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Integrating Africanised play into digital learning of mathematics in the foundation phase

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ABSTRACT

Africanised play is a pedagogical transformation that stresses integrating play pedagogies, African culture and digital learning within the mathematical curriculum. This transformation contributes to learners developing problem-solving, mathematical, digital skills and appreciating culture. Given that, there still needs to be more knowledge on the integration of Africanised play into digital mathematics learning. This study is underpinned by Vygotsky's sociocultural theory, which argues that educators can use applications of the zone of proximal development and integrate cultural tools, mediated learning and social interaction to teach mathematics. The hermeneutic phenomenology research design was employed in a qualitative study. Data was generated using semi-structured interviews, document analysis, and non-participant observations from twelve educators from four primary schools in Limpopo. These educators were selected through homogeneous purposive sampling. The data was analysed through interpretative phenomenological analysis on NVivo 12. The findings indicated that African games that integrate digital learning can teach counting, mathematical and problem-solving skills to Foundation Phase learners. However, there is a challenge of limited digital tools and experiences of planning lessons and implementations in their classrooms. This paper contributes to the pedagogical and theoretical strategies of integrating Africanised play into digital learning of mathematics in the foundation phase.

INTRODUCTION

Recently, there has been a great concern about the transformation of mathematics curriculum in primary education. Intrinsically, this drives towards the integration of African culture, indigenous knowledge and digital learning in early childhood education and the Foundation Phase (FP). The Department of Basic Education (DBE) (2011) calls attention to inclusion of play-based pedagogies, indigenous knowledge, culture and digital teaching of mathematics in the FP. According to Kroeze (2019), the curriculum supports using Africanised play-based pedagogy because it enhances learners' mathematical and scientific skills. To support this, Govender and Mudzamiri (2021) agree that incorporating African games in mathematics helps learners understand mathematical concepts.

According to Sebola and Mogoboya (2020) Africanised play refers to the use of play-based approaches that integrate African culture, customs and identity. Africanised play relates to "*ethnomathematics*" as it encourages the use of games that incorporates culture and mathematics concepts (Ergene & Ergene, 2020, p.402). To teach FP learners mathematics, educators are encouraged to use digital games that reflects African culture in the classrooms. Lamentably, African games such as Ludo, Morabaraba, and Soduko can be played on digital tools to teach young children mathematics skills. For example, Moloi (2014) and Tachie and Galawe (2021) confirm that

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Morabaraba can be used to teach young children probabilitity and promote the understanding of ascending or descending patterns in teaching and learning mathematics. In the same view, Matsekoleng et al. (2023) agree that as the children move cows on the board develops 2D shapes, spatial orientation and digital mathematics skills. It is against this background, the authors argue the integration of Africanised play into digital learning of mathematics in the FP.

It is widely agreed by curriculum policies, educators, researchers and theorists that digital learning should be incorporated in FP classes. Different regions stress the use of digital teaching in the early years. In Europe, the Digital Education Action Plan emphasises the improvement of children's digital literacy and competences of learners and educators (Monnet, 2022). Similarly, the Australian Curriculum, Assessment, and Reporting Authority provides guidelines for using digital learning (Rao, 2021). Lastly, the Continental Education Strategy for Africa underscores the promotion of integrated communication technology (ICT) in education to promote academic excellence of learners (Oladejo, Akinola, Ebisin & Olateju, 2022). Bernstein's sociology of pedagogy can be used to understand how educators use pedagogical transformation within South African mathematical curriculum to integrate digital teaching in childhood education (Muller & Hoadley, 2021). The digital skills can be applied in Science, Technology, Arts, and Mathematics (STEAM) curricula. Thus, this paper aims to explore the integration of Africanised play into digital learning of mathematics in the FP.

