process, but also for the well-being of students (Warren, 2021). When students feel valued and respected, they are more likely to be motivated and engaged in their learning. This is particularly important for indigenous students, who may have been marginalized or overlooked in the past. By valuing diversity, teachers can help to create a more positive and productive learning environment for all students (Mercuri & Hammil, 2020).

2.4.5 Encouraging creativity and innovation

Indigenous knowledge systems often involve unique problem-solving techniques and approaches, which can inspire students to think creatively and explore alternative solutions to Mathematical problems (Restoule et al., 2016). By infusing IK into Mathematics education, we can encourage students to think creatively and innovatively (Conceição & Jaquet, 2020). Indigenous knowledge systems often contain elements of creativity and innovation, as they have been developed over time through the unique experiences and perspectives of indigenous peoples (Yang, 2019). By exposing students to these systems, teachers can inspire them to think outside the box and to generate new ideas and solutions. Building on that idea, the infusion of indigenous knowledge systems into mathematics education can also help to develop a deeper understanding of the interconnectedness of knowledge (Santos, 2021). For example, IK often make connections between Mathematics, language, art, and other subjects.

This interdisciplinary approach can help students to see the connections between different subjects and to develop a more holistic understanding of the world (Bishop & Berryman, 2015). Another potential benefit of this approach is that it can foster a more holistic view of mathematics itself (D'Ambrosio, 2018). Many indigenous knowledge systems include not only the ideas and

principles of mathematics, but also the ways in which these ideas and principles are applied in the real world (Parnel & Finkel, 2020). This can help students to see Mathematics as more than just a set of abstract concepts, and can encourage them to apply their Mathematical knowledge to practical problems and challenges.

2.4.6 Building community connections

Integrating indigenous knowledge into mathematics learning activities can help students build connections with their community and develop a sense of pride in their cultural heritage (Warren, 2017). By infusing IK into mathematics education, teachers can create a sense of community and shared purpose among students (Santos, 2021). This can be particularly important for indigenous students, who may not always feel a sense of belonging in the traditional education system (Yang, 2019). By creating a community of students who share an appreciation for indigenous knowledge, teachers can help to foster a more positive and supportive teaching-learning environment for all. Building on that idea, the researcher can also consider the impact of this approach on the wider community (Masingila, 2021). When teachers infuse IK into Mathematics education, they are not only helping individual students, but also contributing to the preservation and revitalization of these systems (Apukhtina et al., 2019). This can have a positive impact on the overall community, as it can help to promote cultural pride and understanding (Simon & Sheth, 2018).

2.4.7 Promoting cultural sustainability

One of the main goals of infusing IK into Mathematics teaching-learning is to promote cultural sustainability (Wheeler, 2021). This means preserving and transmitting IK to future generations. This can be done by making sure that the material is relevant to the cultural context of the students, and by providing opportunities for students to express their own cultural knowledge and experiences (Gezani & Kambewa,2020). Additionally, it is important to create a supportive learning environment that values and respect all cultures (Jorgensen et al., 2018). Furthermore, another way to promote cultural sustainability is by using indigenous-centered pedagogy (Swan, 2018), this involves teaching Mathematics concepts in a way that is meaningful to students and that acknowledges the diversity of their cultures. This can be done by telling stories that are relevant to the concepts being taught, and by having students create their own stories that incorporate mathematic concepts (Hardy, 2020).

2.5. Approaches that can be used to infuse IK into Mathematics teaching-learning

Infusing IK into Mathematics teaching-learning activities can help students to develop a deeper understanding of mathematical concepts and how they relate to their own culture and traditions (Santana, 2017). Below are some ways in which teachers can infuse IK into their Mathematics teaching-learning.

2.5.1 Incorporating traditional counting system

Smith (2015) highlighted that, one approach is called numeracy pedagogy, which uses a culturally responsive teaching-learning framework. This approach includes using counting system that are familiar to indigenous students, such as using body counting systems or counting sticks (Grande, 2015). Within the numeracy pedagogy framework, teachers can use a variety of strategies to incorporate traditional counting systems into mathematics lessons. One strategy is called multiple representations, which involve using different forms of representation to represent numbers (Aguirre & Ortiz, 2019), for example, this could include using a spoken number, a drawing, a written number and a concrete object.

This approach helps students to connect the different representations and develop a deeper understanding of numbers (Mamidishkicjicik & Waldron, 2017). Another strategy that can be used in numeracy pedagogy is called culturally appropriate visuals (Nakata et al., 2017), this involve using visuals that are culturally relevant to students, such as traditional symbols or images. For example, when teaching about multiplication, the teacher could use a picture of two traditional woven baskets with multiple fish in each to illustrate the concept (Patricio, 2021). This approach can help to make mathematics more accessible and meaningful for students (Eberhardt et al., 2022).

2.5.2 *Using traditional stories or myths to teach Mathematical concepts*

Many indigenous cultures have oral traditions that contain stories or myths that can be used to teach mathematical concepts (Battiste, 2015). For example, teachers can use stories about the patterns in nature or the importance of symmetry in traditional artwork to teach students about geometry (Wadel, 2022). There are many ways in which traditional stories and myths can be used to teach mathematical concepts. One approach is to use stories as a way to introduce and explain

new Mathematical concepts (Parnel & Finkel, 2020). For example, the Navajo creation story can be used to introduce the concepts of zero and infinity (Weaver, 2020). Another approach is to use stories as a way to reinforce mathematical concepts that have already been introduced. For example, the story of Rabbit's Race can be used to reinforce the concept of fractions (Masingila & Flores, 2020).

Many traditional stories are filled with humor and emotion, which can help to make Mathematics more enjoyable and relatable for students (Apukhtina et al., 2019). Tulalip et al (2019) highlighted that, the use of traditional stories can help to create a more interactive and hands-on teaching-learning environment. This can be especially beneficial for students who learn best through experience and exploration (Mercuri & Hammil, 2020). Bowers and Stephens (2020) highlighted that; it is also worth noting that traditional stories can be adapted to different levels of Mathematical understanding. For example, the same story can be used to introduce basic mathematical concepts to young learners, while also being adapted to teach more advanced concepts to older students (Bishop & Jones, 2017). This can be a very effective way to make Mathematics relevant and engaging for all students, regardless of their level of understanding (Martin & Burridge, 2015).

