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Leveraging Kahoot to Support Mathematics Learning in Early Childhood Classrooms

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Abstract

Kahoot is a digital game-based platform that provides immediate feedback to learners as they answer mathematical questions. The literature shows that Artificial Intelligence can give immediate feedback to learners based on their mathematics responses within Kahoot. Teachers need to support mathematical learning in early childhood, especially in rural primary schools, which they could do by using Kahoot. This paper is underpinned by the behaviourist learning theory of Skinner's operant conditioning, which argues that teachers can strengthen desired mathematical behaviours by providing immediate and consistent reinforcement. A hermeneutic phenomenology research design within a qualitative study explored the teachers' lived experiences leveraging Kahoot to support mathematics learning in early childhood classrooms. Twelve educators from four public primary schools in rural areas of Limpopo, South Africa, were selected through a homogenous purposive sampling technique based on their experiences in teaching mathematics in early childhood classrooms. The semi-structured interview guide was used to collect data. An interpretative phenomenological analysis was used to analyse the data with the assistance of Nvivo 12. The findings indicated that teachers leverage Kahoot to support mathematical skills in early childhood classrooms. However, Kahoot is only used during competitions because of time constraints. In light of these findings, it is suggested that teachers need to persuade immediate, consistent reinforcement and use artificial intelligence algorithms in Kahoot, even in their teaching and learning activities. The novelty of this paper lies in the integration of Artificial Intelligence within Gamification in learning mathematics in early childhood.

Keywords: Immediate feedback, Kahoot, mathematics skills, reinforcement, Skinner's operant conditioning

INTRODUCTION

Different pedagogies, including gamification, are encouraged in teaching and learning mathematics in early childhood education worldwide. Recently, game-based learning has received increased recognition for its ability to enhance young children's language and mathematical skills through playful activities (Lamrani & Abdelwahed, 2020). In support of this claim, curriculum policies from different countries, such as Early Learning STEM Australian (Australia) and the Ontario Kindergarten Programme (Canada), have included gamification to integrate children's digital skills into learning mathematics (DeCoito & Briona, 2023). Thus, educators need to use games that integrate digital development in early childhood to develop children's mathematical skills.

It should be noted that there are a few research studies on the use of Kahoot and AI in supporting mathematics learning in early childhood. This paper is different in integrating pedagogical knowledge, technological transformation, digitalisation, and the improvement of mathematics in early childhood in a rural context.

Kahoot is a game-based learning approach in early childhood curricula that integrates digital skills with mathematics. This game provides instant feedback to players as they answer questions, which can help young learners quickly correct their mistakes and reinforce correct answers, promoting better retention of mathematical concepts (Johnson, 2023). Amanda et al. (2024) assert that through Kahoot, educators can give learners mathematical quizzes. As they demonstrate mastery, more complex problems are gradually used to reinforce each step in achieving more advanced mathematical skills. Amanda et al. (2024) discuss the role of reinforcement in shaping a child's behaviour in learning mathematics. Akkuş et al. (2021) explain that when a child selects the correct answer, they receive immediate positive reinforcement in the form of points, encouraging them to repeat the behaviour. If the answer is incorrect, immediate feedback helps the child recognise the mistake and learn the correct response, reducing the likelihood of repeating the error (Akkuş et al., 2021). Thus, this article explores how Kahoot supports mathematics learning in early childhood, particularly in rural schools.

Artificial Intelligence (AI) Algorithms and Kahoot

AI algorithms enhance the capabilities and effectiveness of the Kahoot platform in teaching mathematics. Oksana (2022) agrees that these algorithms can analyse the child performance data in real-time and then adapt Kahoot quizzes' difficulty level and content to suit individual learning needs. This ensures that each learner is challenged appropriately and can progress at their own pace (Janković et al., 2022). According to Balaskas et al. (2023), integrating AI with Kahoot in teaching mathematics to early childhood learners can significantly increase engagement and motivation, support language and accessibility needs, use predictive analytics, and assist in automated content creation. As a result, these AI-driven enhancements can make learning mathematics more effective, enjoyable, and tailored to the unique needs of each young learner. The researcher recognises the work of Balaskas et al. (2023), Janković et al. (2022) and Oksana (2022) on the importance of AI algorithms in Kahoot when teaching mathematics to young children with different learning abilities. For example, if a learner correctly answers addition questions, the AI can introduce more complex problems, such as subtraction or multiplication. Conversely, AI can provide additional practice on more straightforward concepts if a learner struggles.