On the other hand, there is still limited knowledge on the integration of Africanised play into digital learning of mathematics in the FP. Mosimege and Winner (2021) encourage the integration of African culture and play pedagogies in teaching mathematics because South African learners continue to perform poorly in this subject. Ndlovu et al. (2023) and Selepe et al. (2024) investigated play pedagogies in early childhood and recommended indigenous activities while Selepe and Mphahlele (2022) explored the use of play-based pedagogies in teaching mathematics in the foundation phase and recommended the integration of technology in teaching and learning. Despite that, the South African curriculum, Curriculum Assessment and Policy Statement (CAPS) lacks clear guidance on the integration of Africanisation into pedagogical practices, digital learning and teaching and learning mathematics in the FP (DBE, 2011). As such this paper asked: *How do educators integrate Africanised play into digital learning of mathematics in the foundation phase?*

Theoretical framework

This paper is underpinned by the Vygotsky's sociocultural theory that argues that educators can use applications of zone of proximal development (ZPD) and engage children in play activities that integrate cultural tools and social interaction to teach mathematics. ZPD refers to the gap between actual and potential learning as measured by an individual's independence when solving mathematical problems (Kusmaryono et al., 2021). Gehlot (2021) also stated that it is only through collaboration with adults and other learners that this gap can be closed through play-based activities that integrate culture and social interactions. In the context of mathematics learning in South Africa, an educator's role is to assist learners in developing problem-solving skills and using play-based pedagogy that appreciates African culture in digital learning (DBE; 2011; Ling & Mahmud, 2023). As such, Vygotsky's sociocultural theory offers a robust framework for the integration of Africanised play into digital learning of mathematics in the FP. This approach demonstrates how Africanised play can be integrated with digital or digital content to enhance learners' mathematical skills.

Integration of Africanised play and digital learning of mathematics

Cultural activities play an essential role in mathematics content areas such as numbers, operations and relationships, as well as geometry in the FP. From the researcher's perspective, the role of cultural activities in these content areas is to promote learners' problem-solving skills. This is supported by several researchers, such as Acharya et al. (2021), Brandt and Chernoff (2015), and Rosa and Orey (2019), that the role of integrating cultural activities in the classroom is to develop learners' problem-solving skills in mathematics. Brandt and Chernoff (2015) further advised that mathematics educators should incorporate cultural activities into their lesson plans. In addition, Fouze and Amit (2017) agreed that playing African games helps develop problem-solving skills and mathematical thinking that help in teaching and learning mathematics. Acharya et al. (2021)

concluded that one way of decolonising education and transforming the curriculum is by infusing cultural rituals, artefacts and cultural play to teach basic-level mathematics. Through examining how Africanised games can support the teaching and learning of mathematics, it is the intention of the researcher to motivate the integration of Africanised play into the digital learning of mathematics in the FP.

Literature review

Empirical studies from North America, Zimbabwe and South Africa were reviewed to understand the integration of Africanised play into digital learning of mathematics in the FP. These countries have similar mathematics education in the FP to South Africa. The first section explores how other researchers integrate Africanised play into digital learning of mathematics while the following section reviews the role of Africanised play and digital learning of mathematics in the FP.

Integration of Africanised Play and Digital Learning of Mathematics in the FP

Golafshani's (2023) study explored the use of indigenous storytelling in planning and teaching mathematical content in the northern region of Ontario, Canada. A phenomenological case study methodology was employed by Golafshani (2023) to view the experiences of 20 Grade 1 learners and two elementary teachers on implementing indigenous storytelling in the planning and teaching of mathematical content from public primary schools through record observations. Failing to select multiple elementary teachers from different schools may have limited the credibility of the study's findings. Nonetheless, Golafshani (2023) found that indigenous storytelling helps children learn abstract mathematical concepts related to their own real-world experiences. Golafshani (2023) also concluded that educators can use dice games to encourage interaction between learners in teaching mathematics content. Even though Golafshani (2023) did not integrate digital learning, the researcher understands that dice can be played by young learners using digital tools to learn mathematics. Linking the findings of Golafshani (2023) with the theoretical framework of this study shows that Africanised play-based activities that use dice games could be used to teach abstract mathematical concepts as they promote social interaction and cultural awareness.