2.5.3 *Incorporating indigenous perspectives on Measurement and Geometry*

Smith (2015) highlighted that, one important aspect of indigenous knowledge systems is the idea of holistic and relational measurement. This means that measurement is not just about size or shape of an object, but also about its relationships to other objects and to the environment (Hopper, 2016). This can be seen in traditional measurement systems such as the unit system of measuring the length of a caribou by comparing it to the length of a human arm (Ballard & Marsh, 2021). Using this perspective in Mathematics lessons can help students to develop a deeper understanding of measurement and geometry (Hutchins & Bruce, 2019). It can also help to connect mathematics to real-world situations, and to develop a sense of place and cultural identity (Brown et al., 2019). For example, a teacher could use a tradition story about a journey to teach about distance and direction (Patricio, 2021). The students could then create their own journey using a map, and measure the distance and direction of their journey (Wilson & Wilson, 2019).

Another strategy that can be used to incorporate indigenous perspective into Mathematics lessons is called place-based learning (Brown et al., 2019), this involves using local places and stories to teach mathematics concepts. For example, a teacher could take students on could take students on a walk around the school grounds and use the landmarks and objects in the area to teach about measurement and geometry (Tulalip et al., 2019). This could include measuring the length of the playground, or comparing the size of different trees (Smith, 2015).

2.6. Challenges encountered when infusing IK into Mathematics teaching-learning

Infusing IK into Mathematics teaching-learning modern practices can be a complex and challenging process due to a variety of reasons. Below are some of the main challenges encountered when attempting to incorporate indigenous knowledge into mainstream systems.

2.6.1 Lack of recognition and respect

IK is often undervalued and dismissed by mainstream institutions and authorities, which can hinder its integration into collective decision-making processes (Smith, 2019). While there are many benefits to infusing IK into Mathematics education, there are also some challenges that should be acknowledged (La Franiere & Kelvin, 2020). One of the most significant challenges is the lack of recognition and respect for these systems. In many cases, these systems are viewed as primitive or inferior to Western Mathematics (Patricio, 2021). This can create barriers to students learning about these systems and can also perpetuate negative stereotypes about indigenous cultures (Hutchins & Bruce, 2019).

2.6.2 Cultural appropriation

There is a risk of appropriating IK without proper acknowledgement or consent, leading to the exploitation of indigenous communities and undermining their cultural autonomy (Wilson, 2018). Another significant challenge is the issue of cultural appropriation. While it is important to respect and learn from indigenous knowledge systems, it's also important to avoid appropriation or exploitation (Eberhardt et al., 2022). In other words, it's crucial to ensure that the systems are presented in an accurate and respectful manner, and that the voices of indigenous people are heard and amplified (Tulalip et al., 2019). There are a few important guidelines that can help to avoid cultural appropriation. First, it's important to consult with members of the relevant indigenous

communities when developing lessons or materials (Sutherland & Wilson, 2019), secondly, it is important to ensure that the material is accurate and culturally appropriate. Thirdly, it is important to give credit to the source of the knowledge and to acknowledge the contributions of indigenous communities (Aguirre & Ortiz, 2017). It is important to be open to feedback and to be willing to adjust lessons or materials as needed.

2.6.3 Language barriers

Many indigenous knowledge systems are transmitted orally in indigenous languages, which can pose a barrier to understanding and translating this knowledge for wider use (Napoletana, 2016). Loveland (2016), asserts that, another challenge that educators may face is the issue of language barriers. Many indigenous languages are endangered or threatened, and there may be a lack of resources available in these languages (Raseka, 2016). One strategy is to use a combination of English and the relevant indigenous language in lessons and materials (Bowers & Stephens, 2020). Finally, it's important to work with translators and interpreters who can help to bridge the language gap (Bishop et al., 2020).

2.6.4 Lack of documentation and preservation

Indigenous knowledge is often transmitted through oral traditions and practices, making it vulnerable to loss or distortion over time (Kwayimulina & Kwayimulina, 2019). There is a need for greater efforts in documenting and preserving indigenous knowledge for future generations.

Another challenge that should be acknowledged is the lack of documentation and preservation of indigenous knowledge systems (Adams et al., 2020). Many of these systems are passed down orally, and there may not be extensive written records or documentation available. This can make it difficult to verify the accuracy of the material or to determine the historical context. In addition, there may be a lack of funding or support for initiatives to preserve and document these systems (Christou & Comber, 2018). Despite the challenges, there are some initiatives that are working to document and preserve indigenous knowledge systems (Conceição & Jaquet, 2020).

2.6.5 Power dynamics

Battiste (2017) highlighted that, power imbalances between mainstream institutions and indigenous communities can make it difficult for indigenous knowledge to be respected and integrated into decision-making processes on an equal footing. Another important issue to consider is the power dynamics that exist between indigenous communities and the education system (Jorgensen et al., 2018). In many cases, indigenous people have experienced colonization and marginalization, which can lead to a sense of distrust or skepticism towards the education system (Gezani & Kambewa, 2020). This can make it difficult to foster a sense of trust and cooperation between indigenous communities and educators (Grieshaber, 2018). To address the power dynamics issue, is to ensure that indigenous communities have a voice in the process of developing and implementing new materials and lessons (Goos & Comrie, 2019).

2.6.6 Resources and funding

Cajete (2015) highlighted that, lack of resources and funding for research and initiatives focused on infusing IK can hinder progress in this area. It is clear that a lack of resources and funding is a major challenge when it comes to incorporating indigenous knowledge systems into mathematics education (Swan, 2018). This includes a lack of funding for schools and for materials, as well as a lack of resources such as books and websites that are specific to IK (Hutchins & Bruce, 2019). It can also be difficult to find educators who are trained in both the indigenous knowledge system and the mathematics curriculum (Mistry, 2015). A possible solution to the resource and funding issue is to collaborate with organizations and institutions that have the resources and expertise to support the work (Miheso & Dike, 2019).