Developed countries such as Finland, Singapore, and the United States, as well as less-developed Sub-Saharan countries like Nigeria, Rwanda and South Africa, support the leverage of Kahoot to teach mathematics learning in early childhood (Yanuarto et al., 2023; Xezonaki, 2023). All these countries have similar curricula in Early Childhood Care and Education and Early Childhood Education. However, educators still lack experience in leveraging games like Kahoot to support mathematics in early childhood, especially in rural contexts. As a result, teachers need to know how to leverage Kahoot to support mathematical learning in early childhood, especially in rural primary schools. This paper

asked: ***How do teachers leverage Kahoot to support mathematics learning in early childhood?***

THEORETICAL FRAMEWORK

Burrhus Frederic Skinner developed a theory of operant conditioning as a method of learning that emphasises the role of reinforcement and punishment in shaping learners' behaviour (Sari & Rahmani, 2024). This paper is underpinned by the theoretical lens of Skinner's operant conditioning, which argues that teachers can shape and strengthen desired behaviours and mathematical concepts in young learners by providing immediate and consistent reinforcement. This paper supports Barnes (2021), who argues that positive reinforcement entails providing a favourable stimulus following a correct behaviour, thereby increasing the chances of the correct understanding of mathematics being reinforced and repeated. According to Chen et al. (2020), immediate feedback reinforces learning by helping children understand their responses' correctness. Thus, since Kahoot provides immediate feedback, which can help young learners quickly correct their mistakes and reinforce correct answers, this promotes better retention of mathematical concepts.

Operant Conditioning in the Context of Early Mathematics

By incorporating operant conditioning in Kahoot, immediate feedback, reinforcement schedules, shaping, and a gamified learning environment effectively support mathematics learning in early childhood. Zainuddin et al. (2024) explain that Kahoot leverages the power of positive reinforcement and immediate feedback to enhance learners' engagement, motivation, and learning of mathematical concepts. Thus, in the context of using Kahoot for early childhood mathematics learning, when learners answer questions correctly, they receive points (positive reinforcement), encouraging them to continue participating and engaging with the content. The theoretical lens of this theory was used to analyse the data and assisted in the discussion of findings.

LITERATURE REVIEW

The researcher reviewed the recent empirical literature from different regions to synthesise what other scholars found in leveraging Kahoot to teach mathematics in early childhood. Their research methodologies were also interrogated to understand the nature of their studies and what they found. A European study conducted in Greece by Xezonaki (2023) examined the intervention of Kahoot in teaching mathematics to preschool children. An experimental group in a qualitative study was used to investigate mathematics outcomes when children engage in game-based learning. Xezonaki's (2023) findings indicate that Kahoot improves children's mathematics skills.

A limited number of empirical studies have been conducted on using Kahoot in teaching mathematics in early childhood, leading the researcher to review studies conducted in higher grades. The study of Jarrah et al. (2024) investigated the usefulness of Kahoot in teaching Grade 10 learners mathematics in Asia, Abu Dhabi Emirate. Their study used a quasi-experimental approach to investigate a cause-and-effect relationship between Kahoot and mathematics and its impact on learners' motivation. The findings indicated

that Kahoot positively influences mathematics learning and motivation (Jarrah et al., 2024).

RESEARCH METHODOLOGY

Philosophical Assumptions

Philosophical assumptions, such as relativist ontology and subjective epistemology, guided the selection of the interpretive paradigm as the researcher intended to gather multiple truths from multiple individuals (Panya & Nyarwath, 2022). The selection of this paradigm was supported by operant conditioning theory, which holds that reinforcement and punishment play a huge role in shaping individuals' behaviour. Al-Ababneh (2020) supports the idea that a combination of interpretivism and qualitative research assists researchers in gathering in-depth data. As a result, a qualitative research approach was used to gather in-depth and rich data from the participants.