Sunzuma and Luneta's (2023) study was conducted in Zimbabwe based on implementing an digital learner-centred strategy in teaching mathematics. Using a case-study research design, documents, interviews and lesson observation were used to collect rich field notes from four pre-service teachers. Their findings showed that learner-centred methods were used in group work and pairing sessions. Even with this, Sunzama and Lueta (2023) found that digital mathematics teaching still needs to be improved. Although Sunzama and Luneta's (2023) findings may be interesting, it should be noted that the participants need to be more experienced in teaching mathematics. Considering this, the theoretical framework of this study and the findings of Sunzama and Lueta's (2023) study highlight the importance of teaching mathematics digital.

Galawe (2023) investigated the use of indigenous games in teaching geometric patterns in mathematics in the Intermediate Phase (Grades 4–6). With an explanatory sequential approach, questionnaires and interviews were used to collect data from Free State. Galawe (2023) found that the use of indigenous games teaches learners geometric patterns. However, his findings were that educators do not apply the ZPD in teaching and learning geometric patterns. This contradicts the DBE's (2011) emphasis on the use of learner-centred rather than teacher-centred approaches.

The Role of Africanised Play and Digital Learning of Mathematics in the FP

Several previous researchers such as Chirinda (2021), Lunga et al. (2022), and Matsekoleng, Maile, Mashaba and Ntsana (2022) have reported that the role of Africanised play and digital learning of mathematics is to develop problem-solving skills. Chirinda (2021) indicates that using African play improves learners' problem-solving skills in mathematics. Lunga et al. (2022) added that play-based pedagogy integrating African culture supports learners' critical, creative, problem-solving, logical and analytical skills in mathematics. Masemola et al. (2022) added that during Africanised play-based learning, learners can solve complex mathematical problems. It is against this backdrop, the theoretical framework underpinning this study posits that integrating Africanised play activities into digital learning of mathematics in the FP can develop learners' mathematical concepts. In addition, the use of the ZPD is encouraged to promote social interaction among learners and enhance their mathematical skills.

METHODS

Vygotsky's sociocultural theory guided the selection of the interpretivist paradigm. This paradigm is used by researchers who maintain that there are multiple truths and subjectivity in interpreting reality which is socially constructed (Panya & Nyarwath, 2022). For this study, interpretivism was selected based on its philosophical assumptions. As a result, individuals construct knowledge from their experiences shaped by their history, cultural and social perspectives (Moisander, Närvänen & Valtonen, 2020).

In contrast to a quantitative or mixed-method approach, a qualitative research approach aligns well with the interpretivist research paradigm. Because the interpretivist paradigm uses a hermeneutic methodology, it requires qualitative data (Al-Ababneh, 2020). The qualitative research approach values social truth that is embedded in social surroundings (Nigar; 2020). A hermeneutic phenomenology was selected to elucidate and interpret participants' lived experiences and to obtain an in-depth and rich understanding on the integration of Africanised play into digital learning of mathematics in the FP. (Dangal & Joshi, 2022). This was guided by Tomaszewski, Zaretsky and González (2020) who explained that researchers must use a phenomenological research design to understand participants' lived experiences and the meaning of their experiences.

A total of twelve (12) FP educators (Grades 1 to 3) from four primary schools in Limpopo, South Africa were selected using a homogenous purposive sampling strategy. This selection was based on the similarity of their lived experiences, specifically those with at least three years' experience of teaching mathematics in the FP and who identify themselves as Africans (Jedličková, Müller, Halová & Cserge, 2022). The data was collected through semi-structured interviews with all the educators while document analysis, and non-participant observations were collected from Grade 3 educators only from each school. Semi-structured interviews were used to solicit the lived experiences of educators on the integration of Africanised play into digital teaching of mathematics. One-one-one interviews were conducted after the school activities to avoid the disruptions of the lessons. An audio recorder was used to capture the conversation between the interviewer (the authors) and the interveews (educators). An interview schedule was used to ask the educators' open ended questions with probing questions to understand the underlying issues and their lived experiences on the phenomenon under the study. Document analysis was used to corroborate educators' responses from the interviews to see how they planned their lessons to integrate Africanised play into digital teaching of mathematics in the FP. Educators' mathematics lesson plans and learners activity books were requested. The data from the lesson plans was analysed by answering the questions set out in the document analysis tool. Non-participant observations were used to triangulate data from semi-structured interviews and documents to verify the consistency between planned lessons and classroom implementation. An observation schedule was used during the observation of classroom practices to answer the questions from the implementation of the mathemathics lesson. A total number of six (6) observations were conducted from two (2) different mathematics lessons implemented on different days.