2.6.7 Legal and political barriers

Legal frameworks and political structures mat not always support the recognition and infusion of IK into mainstream systems, leading to further marginalization of indigenous communities (Sinyolo, 2016). There are legal and political barriers that can impact the infusion of IK into Mathematics education (Hoyle & Chandra, 2017). For example, there may be laws or regulations that restrict the use of certain materials or prevent the teaching of certain topics. There may also be political opposition to incorporating indigenous knowledge systems into the curriculum (Molosiwa et al., 2015). It is important to recognize that these legal and political barriers are often

the result of historical and systemic issues (Bulajic & Jacka, 2021). For example, IK has been suppressed or banned in the past, and there may be ongoing political tensions that make it difficult to change the status quo. In order to address these barriers, it is important to engage in advocacy and to build relationships with key decision-makers (Sebakunzi & Mukiza-Gapere, 2019).

2.7 Chapter summary

Chapter two addressed the theoretical framework on which the study took reference. The chapter also looked at conceptualization of IK, relevance of infusing IK, approaches that can be used to infuse IK and challenges encountered when infusing IK in the teaching and learning of Mathematics. in the next chapter data generation, analysis and discussion strategies are articulated.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter aims to provide an in-depth understanding of the research paradigm, research approach, sample and sampling procedure, research methods, data generation procedure, data analysis, trustworthiness of the study, ethical issues, and a summary of the chapter.

3.2 Research paradigm

Denzin and Lincoln (2015) define a research paradigm as, 'a world view, or basic set of beliefs, that guides action'. They go on to explain that a research paradigm shapes the research process in several ways, including the way that data is collected and analyzed, and the type of questions that are asked (Frey, 2018). The research paradigm is a set of beliefs and assumptions that guide a researcher's work (Sousa, 2016). It can be thought of as a framework for conducting research and it helps to determine the methods and tools that are used in the research process (Sarantakos, 2016). It is against this background that the researcher opted for the interpretivist paradigm in investigating the main issue of this investigation. This paradigm is based on the idea that reality is subjective, multiple and that knowledge is socially constructed (Orme, 2018). The researcher used this approach because it sought to explain the subjective reasons and meanings that lie behind every social action (Pascale, 2019). Through the use of the interpretivist, the participants were not completely separated from their beliefs and values during this study (Howell, 2021).

3.3 Research approach

A research approach refers to the overall strategy or plan that a researcher uses to conduct their research (Angen, 2016). Qualitative approach is a type of research that uses non-numerical data to explore complex and subjective phenomena (Marshall & Rossman, 2016). Qualitative approach is often used to understand how people make sense of their experiences, and how these experiences shape their lives and identities (Rocco, 2018). Qualitative approach can be used to understand phenomena that are difficult to quantify, such as emotions, beliefs, and attitudes (Merriam & Tisdell, 2015). Qualitative approach was chosen by the researcher because it is a great way to explore and understand the perspectives and experiences of those involved in the research (Noyes et al., 2017). In addition, qualitative approach allowed for flexibility and adaptability, which is

necessary when working with indigenous knowledge systems, as they can vary from one community to another (Tromp et al., 2020).

3.4 Sample and sampling procedure

Cresswell and Cresswell (2018) define a sample as 'a portion or segment of a population from which observations are selected to represent the entire population. The researcher adopted purposive sampling to select participants who have reach experiences and knowledge in both IK and Mathematics education (Lewis and Thornhill, 2017). Purposive sampling is a non-probability sampling technique used in research, where participants are selected based on their expertise, experience, or knowledge related to the research topic (Patton, 2015). Purposive sampling was chosen for this study based on the assumption that the targeted participants had knowledge on the issue under investigation (Neuman, 2016). Purposive sampling was also used in this study since the study assume the respondents to be equipped with relevant knowledge needed for better results. For triangulation purposes, 16 learners were conveniently selected to participate in a focus group discussion. This study adopted a sample size of four teachers at the selected school who are in the sciences department. In addition, sixteen students were purposively sampled since the researcher wanted to extract from their experiences in Ordinary Level Mathematics teaching-learning activities.

3.5 Methods

In generating data from the selected participants, the following methods were employed to capture rich and contextual information:

3.5.1 Document analysis

Document analysis is a research method that involves the systematic examination of documents in order to gather data and gain insight into the topic under study (Silverman, 2020). This study is going to assess documents such as, departmental minutes, curriculum documents, guidance and counseling record books, school yearbooks, student work and teacher lesson plans (Hammersley & Atkinson, 2015). This is done to understand how IK are currently being incorporated into the school environment (Onwuegbuzie & Leech, 2016), this can include looking at what resources are being used, how teachers are integrating IK into their teaching and what students are learning. Sekaran and Bougie (2016) highlighted that; these documents help the researcher to identify gaps or areas for improvement in the way that IK are being included in the school environment.

Document analysis is significant to this study because it will help on generating new ideas and approaches for incorporating IK into the curriculum (Babbie, 2019).

3.5.2 Focus Group Discussion

A focus group discussion as defined by Chavula (2016) as a qualitative research method used to gather data from a small, diverse group of individuals in a facilitated setting. Nyasulu (2019) defined a focus group discussion as a planned group discussion with clear specifications of who should form the groups in order to have people of similar traits in groups to maximize discussions. The researcher divided the students into groups of four meaning each group had a total of four learners. The researcher divided the participants into four groups. The major issues include the relevance of infusing IK in Ordinary Level Mathematics teaching-learning activities, approaches that are being used to infuse IK into Ordinary Level Mathematics teaching-learning activities, obstacles encountered when infusing IK into Ordinary Level Mathematics teaching-learning activities and strategies and strategies that can be used to minimize the challenges encountered when infusing IK into Ordinary Level Mathematics teaching-learning. The researcher made efforts to deal with confidentiality issues. The researcher promised participants that everything that will be said in the focus group discussions will not be disclosed to anyone. The researcher also informed the participants that it is unethical for them to disclose information from the discussions.