Guided by Al-Ababneh (2020) and Dangal and Joshi (2022), a hermeneutic phenomenological research design was employed to explore the use of Kahoot to support mathematics learning in early childhood classrooms. This assisted the researcher in understanding educators' lived experiences and the meaning of their experiences with the phenomenon under study. Tomaszewski et al. (2020) assert that researchers who use a hermeneutic phenomenological design must ensure reflexivity by drawing on their lived experiences with the phenomenon before engaging with the participants. Before collecting data, the researcher had only general knowledge of Kahoot but did not have experience using it in the classroom, especially in teaching mathematics. According to Jedličková et al. (2022), in homogenous purposive sampling, participants must be selected on specific criteria based on their similar experiences.

Sampling

A homogenous purposive sampling strategy was used to select at least three educators (Grades 1 to 3) from four public primary schools in rural areas. Therefore, a total sample of 12 educators was selected to participate in the study. For this paper, educators with at least three years of teaching experience were selected to investigate their experiences using Kahoot to teach mathematics in the Foundation Phase.

The University of South Africa Ethics Committee approved the ethical clearance application with reference number 2023/10/11/64019209/38/AM, and before the collection of data, the participants signed consent letters indicating their agreement to participate. The data was collected through semi-structured interviews with all 12 educators to gather their lived experiences using Kahoot to support mathematics learning in early childhood. Prolonged engagement during the interviews increased the credibility of the results by reducing internal bias (Striepe, 2021). An audio recorder was used to record the conversation between the researcher and the participants during the interviews to ensure the transferability of the results by increasing internal validity (Dangal & Joshi, 2020). The audio recordings were transcribed into text before data analysis. In the analysis, pseudonyms such as Schools (1-4) and Teachers (1-4) (S1T1-S4T4) were used to safeguard the anonymity and confidentiality of the participants.

Data Analysis

Interpretative phenomenological analysis (IPA) was used to analyse the data. The researcher used the model of Smith et al. (2022) in IPA to analyse the semi-structured interview data. The researcher started by coding the data manually and later imported interview transcripts into Nvivo software for recording using the keywords from the study's research questions until data saturation was reached. The codes were grouped to formulate categories and themes to make sense of data. An independent coder was employed to co-code the data to ensure authenticity and consistency and to confirm the accuracy of the findings through multiple coding (Kawamoto et al., 2023). The software created a total number of 43 codes. A word cloud visualisation was exported from Nvivo, which assisted with interpreting results. Figure 1 illustrates the word cloud exported from Nvivo on the use of Kahoot teaching mathematics in early childhood, which illustrates words such as Kahoot, questions, competition, school, and answers, which appeared multiple times during data analysis.

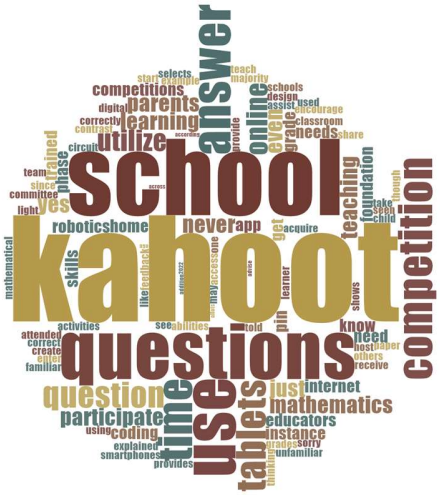

Figure 1: A word cloud on the leverage of Kahoot in teaching mathematics *(Source: Nvivo 12)*

RESULTS

This paper asked *how teachers leverage Kahoot to support mathematics learning in early childhood.* The results from the semi-structured interviews showed that teachers leverage Kahoot during competitions to support learners' mathematical skills. Moreover, they enhance collaboration with parents by using this approach. Enhancing mathematics skills, collaboration between parents and the limitations of leveraging Kahoot are used to present the results.