Methods triangulation in hermeneutic phenomenology research improves the validity and credibility of the research findings (Dangal & Joshi, 2020). Collecting educators' lived experiences on the study's phenomenon through semi-structured interviews, document analysis and non-participant observations increased the credibility of the results (Striepe, 2021). Semi-structured interviews were recorded to increase internal validity in this study. The researcher used audio recordings to capture interviews to reduce internal bias (Stenfors, Kajamaa & Bennett, 2020). Moreover, coding, co-coding and recoding of data using manually and using NVivo 12 softtware during analysis confirmed the accuracy of the findings for this study.

Before data collection began, the following approvals and permissions were obtained to conduct this study. Ethical approval from the University of South Africa (UNISA) Ethics Committee with reference number 2023/10/11/64019209/38/AM. The certificate from Limpopo Provincial Research Ethics (LPRE) was approved by the premier's office with research project number LPREC/144/2023: PG. Parents and participants also consented to the researcher accessing the data from their children's activity books. There were also assent forms for learners. The researcher replaced the names of schools (S1 to S4) and participants with pseudonyms such as School 1

Foundation Phase Educator 1 (S1FPE1) to School 4 Foundation Phase Educator 3 (S4FPE3) during data analysis, presentations and discussions to safeguard anonymity and confidentiality.

Interpretative phenomenological analysis (IPA) based on a subjective epistemology as recommended by Rajasinghe and Garvey (2023) was used to interpret educators' lived experiences to understand the integration of Africanised play into digital learning of mathematics in the FP. Following the model of Smith, Flowers, et al (2022) in IPA, the researcher analysed the semi-structured interview, documents and non-participant data. The codes were created from the keywords in the interview schedule that aligned with the study's research questions. The interview, document and non-participant data was coded manually using a computer. Three data sets (folders) were uploaded on NVivo 12 software for recoding using the same codes. After some time the supervisor co-coded the data to ensure the authenticity and consistency of data through multiple coding (Kawamoto, Koizumi & Yoshikane, 2023). A total number of 43 codes were created on the software. Different visualisations input were exported from NVivo 12 and assisted with the interpretation of results. Lastly, two themes, namely, the role of Africanised play and digital learning of mathematics in the FP and addressing the challenges of limited digital resources through a socio-cultural lens emerged.

FINDINGS

This study asked how educators integrate Africanised play into digital learning of mathematics in the FP. The results indicated that educators use digital games that integrate African culture such as Ludo, Morabaraba and Sudoku to develop learners' counting, mathematical and problem-solving skills. Figure 1 generated from the NVivo 12 illustrates educators' lived experiences from semi-structured interviews, document analysis and non-participants data on the integration of Africanised play into digital learning of mathematics in the FP. Figure 1 highlights the percentage of codes on the integration of Africanised play into digital learning of mathematics arising from interviews, documents and observation data. As shown in Figure 1, the results emerged from eight educators: S4FPE2, S1FPE1, S1FPE3, S3FPE3, S1FPE2, S2FPE3, S2FPE2 and S4FPE3

Figure 1 illustrates that educators' lived experiences on integrating Africanised play into digital learning of mathematics in the FP reflected mostly from the semi-structured interviews. This indicates that there is still a gap in planning of lesson and their implementation in the classroom practices is still lacking.