3.5.3 Interview

Harry (2019) defines interviews as,' conversations in which the interviewer attempts to elicit information from the interviewee, about a particular topic. An open-ended interview was preferred because it allows the researcher to gain a better understanding of the interviewee's perspectives and experiences (Luenendonk, 2019). This allowed the research to ask follow up questions to clarify or probe for more information greater flexibility and depth of responses from the interviewee (Stake, 2018). Interviews were used in this research as they generate qualitative data, which can complement quantitative data, offering a more comprehensive understanding of the topic under study (Mak et al., 2017). Furthermore, interviews allow participants to share their personal stories, experiences and opinions providing a unique and subjective perspective which is required by this study (Kenton, 2019). The interview guides were centered on the following questions: relevance of infusing IK, approaches that can be used to infuse IK, challenges

encountered when infusing and strategies that can be used to minimize challenges encountered in infusing IK into Ordinary Level Mathematics teaching and learning activities.

3.6 Data generation procedure

During the data generation procedure, the researcher obtained an introductory letter from the Bindura University of Science Education from the faculty of Science Education. The introductory letter enabled the researcher to seek permission from the Ministry of Primary and Secondary Education Buhera District, the researcher also sought permission from the school where the data was collected and the school head granted their permission, to carry out the study on the selected school. The researcher outlined the objectives of the study to the school head, who later included it among the activities being done at the school. The researcher asked for all the relevant policy documents that guided the infusion of indigenous knowledge systems in mathematics learning activities. Thereafter the researcher organized a meeting with the potential participants to highlight their role in the study as well as sought their consent. The participants were selected purposively and the researcher personally interviewed the selected participants during their spare time. The researcher explained the purpose of the study to the participants and their role in it. Ethical issues were taken care of during the data generation procedure.

3.7 Data analysis

Shaughnessy and Zechmeister (2020) define data analysis as ‘the systematic application of statistical techniques to investigate, describe and summarize data. In this study data was generated through document analysis, interviews and focus group discussion. In this study data analysis was seen as a process that systematically interrogates the sourced experiences, views, and opinions about the issue under study (Schilling, 2016). In this study thematic analysis was adopted to analyze data from selected documents and interviews (Huberman & Saldana, 2016). Furthermore, it involved data generation, and sorting of raw data to extract meaningful insights that support the basis of an argument (Stevens, 2021).

Thus, through this, the researcher was well-positioned to carry out an iterative and recursive type of data generation and analysis (Stoffels, 2018). In this study data sourced through the application of the selected methods was analysed according to emerging themes (Babbie, 2022). In this study qualitative data is going to be generated and the themes that guided the data presentation, analysis, and discussion were derived from the research questions in chapter 1. Patton (2015) reviewed that,

data aanalysis enables the researcher to uncover hidden patterns, trends and relationship within the data and also to discover connections between variables and phenomena.

3.8 Research integrity

This section centres on the following:

3.8.1 Trustworthiness of the study

Trustworthiness of a study is a term in qualitative research used to describe the degree to which the findings of a study are credible and believable (Pilot and Beck, 2016). To improve on trustworthiness, the researcher allowed the data to be assessed to check on its credibility, dependability, transferability and conformability (Baker, 2022). Dependability in this investigation ensures that the findings are reliable and can be replicated by other researchers (Patton, 2015). Transferability in this study increased the credibility and applicability of the findings (Salkind, 2017). Conformability in this investigation ensures that the findings are not influenced by the researcher's own biases or assumptions (Given & Saumure, 2016) for example triangulation which involves using multiple sources or multiple methods to confirm the findings was used.

3.8.2 Ethical Issues

Saldana (2022) highlighted that; ethical issues refer to any potential ethical concerns that may arise during the research process. Ethical issues that are at the centre of this study are:

3.8.2.1 Confidentiality

Confidentiality is an important ethical consideration that refers to the protection of personal information about the participants in the research (Cohen & Morrison, 2018). In this study participants were assured that their information will be kept confidential, data will be stored securely using encryption and password protection were appropriately and will make sure that only authorized personnel have access to the data (Graue & Walsh, 2017). Participants were assured of the voluntary nature of participation and the right to withdraw at any stage without repercussions.

3.8.2.2 Anonymity

In this study participants cannot be identified, even if the data is accessed by unauthorized people (Berg, 2016). Therefore, this study is going to strive to protect the anonymity of its participants as much as possible. To ensure that there is anonymity the study will use coding systems to keep track of participants' identities without revealing their identities to others (Willmott, 2016). Furthermore, the study will use pseudonyms to refer to participants in research reports, finally steps will be taken to ensure that the data is kept secure and confidential (Johnson & Jackson, 2015). This will increase the likelihood that people will agree to participate in the research, since they know their identity will be protected (Cresswell & Creswell, 2018).

3.8.2.3 Privacy

Privacy refers to the right of individuals to control who has access to their personal information, and to decide how that information is used (Nissenbaum, 2020). This includes the right to decide who can see or hear their conversations, and who can access their personal records (Solove, 2017). To ensure privacy of participants the investigation will make sure that they have the interviewee's consent to record or transcribe the interview (Moor, 2017). Also, the study will anonymize the data by removing any identifying information such as names and locations.

3.8.2.4. Informed consent

Ruhanya (2015) defines informed consent as a principle which refers to the providing potential research participants with all of the information necessary to allow them to make decision concerning their participation. Informed consent requires that, i. receive clear, concise, and accurate information about the purpose, risks, benefits and procedures involved, ii. Understand the information provided including the potential consequences of their decision, iii. Make a voluntary decision to participate or decline, without coercion or manipulation, and iv. Provide explicit consent, usually through a signed document or verbal agreement (Prentice-Dunn, 2016). To obtain informed consent the researcher is going to, provide all relevant information, ensure that individuals understand the information, ensure freedom from coercion or manipulation and obtain explicit consent (Cohen & Morrison, 2018).