Enhancing mathematical skills through Kahoot

The teachers were asked how they leveraged Kahoot to support mathematics skills. The teachers from S1 did not mention anything concerning Kahoot. It showed that they do not use Kahoot as yet. In School 2, the educators' lived experiences were described as follows:

> **S2T2: "***… to develop learners' critical thinking skills and to be open-minded."*
>
> **S2T3***: "… This could help learners to enhance their mathematics thinking skills,"*
>
> **S4T2: "***For example, learners familiar with Kahoot at the foundation phase acquire digital abilities in contrast to those not. If learners are unfamiliar with mathematical vocabulary, they can use the internet to google them."*
>
> **S4T3: "***They are developing their sensory motor skills by answering the questions and using their little fingers to touch the keyboards. They even take pride in answering questions correctly. Kahoot, for instance, provides immediate feedback."*

A probing question asked: What kind of questions do learners formulate for mathematics in Kahoot? Why? **S2T2** answered:

> *"Typically, they ask questions about numbers, operations, and relationships since it is the most weighted subject across all Foundation Phase grades and is integrated into all maths core areas."*

The results show that Kahoot helps children understand mathematics concepts as it promotes critical thinking, problem-solving, and digital skills. Further, this game-based learning encourages teachers to work closely with parents.

Collaboration between teachers and parents

The teachers articulated that there is parental involvement when using Kahoot in their teaching and learning activities. Most educators explained that they collaborate with educators in using Kahoot in their classrooms. They said:

> **S2T2:** *"We do not use Kahoot in our school. I know it from my child's school. They urge parents to download the Kahoot app from their smartphones. We were given guidelines by the educators. They provide us with URLs and pins to enter the competition. They inform us about the start and end times of the competition. When you log in, you will find different questions a child needs to answer. Kahoot provides instant feedback after each question."*
>
> **S4T2:** *"You might use Kahoot. We advise parents to install the Kahoot app on their mobile devices. I would make math problems on Kahoot and send parents the URL over WhatsApp, or I could just let them know that their kids must finish a worksheet at home. In addition, I would give them a pin. I could utilise Kahoot to teach mathematics to learners at home throughout the holidays or even while dealing with COVID-19."*

> **S3T1: "***Yes, you can. I have not started. Nevertheless, you can create questions on Kahoot and share a pin with parents to assist learners with their homework because most learners have smartphones and others use their parents' phones."*

The results indicate that Kahoot promotes collaborative learning beyond the classroom by providing an interaction between teachers and parents. By actively encouraging parents to download the Kahoot app to their smartphones, educators demonstrate a partnership approach in which both sides support children's mathematical learning.

The limitations of leveraging Kahoot in rural school

The teachers explained that they experience limitations in leveraging Kahoot in teaching mathematics in their rural schools. Even though they get support from their parents, they still experience the challenges of using this pedagogical tool. Therefore, they use Kahoot mostly during the circuit competitions. These competitions take place once a quarter per year. They articulated:

> **S3T1:** *"…We group schools according to the circuit. Each school needs to formulate a question paper. For example, School A would design a mathematics question paper for Grade 1. The school hosting the competition must share the Kahoot pin that participating schools need to use. Each school would select learners to participate in the competition. Kahoot would show the time to start and depart. We encourage learners to answer questions with understanding. Learners would be using tablets. The questions have pictures and a timer. It is like multiple choice questions. If the learner selects a wrong answer, it shows a red light, and we apologise. We encourage learners to say sorry. If a learner selects a correct answer, it shows a green light, and we say yeah!"*

> **S3T2:** *"We request tablets from the principal's office. We create inquiries on the app. To access the questions, learners must enter a passcode upon login. There is a time limit on each question. The team that gets most of the answers correct wins; the team that cannot manage their time loses points. We design similar questions for continuous assessments. This could help learners to enhance their mathematics thinking skills."*

> **S3T3:** *"I do not use it. However, last year, our school served as the host for a competition. I am not one of the instructors at our school who knows how to use it; others do. I went only to see the competition. It is quite fascinating. One school creates tests and allots a particular amount of time for each question. The contest is won by those who answered most of the questions correctly. I am not involved at the school level; I simply witnessed it during the tournament."*

> **S4T3: "***As I mentioned, we would have received notification that this day is a competition. After we have trained our learners, we take them to the competitions, where you will notice that we hand them tablets and place them in groups. After that, we go online and answer any questions we receive—the majority of them choose educators for circuits. For instance, by the time we write this, school A may have already set a mathematics examination and made it available online for*

> *students to access. People supervise us. The grades are automatically assigned. After they receive the results, they decide which school is the best. At a specific school, we get together."*

Although Kahoot could potentially improve mathematics learning in rural schools, the participants pointed out a few limitations. Digital resource availability and accessibility are crucial concerns because teachers must request tablets from the principal's office, which limits how often they are used. Additionally, because competitions rely on real-time access to the platform, difficulties with internet connectivity may further affect ideal participation. Lastly, some teachers are not competent with Kahoot, as evidenced by the fact that some teachers solely observe rather than actively use the technology. This indicates that some teachers lack the professional development and digital literacy necessary for successful integration into their regular mathematics teaching in early childhood classrooms.