Promotion of counting and mental mathematics skills

The promotion of counting skills was mentioned again by S1FPE1, S2FPE1, S2FPE2, S2FPE3 and S3FPE1. Other educators proposed various outcomes, including improving counting skills, mathematical thinking skills, long-term memory and excitement for mathematics-related activities. A follow-up question (Question 15) asked educators to give their views and experiences on the function that Africanised play-based pedagogy serves in teaching FP learners mental mathematics digital. S2FPE1, S2FPE3, S3FPE1, S3FPE3 and S1FPE2 said this phenomenon could develop learners' counting skills. S1FPE2 said:

> *"They improve their ability to count forward and backward. It helps with the recognition of numbers, sharing and grouping. It teaches children how to interact with other people. They enhance learners' cognitive abilities by observing the digital Google and YouTube videos. For instance, I can use my smart TV to stream a video on how to play Diketo, and learners can watch and use the teacher-provided resources—like stones—while they play. This allows learners to learn number patterns"* (S1FPE2).

The development of problem-solving skills was brought up again when S1FPE1 highlighted:

> *"Even in teaching and learning activities, indigenous knowledge is helpful. Learners should be able to connect what they learn in the classroom to real-world situations and to solve mathematical problems. Learners need to recognise the significance of culture in our day-to-day endeavours".* (S1FPE1).

Nevertheless, S2FPE2 was at a loss for words when explaining it. A pause ensued before the following was said:

> "*I do not know how to explain it."* (S2FPE2).

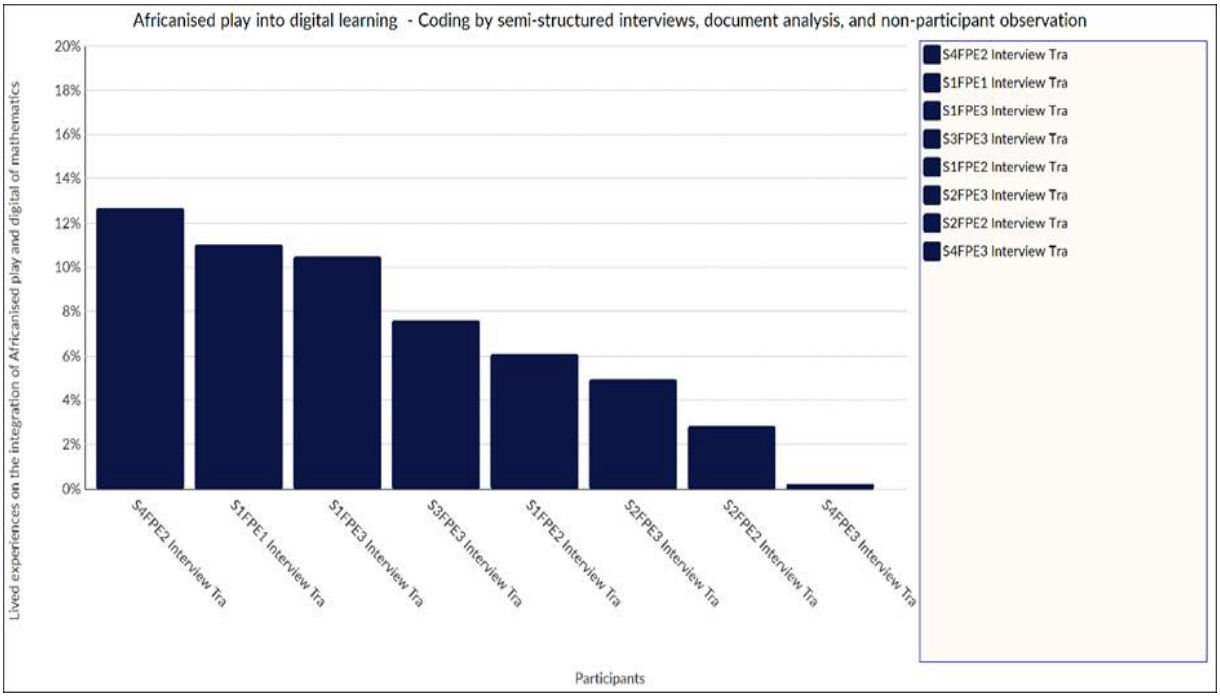

Figure 1. The integration of Africanised play into digital learning of mathematics (Source: NVivo 12)

Even though the interview findings indicate that educators have lived experiences on the role of Africanised play-based pedagogy in the digital teaching of mental mathematics, they do not include it in their lesson plans. There needs to be evidence in the lesson plans regarding the relevance of this approach in teaching mathematics. Lesson objectives and aims should be indicated in the lesson plans.