3.9 Chapter summary

Chapter Three provided insights into the research paradigm, research approach, sample and sampling procedure, research methods, data generation procedure, data analysis, trustworthiness of the study, ethical issues, and a summary.

CHAPTER 4: DATA ANALYSIS AND DISCUSSION

4.1 Introduction

The chapter will present, analyze and discuss the findings from the study on the infusion of indigenous knowledge systems at Ordinary level mathematics teaching and learning activities. The data was presented using thematic analysis in qualitative research under the following themes: relevance of infusing IKS into ordinary level mathematics teaching-learning activities, approaches being used to infuse IKS into mathematics teaching –learning activities, challenges encountered when infusing IKS into ordinary level mathematics teaching-learning activities and strategies that can be used to minimize the challenges encountered when infusing IKS in mathematics teaching-learning activities

4.2 Characteristics of the participants

In this section demographic characteristics of learners and teachers are pictured on table 4.1 and 4.2 respectively.

4.1 Demographic characteristics of selected learners (n=16)

Attribute(s)		**(n)**	**(%)**
Sex	Females	8	50
	Males	8	50
Age Range (years)	13 – 15	4	25
	16 – 18	8	50
	Above 18	4	25
Level of Education	Form 3	7	43.75
	Form 4	9	56.25

Firstly, it was noted that the purposively selected 16 participants were males and females with ages ranging from 13 - 18 years, and doing Ordinary Level Mathematics at the selected school. Furthermore, it was noted that these participants were enrolled according to the demands of the Education Act (Ministry of Primary and Secondary Education, 2020). There was a balanced number of females and males. Form threes constituted 43.75% whilst form fours constituted

56.25%. This enabled the researcher to interrogate the generated data to understand with claritythe extent to which the infusion of indigenous knowledge systems in Mathematics learning activities from learners' experiences. With the view to triangulate the data generated from the participants, 4 teachers were purposively included in this study.

Table 4.2 Demographic characteristic of the selected teachers (n=4)

Attributes		**(n)**	**(%)**
Sex	Females	2	50
	Males	2	50
Professional qualifications	Certificates in education	0	0
	Diploma in education	3	75
	Degree in education	1	25
Teaching experience (years)	5-10	1	25
	10-15	1	25
	Above 20	2	50

Table 4.2 presents the distribution of participants according to sex, professional qualification and teaching experience. There are both female and male teachers, there is gender balance in the mathematics department. The researcher noted that the participant's qualifications ranged from diploma in education (75%) to degree in education (25%) and teaching experience ranged from 5 - 20 years. Most of the participants have been in the teaching fraternity with experience ranging from 9 years and above. This is a clear indication that through experience they have gained enough knowledge, skills attitudes to enable them to infuse IK into Ordinary Level Mathematics.

4.3 The relevance of infusing IK into Ordinary Level mathematics teaching-learning activities

In this section data generated from the participants from interviews and focus group discussion is analyzed, and discussed with the view to provide an answer to research question 1 in chapter one. In line with the theme derived from the question, one of the teachers noted that:

Indigenous knowledge brings reality into the learning activities, so that learning become realistic and practical to students since there will be interaction with what they know from the community in order to gain knowledge (Interviewee 3)

In support a participant revealed that:

Incorporating IK into mathematics teaching makes the subject more culturally relevant for students, helping us to connect with the material on a deeper level (Focus Group Discussion Participant 9)

In the same vein another participant noted that:

IK encourages learners to appreciate the importance of what is offered from the local thereby motivating learners in mathematics (Interviewee 2)

IK often contains practical mathematical concepts and applications that we use to demonstrate mathematical principles in real world contexts such as engaging students in solving mathematical problems that are relevant to their communities for example, land measurement, resource allocation or traditional trade systems (Focus Group Discussion Participant 6)

Another participant from interview highlighted that:

Infusion of IK improves learner's critical thinking skills, for example learners could be asked to compare and contrast their own indigenous knowledge with the knowledge of other indigenous groups or cultures (Interviewee 3).

In addition to above another speaker highlighted that:

We understand better when we see the reality unlike what we do when we just use our sense of hearing we tend to forget the concepts (Focus Group Discussion Participant 5)

From another angle one of the selected participants highlighted that

Infusion of IK into mathematics enhances student engagement and motivation, this creates a more meaningful and engaging learning environment, thereby increasing student's interest and enthusiasm for the subjects (Interviewee 1)

From the above contributions it can be acknowledged that infusion of IK enhances learners critical thinking skills as they will be able to differentiate their culture from other cultures, this concurs with Cajete (2020) who postulated that, engaging with IK can help learners develop critical thinking skills as they analyze and interpret mathematical problems for multiple perspectives. One way that infusion of indigenous knowledge systems can improve critical thinking skills is by providing students with opportunities to think critically about how their knowledge relates to the

knowledge of others (Aguirre & Ortiz, 2019). In support of this, one participant in a focus group discussion revealed that:

It allows for the inclusion of diverse perspectives and ways of knowing, enriching the learning experience for all students for example integrating traditional stories and folklore that contain mathematical concepts such as patterns, sequences and spatial reasoning (Focus Group Discussion Participant 10)

From the above quotation the researcher noted that incorporating IK into mathematics learning activities promotes the value of diverse ways of knowing and thinking, fostering a sense of inclusion and respect for different cultural perspectives. This concurs with Ernest (2016) who alluded that by valuing diversity, teachers can create a more welcoming and inclusive learning environment for all students, regardless of their background or cultural identity. In addition, valuing diversity can help students to appreciate the unique perspectives and experiences of others, which can in turn lead to a more nuanced understanding of mathematics (Weaver, 2020).