DISCUSSION OF FINDINGS

The main finding shows that teachers leverage Kahoot to support mathematics learning by engaging learners in gamification to enhance their mathematical skills. They also engage with the learners' parents to assist their children in engaging in Kahoot, even at home, to learn mathematics. However, they are limited by the time constraints for leveraging Kahoot in their classrooms as they use it mainly during competitions, not in teaching mathematics in the classroom. The findings are discussed under four themes and corroborated with the reviewed literature and the theoretical framework.

Theme 1: Stimulating Mathematical Skills

Mathematical skills are important across all content areas in early childhood. The findings of this study revealed that teachers' lived experiences in the use of Kahoot stimulate learners' mathematical skills, such as critical and mathematical thinking skills, mathematical vocabulary, and sensory motor skills. The literature review confirms that Kahoot can support mathematics learning by enhancing learners' mathematics skills (Xezonaki, 2023) and motivation (Jarrah et al., 2024). Similarly, the theoretical framework showed that the encouragement and immediate feedback from Kahoot can enhance learners' engagement, motivation, and learning of mathematical concepts (Zainuddin et al., 2024). From the aforementioned, the researcher emphasises operant conditioning in using Kahoot to enhance mathematical skills in early childhood. However, this paper showed that teachers are limited in using Kahoot to support mathematics in early childhood as they use the platform only during circuit competitions.

Theme 2: Operant conditioning in the use of Kahoot

The theory of operant conditioning refers to how learners acquire knowledge by integrating reinforcement and punishment (Sari & Rahmani, 2024). The theoretical framework emphasises that reinforcement and punishment must be used to support mathematics for early childhood learners. In this regard, in the theoretical framework, Chen et al. (2020) and Zainuddin et al. (2024) emphasised their belief in operant conditioning, immediate feedback and reinforcement provided in Kahoot when teaching mathematics to early childhood learners.

Theme 3 Parental involvement in the use of Kahoot

Teachers involve parents in using Kahoot by encouraging them to actively participate in their children's learning through the Kahoot app. For instance, parents are urged to download the Kahoot app, provide guidelines, URLs, and pins to enter competitions and be informed about the start and end times, with instant feedback provided after each question. Similarly, teachers advise parents to install the Kahoot app on their mobile devices and use the app to present mathematics problems for learners to solve at home.

Theme 4: The way Kahoot works

The literature from Balaskas et al. (2023), Janković et al. (2022), and Oksana (2022) indicated the importance of AI algorithms within Kahoot in teaching mathematics to young learners. Xezonaki (2023) explains that using Kahoot improves children's mathematics skills by integrating AI algorithms to emphasise activities that promote positive and negative reinforcement. Using algorithms, Kahoot can provide intelligent, context-sensitive feedback to learners based on their responses. This feedback can go beyond correct or incorrect answers, offering explanations and hints to guide learners toward the correct solution. Kahoot can identify patterns and predict future performance based on historical data. This can help identify learners who may need additional support or are ready for more advanced challenges. Using algorithms, the program predicts that a learner who has consistently performed well in addition and subtraction is ready to start learning multiplication and then suggests appropriate mathematics quizzes and activities to teach multiplication principles.

CONCLUSION

This paper explored teachers' lived experiences in using Kahoot to support the development of mathematical skills in early childhood. However, the teachers lack experience using Kahoot during their teaching and learning activities and mainly use it during competitions. Teachers collaborate with parents in using Kahoot as learners are expected to engage in this game-based learning at home to learn mathematics. In light of these findings, this paper suggests that teachers use Kahoot! Because its AI algorithms provide immediate and positive reinforcement that helps learners develop their mathematical skills. This saves time for the teacher in lesson planning and allows for different learning needs to be addressed, thus promoting inclusivity. Finally, educational technology increasingly uses AI, which plays a significant role in making platforms like Kahoot even more effective in teaching learners mathematics in early childhood.

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