From S1FPE3's classroom, Africanised play-based pedagogy (Sudoku game) assisted in developing problem-solving skills. Mathematical thinking skills, counting skills, social interaction and enthusiasm were evident, among other roles. Most, if not all, of the learners achieved full marks. The learners engaged in the Tsheretshere game and developed mathematical thinking and counting skills as they played it in S2FPE3's classroom. The development of problem-solving, socialisation and mathematical thinking skills was evident in S3FPE3's classroom. After watching the video of the Diketo game on the screen, learners played the game physically, following the rules. The learners could perform number patterns. However, learners needed help to get all the marks for the class activity.

Enhancement of mathematical and problem-solving skills promotion of counting and mental mathematics skills

The experiential statements from S4FPE2, S1FPE1, and S1FPE3 are provided in full for close reading and engagement of participants on the role of Africanised play-based pedagogy in the digital teaching of mental mathematics to FP learners. S1FPE1 and S2FPE3 clarified that their role was to help learners build their ability to solve mathematical problems. S1FPE1 described their experiences:

> "*Ludo game, for instance, teaches learners how to solve mathematical puzzles and be responsible. Learners should be able to defend themselves from the assailants while they play this game. They can solve challenges in real life because of this. It instils independence in them*" (S1FPE1).

Conversely, S1FPE2 and S2FPE1 discussed that Africanised play-based pedagogy develops learners' social skills in the classroom. S3FPE1 and S4FPE2 substantiated the development of technology skills in learners through digital mathematics teaching to FP learners. S1FPE3 brought up an appreciation of culture and identity. S1FPE3 distinguished between learners who showed technological and cultural intelligence during conversations. S1FPE3 provided evidence for this:

> *"Since culture broadens learners' comprehension of mathematics, it would be beneficial to incorporate it into mathematics teaching. With an Africanised perspective, digital teaching and play-based pedagogy can benefit learners from diverse backgrounds. It accommodates various learning styles as well. Because learners differ from one another and do not all acquire their information from the same pedagogy, it may be able to accommodate learners with learning disabilities. While some learn from video games, others learn from African culture. Some are e-learning savvy; some are culturally smart. It helps our kids rediscover their African identity and culture"* (S1FPE3).

In Question 15, educators were questioned about the roles of integrating African games in teaching mathematics in their past experiences. S1FPE2, S1FPE3, S4FPE2 and S4FPE3 said they extended learners' memory in teaching mathematics. S1FPE3 mentioned that they used to look down on African games in teaching mathematics in the FP. S1FPE3 verbalised:

> *"We used to limit our attention to using African games in traditional education. The games helped learners learn how to think quickly and solve mathematical difficulties. For instance, my FP teacher employed African games to help learners learn arithmetic through long-term memory. As a teacher, I applied them to enhance learners' mathematics comprehension.*
>
> *Additionally, it promotes the drilling method among educators. Learners engage in outdoor play to help each other comprehend the day's material. It could involve addition, subtraction or counting".* (S1FPE3).