4.4. Methods being used to infuse IK into Ordinary Level Mathematics teaching-learning activities

The researcher in this section centres the analysis and discussion on how teachers are infusing indigenous knowledge systems in mathematics teaching and learning activities giving their influence on content mastering with the view to provide answers to research question 2 in chapter 1. In this context one of the participants highlighted that:

The use of indigenous languages and terminology when teaching is an approach used to infuse IK in the teaching of mathematics at school (Focus Group Discussion Participant 7)

In the same vein, one of the teachers highlighted that:

Traditional counting system can be used in infusing IK in mathematics, this include using counting system that are familiar to indigenous students such as, using body counting systems or counting sticks (Interviewee 3)

In addition to the above a participant pointed out that:

Community engagement is another approach that is being used at the school such as field trips that is going into the field to measure circumference of different trees (Focus Group Discussion Participant 12)

In support of the above another participant revealed that:

Using local examples and contexts to Mathematics concepts such as when introducing the topic of volume of solid shapes, shapes like cones using top of a hut which is familiar to the kids, cylinder give example of a drum or cup and so on (Interviewee 1)

From the above presented data, it can be revealed that, traditional counting system can be used in infusing IK in mathematics, this include using counting systems that are familiar to indigenous students such as, using body counting systems or counting sticks. This concurs with Martin and Burridge (2015) who noted that, traditional counting systems can be very effective and relevant in engaging students regardless of their levels of understanding different Mathematical concepts. This can be supported by one of the participants who noted that:

Traditional games (i.e., nhodo and pada) are another approach that we can use in Mathematics teaching (Focus Group Discussion Participant 3)

In support of this another participant revealed that:

Storytelling, is another approach that is being used to introduce some topics in mathematics such as the traditional way used by our elders to count their cattle, they use sticks to see if all beasts are present that is the tally system (Interviewee 4)

From the above opinions it can be noted that, the use of traditional stories or myths can be used to teach mathematical concepts for example, teachers can use stories about the patterns in nature or the importance of symmetry in traditional artwork to teach students about geometry. This concurs with Apukhtina et al (2019) highlighted that, many traditional stories are filled with humor and emotion, and this helps in making Mathematics more enjoyable and relatable. In support, Tulalip et al (2019) highlighted that, the use of traditional stories creates a more interactive and hands-on teaching-learning environment in Mathematics. This can be especially beneficial for students who learn best through experience and exploration (Mercuri & Hammil, 2020).

4.5 Challenges encountered when infusing IKS in Ordinary Level Mathematics teaching-learning activities

In this section, findings are anticipated to indicate challenges encountered by teachers and learners in the infusion of IK in Ordinary Level Mathematics teaching and learning activities. One of the teachers exclaimed the following:

When carrying out field trips with learners some with deviant behaviours might end up getting injured in the process (Interviewee 2)

Furthermore, another participant had this to say:

There will be limited time to engage in practical activities like trips (community visits), since mathematics lessons are given time less than or equal to 35 minutes it will be difficult to engage in trips during lesson period (Focus Group Discussion Participant 7*)*

Another participant reviewed that:

Lack of teacher experiences if a teacher has no experience in using IK in classrooms it might be difficult to implement them (Focus Group Discussion Participant 16)

In support, a participant noted that:

Lack of IK of the community by the teacher for example some teachers are not able to speak the community's language (Interviewee 4)

The same participant went on to say:

Lack of resources to use in the process is another challenge, this includes lack of funding for the schools and for materials, as well as lack of resources such as such as books and websites that are specific to IK (Focus Group Discussion Participant 13)

The above contributions from the participants are in agreement with Cajete (2015) who postulated that, lack of resources and funding for research and initiatives focused on infusing IK can hinder progress in this area. It is clear that a lack of resources and funding is a major challenge when it comes to incorporating indigenous knowledge systems into mathematics education (Swan, 2018).

In the same vein, another participant noted that:

Colonization (perceiving western education system as more superior than our education) for example the use of English in mathematics (Focus Group Discussion Participant 11)

In support to the above another participant reviewed that:

It is difficulty aligning with curriculum standards for example some methods won't be tested at the end (Focus Group Discussion Participant 3)

In addition, a participant said:

Resistance to change from parents and participants due to fear of loss of power or status and political and ideological differences (Interviewee 3)

From the above opinion it can be noted that; cultural sensitivity issues might be difficult to tackle or teach using IK systems. This concurs with Sinyolo (2016), who postulated that, legal frameworks and political structures may not always support the recognition and infusion of IK into mainstream systems, leading to further marginalization of indigenous communities. There are legal and political barriers that can impact the infusion of IK into Mathematics education (Hoyle & Chandra, 2017). For example, there may be laws or regulations that restrict the use of certain materials or prevent the teaching of certain topics. There may also be political opposition to incorporating indigenous knowledge systems into the curriculum (Molosiwa et al., 2015). It is important to recognize that these legal and political barriers are often the result of historical and systemic issues (Bulajic & Jacka, 2021). For example, IK has been suppressed or banned in the past, and there may be ongoing political tensions that make it difficult to change the status quo. In order to address these barriers, it is important to engage in advocacy and to build relationships with key decision-makers (Sebakunzi & Mukiza-Gapere, 2019).

4.6 Strategies that can be used to minimize the challenges encountered when infusing IK into ordinary level mathematics teaching and leanings activities

Based on the findings from the participants this section provides answers to the demands of research question 4 in chapter 1. In line with the theme derived from the question, one of the teachers noted that:

As teachers we must plan well ahead, source the materials to use and utilize crowd funding platforms or community fundraising initiatives to support specific IK projects or programmes (Interviewee 1)

In addition, another participant highlighted that:

Professional development for teachers- teachers need to acquire knowledge of IK principles, concepts and practices to integrate in mathematics. This includes understanding indigenous perspectives on Mathematics studies (Focus Group Discussion Participant 1)

In support of the above contribution a participant highlighted that:

Mathematics lessons should be given more time above 30 minutes since IK mathematics focuses on in-depth understanding and critical thinking, rather than superficial coverage of topics. Additional time allows for exploration and connection-making (Focus Group Discussion Participant 8)

From the above contribution it can be acknowledged that IK mathematics often involves storytelling and real-world applications, requiring more time to develop contextual understanding and connections to students' lives. This concurs with Lipka and Adams (2017) who postulated that mathematics content coverage is a significant challenge in integrating IK. Teachers needs time to develop culturally responsive teaching strategies and adapt mathematics content to incorporate IK principles and practices (Vithal & Skovsmose, 2019). In addition, another participant pointed out that:

