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Practitioners' challenges in the application of conceptions of mathematical knowledge in the foundation phase mathematics learning

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ABSTRACT

This study used a qualitative research design to examine the difficulties faced by ECD practitioners when applying their mathematical expertise to improve young children's arithmetic learning. Five practitioners were selected from among the five ECD centers using a purposive sampling method for the study. Semi-structured interview questions were employed to collect the data. The construction of themes and sub-themes resulted from analyzing the collected data thematically. According to the research's findings, early childhood educators face difficulties due to their limited grasp of mathematical language, lack of classroom environments conducive to children learning mathematics, and lack of experience incorporating play into their instruction. It was discovered that some practitioners struggled to get kids interested in learning the language since they don't know how to communicate and take a long time to educate because they don't pay attention in class and forget rapidly. Based on the findings of this research, there is a need for proper in-service training of the practitioners, as was the provision of adequate space for the ECD centers.

Introduction

Following the democratic elections in 1994, South Africa entered a new era, and access to high-quality education was given priority. The improvement of high-quality basic education was made possible by the recognition of early childhood development (ECD), which also laid a strong foundation. A National Curriculum Framework was designed by the Department of Basic Education in 2015 with the idea that delays in cognitive and general development before schooling can frequently have costly and enduring effects on children, families, and society. Therefore, establishing a strong mathematics foundation in the early years is the best period for intervention (DBE, 2015). As one of the pinnacle achievements of mathematics in human civilizations, and the inquiry into the factors that contribute to its growth have garnered considerable scholarly interest (de Vita et al., 2022). However, South African students continue to do poorly in mathematics despite numerous interventions implemented by the DBE (2015).

The lack of basic knowledge is one of the major contributing elements to this subpar performance, according to research and evaluations of mathematics education (Feza, 2014). Additionally, Sinyosi (2015) conducted research on the variables influencing the mathematics performance of grade 12 pupils in Limpopo. Similarly, Despite the emphasis placed on the topic, a sizable portion of Tanzanian students struggle with mathematics, according to Mazana, Montero, and Casmir (2019). Their dismal performance in the national tests is proof of this (Mazana et al., 2019). The high failure rate has detrimental effects on the youth and the country as a whole because mathematics is crucial for obtaining academic credentials as well as preparing students for the future (Mazana et al., 2019). Diverse groups of individuals, both domestically and abroad, are mathematically underrepresented (Hunter, 2022). According to a study done in Tanzania, students who fail arithmetic have trouble studying other subjects, topic and other associated courses at

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the higher levels, especially those in science, engineering, and business. Additionally, Sa'ad, Adamu, and Sadiq (2014) emphasize that without mathematics, science cannot exist; without science, contemporary technology cannot exist; and without modern technology, modern society cannot exist. Sa'ad et al. (2014) believe that to promote the growth of science and technology for the competitiveness and economic development of the country, Tanzania's education sector should place an emphasis on developing math capacity. There is little to no discussion of what is occurring in ECD, which is the foundation for future learning, even though Tanzania's mathematics problem appears to be obvious at higher levels.

One of the elements that contributes to poor performance, according to Mazana et al. (2019), is a lack of a solid mathematical background and foundation at ECD. The researchers went to some of the ECD centers in the Eastern Cape Province's OR Tambo Inland District, which is a rural area plagued by poverty. It was obvious that majority of the district's ECD centers do not provide ECD programs. The ECD program comprises, among other things, the following fundamentals: literacy, numeracy, and life skills. The majority of practitioners at those centers worked as volunteers, only acting as practitioners with limited training which invariably will affect their application of conceptions of mathematical knowledge in enhancing early learning of mathematics at ECD centres.