Lack of digital devices

Educators raised the challenge of the lack of technological devices to use Africanised play to teach mathematics to FP learners. Learners from S1 had tablets from Grades 1 to 3. However, educators did not have individual laptops, and the school shared only one smart classroom. Learners from S2 did not have tablets, but they had access to a computer laboratory. The educators from this school had laptops; each class had a smartboard, while every building block had a hub. When asked a probing question during the interviews about where they acquired knowledge of digital teaching platforms in the FP, S2FPE2 replied:

> "*Our principal is technologically advanced. He had/has a friendship with a certain private school in Polokwane. He saw the necessity of these technological devices at our school. We were using chalkboards first, followed by whiteboards and interactive whiteboards, and most recently, we used smartboards. Interactive whiteboards are more like smartboards, and they are not technologically advanced. They were not sponsors but used the funds allocated for the COVID-19 pandemic by the DBE. Although my class uses the computer labs frequently, we can access them*" (S2FPE2).
>
> "*Not really due to lack of tablets. Learners would not be able to participate even if I used my laptop…"* (S3FPE3)

These participants could access the school WI-FI in their classrooms. S3 learners had tablets even though they were limited; their school had projectors, and educators had laptops. Learners from S4 had tablets, but they were limited; the educators could not access the school's WI-FI.The results presented in the previous section are discussed through the reviewed literature and lens of Vygotsky's socio-cultural theory as the theoretical framework underpinning this study. The researchers used themes to discuss how social interaction, cultural tools, and the ZPD play crucial roles in learning. Vygotsky's theory emphasizes that learning is inherently social and culturally embedded, which can be directly related to the educators' integration of Africanised play into digital learning of mathematics in the FP (Vygotsky, 1967).

DISCUSSION

Theme 1: The role of Africanised play and digital learning of mathematics in the FP

The findings from the revealed that educators promote counting and mental mathematics skills by integrating Africanised play into digital learning of mathematics in the FP. They use of digital games that incorporate African culture, such as Ludo, Morabaraba, and Sudoku, to develop learners' counting and problem-solving skills aligns with Vygotsky's concept that learning occurs through social interaction. The literature from Golafshani (2023) support that when learners play dice games, they develop mathematical concepts as it promotes social interaction and cultural awareness. Even though Galawe (2023) did not specify social interaction, their study indicate that Africanised play can teach geometrical skills. In the same vein, Vygotsky's sociocultural theory corroborates that the

participants need to use social interaction and cultural tools to improve learners' counting, mental mathematics and geometry skills through digital games in the FP. In addition, Gehlot (2021) agreed that the social interaction that was promoted within this approach closed the gap in FP learners' mathematical understanding. The findings showed that other than promotion of counting and mental mathematics skills, the integration of cultural tools such as digital learning into mathematics enhances mathematical and problem-solving skills. The reviewed literature from Acharya et al. (2021) corroborates that including cultural rituals, artefacts and cultural play in teaching mathematics at low levels need an incorporation of cultural tools and mediated learning. For instance, the use of traditional games like Morabaraba in a digital format allows learners to connect their cultural knowledge with mathematical thinking, thus making the learning experience more meaningful and contextually relevant.

The findings showed that other than promotion of counting and mental mathematics skills, the integration of Africanised play into digital learning of mathematics in the FP, this approach enhances mathematical and problem-solving skills. The literature from Matsekoleng et al. (2024) and Russo et al. (2021) corroborated the findings of this study that the role of cultural activities in teaching and learning mathematics is to develop learners' problem-solving skills. In the same vein, Vygotsky's sociocultural theory supports that using ZPD activities that integrate Africanised play and digital skills can improve learners' mathematical and problem-solving skills. In the same vein, Vygotsky's sociocultural theory corroborates that teachers need to use the ZPD to improve learners' counting, mental mathematics and geometry skills through digital games in the FP. The researchers agree that these games provide a platform for learners to engage with their peers, discuss strategies, and collaborate on solving mathematical problems. This interaction helps learners internalize mathematical concepts and promotes social skills, as observed in the classrooms where learners interacted with others while engaging in these culturally relevant games.

The findings also highlight how integrating Africanised play in digital learning supports cognitive development, particularly in problem-solving, counting, and mathematical thinking. Vygotsky's theory suggests that cognitive development is deeply connected to social and cultural contexts. The emphasis on cultural identity, as seen in S1FPE3's observation that learners showed technological and cultural intelligence, reinforces the idea that learning is a culturally situated process. The literature from Masemola et al. (2022) indicated for learners to solve complex mathematical problems they need cognitive and social skills. The researchers view that by incorporating African games into mathematics education, educators help learners develop a stronger sense of identity and cultural pride, which Vygotsky would argue is essential for holistic cognitive development.