There must be community engagement and involvement this involves actively engaging with indigenous communities, involving them in the development and implementation of IK-infused curricula, and building relationship that ensure authenticity and relevance (Interviewee 4)

In addition, a participant revealed the following:

Curriculum designers must include IK when designing their curriculum and teachers to implement what is already there in the curriculum (Focus Group Discussion Participant 5)

In agreement with the above another participant pointed out that:

There should be an ongoing support and monitoring in schools to make sure all learners receive indigenous knowledge education in mathematics as they make mathematics more understandable. (Focus Group Discussion Participant 11)

From the above contribution it can be acknowledged that regular feedback, reflection and evaluation help teachers refine their practice and address challenges. This concurs with Matthew and Eickelkamp (2015) who postulated that, this ongoing support ensures sustainability and continuous improvement. In addition, another participant revealed that:

The ministry of education must deploy teachers from the same community who are well versed with the indigenous knowledge for example deploying Ndebele speaking teachers in Ndebele communities (Interviewee 4)

From the above contribution it can be acknowledged that teachers from the same community can speak the local language and understand the cultural nuances, enabling them to revitalize Indigenous languages and cultures in the classroom. This concurs with Kirkness and Barnhardt (2017) who postulated that, teachers from the same community can provide culturally authentic teaching, ensuring that IK is taught in a way that is true to the community's values, beliefs and practices.

4.7 Chapter summary

Chapter four analyzed, and discussed data generated through document analysis and personal interviews. In addition, the researcher attempted to provide answers to the research questions raised in chapter 1. The next chapter will provide a summary of the study, general conclusion, and recommendations.

CHAPTER 5: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The previous chapter looked at data analysis and discussion. In this chapter, the researcher will direct focus on the summary of the project, conclusion, recommendations, areas for further study and chapter summary

5.2 Summary of the project

In chapter 1, the researcher looked at the problem and its context where the focus was directed on the key terms. Chapter 2 outlines the theoretical framework through which gaps in the related literature were interrogated. Chapter 3 highlighted the strategy for data generation presentation, analysis, and interpretation. More so in chapter 4, the researcher looked at the data analysis and discussion. The findings of the research were presented and analysed based on the research questions. This chapter came up with the following major findings:

- The participants acknowledged the relevance of infusing IK into Ordinary Level Mathematics into Ordinary Level Mathematics teaching-learning.
- It was revealed that various approaches (such as inquiry-based learning, problem-based learning, storytelling, traditional games, etc.) were when integrating IK into Ordinary Mathematics teaching-learning.
- The participants indicated that on integrating IK into Ordinary Level Mathematics teaching-learning numerous challenges (such as lack resources, resistance to change, etc.).
- Participants highlighted some of the strategies that can be used to overcome the challenges encountered when infusing IK which are professional development for teachers and community engagement and involvement to be done.

5.3 Conclusion

From the data generated, analyzed and discussed for this study it can be concluded that approaches such as real-world application, storytelling, and language integration among others are being effectively used in infusing indigenous knowledge systems at the school under investigation. From the analyzed and discussed data it can be concluded that numerous approaches (i.e., storytelling, inquiry-based learning, project-based learning, etc.) were being used when infusing IK into Ordinary Level Mathematics teaching-learning.

5.4 Recommendations

From the findings, the following recommendations were advanced:

- Professional development for teachers. Furthermore, teachers are required to engage with the communities they are deployed in and learn their IK.
- There should be an ongoing support and monitoring in schools to make sure all learners receive IK education in mathematics as they make mathematics more understandable.

5.5 Areas for further study

The study was limited to a single secondary school in Manicaland Province, it will be necessary for the study to be carried out on a wider geographical area to enable stakeholders to have a clear picture of the situation.

5.6 Chapter summary

In this chapter the research was summarized, the conclusion articulated based on the findings, recommendations were made and the areas for further study were highlighted.

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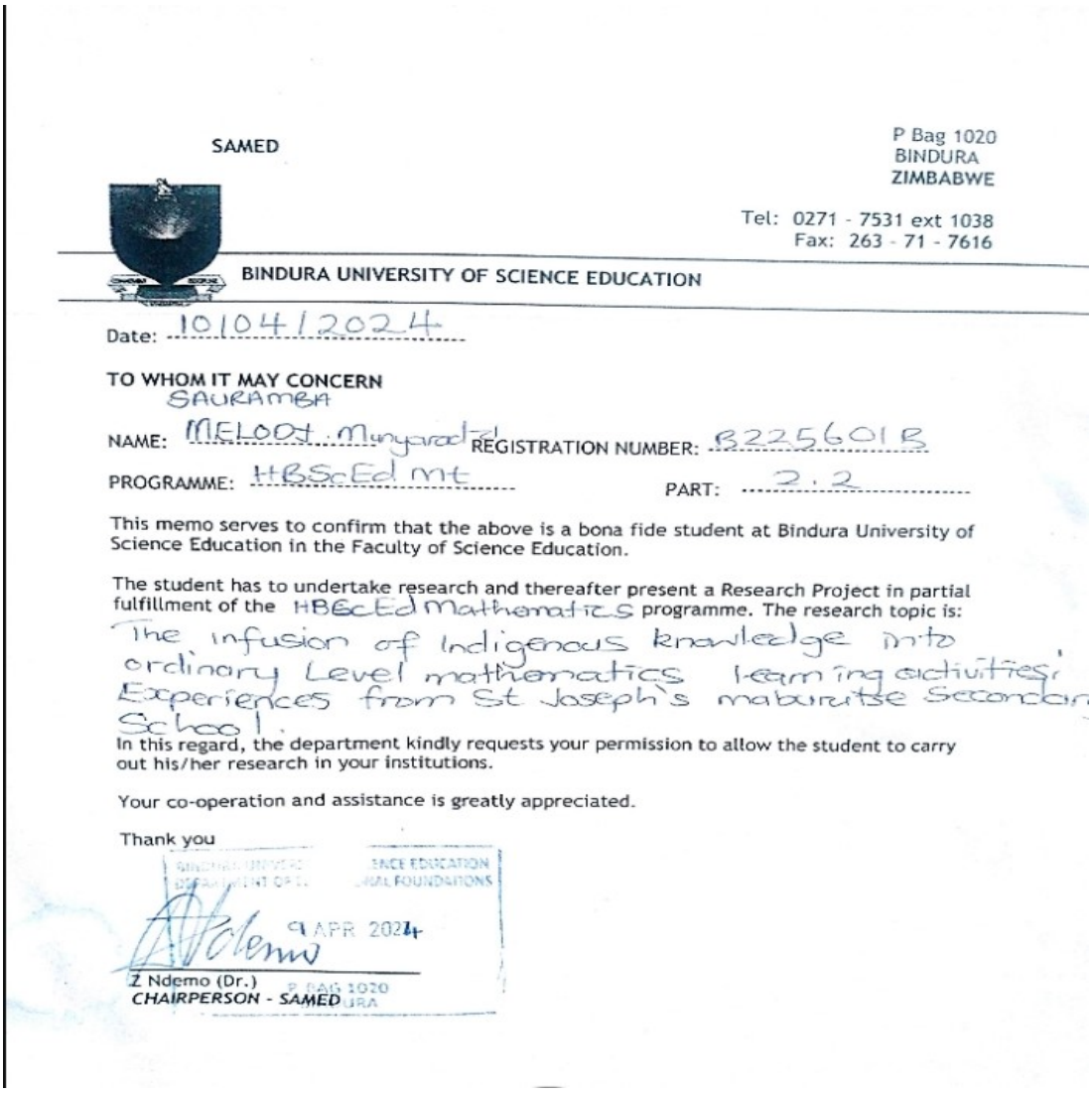
APPENDICES