Literature has revealed that early childhood development (ECD) practitioners have not effectively applied their conceptions of mathematical knowledge in the foundation phase mathematics learning. This might be as a result of some impediments to the application of conceptions of mathematical knowledge by the practitioners. However, there is a dearth of empirical evidence on the challenges ECD practitioners face in the use of conceptions of mathematical knowledge in the foundation phase mathematics learning. Therefore, this study used a qualitative research design to examine the difficulties faced by ECD practitioners when applying their mathematical expertise to improve young children's arithmetic learning.

Literature review

In South Africa, views of roles, content knowledge, pedagogical knowledge, as well as children's capital and cultural knowledge, are seen as notions of mathematical knowledge. The self-perceptions of practitioners, according to UNICEF & DBE (2010), include observing the children in their charge and organizing and providing activities that will support the children's developmental learning requirements and interests. Every child and family who enrolls in a setting will have their unique knowledge and experiences that are connected to their culture and extended family, according to Chalmers and Crisfield (2019). Therefore, knowledge gleaned from the children's home environment is included in their capital and cultural knowledge. Regardless of the circumstance, practitioners should possess in-depth understanding of high-quality teacher-child connection ECD programs in order to scaffold students' mathematics learning by utilizing the knowledge that children bring from their households (O'Connor, 2010). In order to effectively build mathematical skills, practitioners, according to Mofokeng (2018), should be able to incorporate play into the learning process. Such instructional techniques call for intentionally integrated experiences that give practitioners the chance to develop their pedagogical and mathematical expertise, as well as to make connections that encourage the creation of new knowledge. Additionally, this will assist in raising the subsequent grades' subpar mathematical performance. Additionally, according to Moala and Hunter (2019), despite the significance of resilience, teachers frequently lack the resources to create resilient students, especially in the subject of mathematics.

Additionally, it is thought that the development of young children's mathematical understanding is dependent on instructors' understanding of the big ideas in children's mathematical learning, especially in the US (Dooley, 2019). Mathematical concepts are essential for all practices, not just learning, which makes them extremely important for ECD practitioners. This can be done if ECD professionals accept that young children can have access to high-quality mathematics instruction and activities. According to Parks and Wager (2015), understanding American ideas of mathematical knowledge is essential for helping early childhood practitioners identify the precise skills, knowledge, and personality qualities needed of teachers of young children. To do this, teachers must be prepared to provide children with rich mathematics experiences that are consistent with their knowledge of how children learn across domains (Parks & Wager, 2015). Furthermore, according to NAEYC (2002), conceptions of mathematical knowledge give early childhood professionals the tools they need to address the issue of low mathematics achievement by teaching young children the necessary mathematical material in ways that are both intellectually relevant and considerate of their needs. Although early childhood educators in South Africa's rural ECD centers are equipped with the necessary abilities to teach mathematics, little to nothing is written regarding the barriers to their application of concepts of mathematical knowledge in the early learning of mathematics.

Young children's mathematical development is influenced by the mathematical expertise of practitioners. To fully improve mathematics in early children, practitioners must overcome a number of obstacles. Muraya and Wairimu (2020) stated that one of the issues affecting practitioners' capacity to conceptualize their mathematical knowledge is teacher quality. Practitioners play a crucial role in closing the gap between low-quality and high-quality education by maximizing the advantages of learning for every child in every classroom (Muraya & Wairimu, 2020). Since many inexperienced instructors are unable to meet the educational goals of the twenty-first century, the emphasis should be on teacher quality in order to achieve excellent education. Despite the fact that the literature highlights the value of teachers, less is known about the precise qualities of teacher quality required to improve mathematics in rural early childhood development centers, despite the fact that quality is a predictor in student learning. Language proficiency is cited by Machaba (2019) as a hindrance to practitioners' improvement of their mathematical abilities. As a result, it's critical that educators understand different ways in which language is used since language is a crucial component of early mathematics learning (Machaba, 2019). To utilize language successfully, teachers must be able to tell the difference between what is said and