Theme 2: Addressing the challenges of limited digital resources through a socio-cultural lens

The findings demonstrated that educators have a challenge with access to digital devices to integrate Africanised play into digital learning of mathematics in the FP. In contrast, the literature from Matsekoleng et al (2024) showed that for a successful implementation of Africanised play into digital learning of mathematics, FP educators need some knowledge of how to use technological devices. The theoretical framework supports that the application of ZPD should integrate play activities, digital learning, culture and social interaction.

The study revealed that educators' lesson planning could be more satisfactory because their copies of lesson plans must demonstrate the integration of Africanised play into digital learning of mathematics in the FP. Only S3FPE3 planned a lesson on a government website, with available digital resources. Brandt and Chernoff (2015) proposed that mathematics educators can include cultural activities into their lesson planning. As a result, the challenges identified, such as the lack of digital devices and limited knowledge of planning lessons, can be viewed through Vygotsky's socio-cultural lens as barriers to accessing the full range of cultural tools necessary for learning. The disparity in resources between schools underscores the importance of equitable access to technology, which is crucial for implementing culturally relevant pedagogy. Vygotsky would likely argue that overcoming these barriers is essential to ensure that all learners have the opportunity to engage in meaningful, culturally grounded learning experiences.

Contribution of the study

This paper makes a significant contribution to the growing literature on the integration of culturally relevant pedagogies and digital learning in early mathematics education. By exploring how FP educators integrate Africanised play into digital learning of mathematics, this study reveals fundamental perceptions into pedagogical approaches and theoretical implications. Firstly, this study a practical lens of using Africanised play-based pedagogical approaches into digital learning of mathematics that enhances young learners' problem-solving and mental-maths skills. The participants shared their lived experiences of using digital games that incorporates African culture such as Ludo, Morabaraba, and Sudoku to develop mathematical concepts to FP learners. However, viewed through Vygotsky's lens, limited access to digital devices serves as a barrier of integration of Africanised play into digital learning of early mathematics. In addition, there is still a challenge of integrating these practical approaches into lesson planning and classroom practices. As a result, the authors suggest that FP educators can be guided by Vygotsky's sociocultural theory in planning of lessons and implementation in their mathematics classrooms.

CONCLUSIONS

This paper explored the integration of Africanised play into digital learning of mathematics in the FP. The findings indicated that African games that integrate digital learning play a significance role in teaching counting, mathematical and problem-solving skills to FP learners. Educators use African games that integrate digital learning such as Ludo, Morabaraba and Sudoku to develop these skills. However, there is a lack of digital devices and educators still lack knowledge on how to integrate Africanised play and digital learning into their lesson plans for teaching mathematics in the FP. In light of these findings, this study recommends that the curriculum policy makers need to implement content-specific training workshops to FP teachers with a focus on integrating Africanised games such as Ludo, Morabaraba and Soduko into digital mathematics teaching especially in under-resourced and disadvantaged primary schools. Furthermore, the educators can scaffolds mathematics learning activities through meaningful play-based pedagogies and digital learning activities that incorporate African cultural context. Lastly, in the classroom environments where access to digital devices is limited, educators can encourage learners to play Africanised games in groups using shared digital tools to support mathematics learning, foster teamwork, and enhance social interaction. One of the limitations of this paper is that the participants were only Africanised and based in rural primary schools. The further research can focus on multiple cases in qualitative scope to focus on different races and schools.

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AUTHOR'S DECLARATION

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Availability of data and materials	The PhD thesis, "Using Africanised play-based pedagogy in the online teaching of mental mathematics to foundation phase learners," served as the foundation for this paper.
Competing interests	The authors declare no competing interests in this paper. This work has not been published or submitted for publication elsewhere, and is entirely original work.

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