Appendix 1: Introductory letter from Bindura University of Science Education



SAMED

P Bag 1020
BINDURA
ZIMBABWE

Tel: 0271 - 7531 ext 1038
Fax: 263 - 71 - 7616

BINDURA UNIVERSITY OF SCIENCE EDUCATION

Date: 10/04/2024

TO WHOM IT MAY CONCERN

NAME: SAURAMBA MELODY Munyaradzi REGISTRATION NUMBER: B225601B

PROGRAMME: HBScEd Mt PART: 2.2

This memo serves to confirm that the above is a bona fide student at Bindura University of Science Education in the Faculty of Science Education.

The student has to undertake research and thereafter present a Research Project in partial fulfillment of the HBScEd Mathematics programme. The research topic is:

The infusion of Indigenous knowledge into ordinary Level mathematics learning activities; Experiences from St Joseph's mabuwitse Secondary School.

In this regard, the department kindly requests your permission to allow the student to carry out his/her research in your institutions.

Your co-operation and assistance is greatly appreciated.

Thank you

9 APR 2024

Z Ndemo (Dr.)
CHAIRPERSON - SAMED

Appendix 2: Approval letter from the Ministry of Primary and Secondary Education

St Josephs' Maburutse Secondary School

P.O Box 281

CHIVHU

08 May 2024

The Head of Department

Bindura University of Science Education

P Bag 1020

BINDURA

ZIMBABWE

Dear Sir/Madam

Re: Permission to carry out a research

Sauramba Melody Munyaradzi, Ec number (1978773P) is a mathematics teacher at St Josephs' Maburutse Secondary School. She has been granted permission to carry out a research at the school on, **'The infusion of indigenous knowledge systems at St Josephs' Maburutse Secondary School in mathematics teaching and learning activities'.**

Yours faithfully

Kurambwi Brighton (Head)

Phone no (0777723032)

Signature

1/1

THE HEAD ST JOSEPHS MABURUTSE SEC SCH
05 MAY 2024
P.O.BOX 281
CHIVHU

Appendix 3: Interview guided for the selected Mathematics teachers

Thank you for agreeing to be interviewed. This study particularly focuses on the infusion of Indigenous Knowledge Systems into Ordinary Level Mathematics teaching-learning activities at. I believe you can make a significant contribution to gaining insight into the issue under investigation. I am going to ask you some questions which you are free to elaborate on, in ways you consider fit. In case you do not feel like answering the question, you are at liberty to say so. I would like to let you know from the start that your personal and school details will not be included in the final report.

1. Briefly tell me about yourself (With specific reference to professional qualifications, teaching experience in general)
2. What is your understanding of the concept 'Indigenous Knowledge'?
3. Of what importance is the inclusion IK in Ordinary Level Mathematics teaching-learning activities?
4. Are there any policy circulars guiding the infusion of IK into Ordinary Level Mathematics teaching-learning activities? (If yes, please elaborate)
5. How do you infuse IK into Ordinary Level Mathematics teaching-learning activities?
6. What obstacles do you encounter when infusing IK into Ordinary Level Mathematics teaching-learning activities?
7. In your own opinion what strategies can be used to minimize the challenges encountered when infusing IK into Ordinary Level Mathematics teaching-learning?
8. Thank you for participating in this interview.

Appendix 4: Focus Group Discussion schedule for the selected Ordinary Level Mathematics learners

Thank you for accepting the interview request. This study particularly focuses on the infusion of IK into Ordinary Level Mathematics teaching-learning activities at. I hope you can make a significant contribution to gaining insight into the issue under investigation. I am going to ask you some questions which you are free to elaborate on, in ways you consider fit. In case you do not feel like answering the question, you are at liberty to say so. I would like to let you know from the start that your personal and school details will not be included in the final report.

1. Briefly tell me about yourself
2. What is your understanding of the term 'Indigenous Knowledge'?
3. Why do you think IK should be included in your Ordinary Level Mathematics teaching-learning activities?
4. Can you give examples of activities in which IK was part of teaching-learning?
5. Did you encounter any challenges in including IK in the Ordinary Level Mathematics teaching-learning activities? (If yes elaborate your answer)
6. Thank you for participating in this interview.