what is meant. Language in the classroom should be kept as plain as possible, in other words. Language, especially number phrases and quantitative terminology, is essential for the development of verbal-based number concepts and skills, according to Clements, Baroody, and Sarama (2013). Additionally, the fundamental component of linguistic subitizing recognizes the total (cardinal value) of a collection without counting and labels that total with a relevant number word for other verbal-based number, arithmetic ideas, and abilities (Clements et al., 2013). However, the problem is that so many children, especially those from underprivileged communities, sometimes have little to no grasp of the language of instruction when they first enter school (Gqoli, 2021). Fesseha and Pyle (2016) identify the difficulty teachers face as a lack of knowledge regarding interpretations of play-based learning, which leads to misunderstandings of their role during play. Fesseha and Pyle (2016) found that although practitioners claimed to have included play in their lessons, their actions did not correspond to actual play practices. However, play was restricted to particular settings and materials in their classrooms and was employed independently of academic instruction. The use of play-based learning is supported by many kindergarten teachers, however the way this play is handled lacks consistency and clarity (Fesseha & Pyle, 2016). Blanco et al. (2022) indicated that future instructors have trouble analyzing certain of the program's activities, which may be a result of their inadequate understanding of basic mathematical concepts. The degree of a child's mathematical success is largely influenced by their upbringing or background (Wright et al., 2022). The trajectory of elementary teachers' mathematical knowledge and effectiveness as teachers is better understood with the aid of teacher preparation programs (Thomson et al., 2022). According to research, it might be difficult for math teachers of all grade levels to provide evidence for their arguments in math classes (Francisco, 2022).

The above review of literature has shown that a lot of challenges bedevil the achievement of mathematics curriculum at different levels. It is obvious that certain challenges to effective mathematics instruction have been found in literature but none of these studies in literature were direct on the challenges practitioners face in the application of conceptions of mathematical knowledge in foundation phase learning of mathematics at different ECD centres in South Africa. Hence, the need for this research.

Methodology

Research Approach and design

For the conduct of this research, qualitative phenomenological research design was adopted. This design aims to comprehend and characterize a phenomenon's fundamental elements. The methodology examines human experience in daily life while putting aside the researchers' prior notions about the phenomenon. In other words, phenomenology research investigates actual events to learn more about how people interpret them.

Participants

The practitioners for this research comprised five (5) ECD practitioners from rural ECD centers in the Eastern Cape Province's OR Tambo Inland District. These participants were purposively sampled for the study. Purpose sampling technique in this case enabled the researchers to select the participants at various ECD centres who meet the target of the research.

Instruments for Data Collection and Procedure

Necessary data for this research were collected using semi-structured interview guide. The interview guide contained questions like *do you possess adequate mathematical language proficiency, do you have conducive learning space for children's mathematics learning, are you able to infusion of play in the teaching of mathematics.* Expertise of five early childhood professionals was sought to ensure that the items of the interview guide are valid. To ensure the trustworthiness of the interview guide, the items of the interview guide were stated and read several times and as well recorded using a voice recorder. With the validity and trustworthiness of the interview ensured, the researchers proceeded to the field for the actual data collection. Gatekeepers' letters were properly obtained from the participating schools after the ethical approval for the conduct of the research was granted. This enabled the researchers met one on one with the participants at their various ECD centres. At this stage, voice recorder was deployed to collect the data during the interview session. Each interview session lasted for approximately 15 minutes.

Ethical Considerations

The ethical approval for the conduct of this research was granted by the University of the Free State Faculty of Education's research ethics committee. Other research ethics were observed according such as maintaining participants' anonymity, vulnerability and participants' right to walk away if he or she decides not to continue with the interview session. Also, informed consent forms were given to the participants to fill out and sign before the commencement of the interview session.

Data Analysis

The data collected were analysed thematically to draw the major theme and sub-themes. The data scripts were read and listened over and over to make meaning out of them.

Results

The results were organized in theme and sub-themes.

Theme: Challenges confronting practitioners within early learning

Despite the numerous challenges and obstacles that practitioners must overcome to ensure that young children have access to excellent early mathematical learning chances, and the mathematical expertise they possess has an impact on how young children develop in math. Three sub-themes emerged from this theme, including the inability to use mathematical language, the absence of a favorable learning environment for children to study mathematics, and the understanding of how to incorporate play into the classroom.

Sub-theme 1: Lack of mathematical language proficiency

For the development of verbal-based number concepts and skills, Clements, Baroody, and Sarama (2013) state that language, particularly number words and Quantitative language is crucial. Language issues significantly affect children from underprivileged neighborhoods who are entering the centers for the first time and impact how well they learn math. Further aggravating the circumstance, some first come into contact with the language of instruction while in school. When practitioners were questioned regarding the challenges they faced when instructing at the centers, their comments demonstrated that they did have certain challenges:

P1: *"I struggle to get kids interested in learning the language since they don't know how to communicate and I have to spend a lot of time teaching them because they don't pay attention in class and forget things easily."*

P2: *"We didn't delve far into mathematics throughout the training, and some of the terms weren't further explained. I am finding it difficult to explain some mathematical concepts to the students and to develop a mathematics language learning environment and opportunities within the subject of mathematics*

P3: *"When kids arrive at school, they speak and comprehend their native speech. After that, as a practitioner, I must show them how to apply the mathematics they already possess from the classroom's atmosphere. Some children will comprehend, while others will first be perplexed, but while playing, they pick up other children's mathematical language.*

P4: *"There are no training sessions or workshops held to remind us of what we done throughout our training. I go to the website before I explain a new concept. To replicate how specific ideas are taught in class, visit a nearby center.*

The lack of workshops or training for practitioners is concerning since it would have allowed them to brush up on their understanding of mathematics and pedagogy and feel more secure in their work in the centers.

Sub-theme 2: Conducive learning space for children's mathematics learning

Having a physical space where pupils can sit comfortably, see and understand what their teacher is saying, and connect with their peers is one of the most crucial elements of a supportive learning environment. The following are the practitioners' comments regarding a favorable learning environment for kids to learn mathematics:

P1: *"There isn't enough space for both indoor and outdoor learning since, as I've already explained, the center is occupying a yard that is also used by other people. Because the center does not get money from the Department of Social Services Development, there are few toys and charts on the walls in the indoor learning area. The only items in the outdoor learning environment are a broken-step ladder that the kids can climb up and down, and a colorful swing".*

P2: *"The training I received from the NGO helped to widen my understanding of the subject of mathematics and provided me a hint on how to teach the subject in the early years, but it is difficult to put it into practice because the center lacks space and a supportive environment. Itis challenging to create play areas and outdoor games because the center rents space in a yard that is also used by rental households".*

P3: *"The center has a structure, but it is not maintained, and we don't even have educational resources to set up an indoor learning environment, and the ones things we did have were stolen during the break-in that occurred. For the setting of outdoor education, the number of the materials we have, such as the broken swings and seesaws, need to be repaired.*

Depending on where the center is located, a different learning environment exists for mathematics. Additionally, a conducive learning environment for mathematics encourages critical thinking, and students need a setting that supports a range of learning styles. The scenario is different in the Eastern Cape's OR Tambo Inland region, though.

Practitioners gave numerous explanations in their responses, demonstrating that the situation prevents them from creating a favorable learning environment.

Sub-theme 3: Infusion of play in mathematics teaching

Playing with numbers allows kids to learn more about the subject in general. It fosters a sense of interest in kids by encouraging them to converse, reason, and think as they solve math problems. Some centers' teachers had little to no knowledge of how to incorporate play into their instruction, as evidenced in their comments:

P1*: "I oversee the playtime activity outside. Children take turns climbing and descending the ladder, counting each step as they go. They then keep track of how many times each swing during the swing game.*

P2*: "When playing indoors, kids go to the math area, where I supervise and give directions, like sitting on the mat with the numbers. I next ask kids to identify the number that is written on the mat they are seated on. They play the swing game outside and keep track of how many times each kid swings. They also play a game in which they create a circle and one of them touches them, as in "duck, duck, duck, goose." The goose that was touched then runs around the circle; whomever gets there first wins. I am engaging in physical exercise while playing this game, which also incorporates calculation because they multiply the duck by three and the goose by one.* ***P5:*** *"I direct the play in the classroom, and the students follow the guidelines I am teaching them. They go outside to swing and slide during the break, and I don't watch them since I have other things to do.*

P3*: "I have little knowledge of learning theories, and when the kids play independently outside, I find time to do my own tasks, such get ready for the next day."*

Practitioners at other centers lacked understanding about how to incorporate play into their teaching and learning. They were seen using the time while playing outside for their own activities.

Discussion of Findings

According to the research's findings, early childhood educators face difficulties due to their limited grasp of mathematical language, a lack of classroom environments that are conducive to children learning mathematics, and their lack of experience incorporating play into their instruction. It was discovered that some practitioners have trouble getting kids to use the language of learning since they don't know how to communicate and take a long time to instruct because they do not pay attention in class and forget rapidly. Some practitioners struggle to translate some of the mathematics terms to the learners and to create opportunities for mathematics language learning within the mathematics content because they did not dive deeply into mathematics during their training and some of the terms were not further explained. Additionally, it was discovered that some ECD facilities are rented apartments with inadequate room for both indoor and outdoor schooling. Since the centers do not receive money from the Department of Social Development, the lack of resources is the main issue in the interior learning environment, which has few toys and charts hanging on the walls. Buttressing these finding, Wairimu and Muraya (2020) stated that one of the issues affecting practitioners' capacity to conceptualize their mathematical knowledge is teacher quality. Practitioners play a crucial role in closing the gap between low-quality and high-quality education by maximizing the advantages of learning for every child in every classroom (Muraya & Wairimu, 2020).

Language proficiency is cited by Machaba (2019) as a hindrance to practitioners' improvement of their mathematical abilities. As a result, it's critical that educators understand different ways in which language is used since language is a crucial component of early mathematics learning (Machaba, 2019). To utilize language successfully, teachers must be able to tell the difference between what is said and what is meant. Language in the classroom should be kept as plain as possible, in other words. Language, especially number phrases and quantitative terminology, is essential for the development of verbal-based number concepts and skills, according to Clements, Baroody, and Sarama (2013). Blanco et al. (2022) indicated that future instructors have trouble analyzing certain of the program's activities, which may be a result of their inadequate understanding of basic mathematical concepts. The degree of a child's mathematical success is largely influenced by their upbringing or background (Wright et al., 2022). The trajectory of elementary teachers' mathematical knowledge and effectiveness as teachers is better understood with the aid of teacher preparation programs (Thomson et al., 2022). According to research, it might be difficult for math teachers of all grade levels to provide evidence for their arguments in math classes (Francisco, 2022).

Conclusion

Based on their findings, the researchers came to the conclusion that ECD practitioners have some difficulties when applying conceptions of mathematical knowledge to improve early learning of mathematics. This proves that it may not be possible to improve the teaching and learning of mathematics at diverse ECD centers in South Africa by effectively utilizing practitioners' concepts of mathematical knowledge in light of those difficult variables. Therefore, the researchers advise making enough provisions for an environment that will enable practitioners to use their ideas of mathematical knowledge to improve the teaching of mathematics to young children.

The study's primary focus was on practitioners as its units of analysis, hence the findings only applied to the sample of five practitioners from five early childhood facilities. Because the study only included participants from a small sample of five OR Tambo Inland District participants and five ECD sites, generalization of the findings to the entire population are difficult to establish. Therefore, in the future, studies should mix several methodologies to offer population-level data.

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