



## From phobia to fun: Enhancing mathematics engagement with AI-powered tools

GA Lukumon,<sup>1</sup> A Maharaj,<sup>2</sup> KA Salaudeen,<sup>3</sup> LO Aselebe,<sup>4</sup> SO Sangoniya,<sup>3</sup> AM Gbolagade,<sup>3</sup> TM Asiru,<sup>3</sup> PI Farayola,<sup>3</sup> AA Waheed,<sup>5</sup> OO Fadara,<sup>6</sup> KO Aselebe,<sup>7</sup> SD Ogundiran<sup>8</sup>

<sup>1</sup> Centre for Artificial Intelligence and Multidisciplinary Innovations Studies, Department of Auditing, College of Accounting Science, University of South Africa, Pretoria, South Africa

<sup>2</sup> School of Mathematics, Computer Science and Statistics, University of KwaZulu-Natal, South Africa

<sup>3</sup> Department of Mathematics, Emmanuel Alayande University of Education, Oyo, Nigeria

<sup>4</sup> Directorate of General Studies (Mathematics Units), Federal School of Surveying, Oyo, Nigeria

<sup>5</sup> Department of Mathematics, Lead City University, Ibadan, Nigeria

<sup>6</sup> Department of Mathematics, Oyo State College of Education, Lanlate, Nigeria

<sup>7</sup> Department of Educational Management, Library and Information Science, Emmanuel Alayande University of Education, Oyo, Nigeria

<sup>8</sup> Atiba University, Oyo, Nigeria

Corresponding author, email: [lukumga@unisa.ac.za](mailto:lukumga@unisa.ac.za)

### Abstract

Can AI-powered tools improve students' engagement in mathematics, reduce math phobia, and increase motivation and positive perceptions despite persistent challenges such as low participation rates and diminished enjoyment? This study, involving  $N = 98$  first-year undergraduate students, investigated the impact of AI-powered tools on students' engagement and attitudes in mathematics classes. We compared two groups: one using an AI-powered assessment tool and the other employing traditional assessment methods. Outcomes were measured through enjoyment, willingness/motivation to participate, math perception (phobia vs. fun), and quiz participation intention. Results indicated trends suggesting that the AI-powered tool group experienced slight improvements in enjoyment and participation. Those findings suggest the potential of AI-powered tools not only for creating a more engaging and enjoyable mathematics learning environment but also for informing education policy. Policymakers may consider integrating such tools into curricula to support innovative teaching practices. However, further research with a larger sample size is needed to validate these trends and better understand the benefits of AI-powered assessments in education.

**Keywords:** AI-powered tools, mathematics phobia, artificial intelligence, motivation, enjoyment, assessment, education policy

### Introduction

Mathematics plays an essential role in numerous fields, from gaining admission into academic institutions to supporting everyday activities like trading. For instance, traders use basic arithmetic and percentages to calculate profits and losses, while scientists and engineers rely on advanced mathematical models to predict outcomes and design systems. Also, mathematics

applications extend to physics, engineering, computing, commerce, and finance, where mathematical understanding drives innovation and problem-solving. Despite these importances, mathematics is often disliked by students, who perceive it as abstract, rigorous, and inaccessible. This negative perception is reflected in widespread poor performance in mathematics, as evidenced by mass failures in standardized tests globally (Aselebe et al; 2024; Rameli et al; 2016; Maharaj

& Lukumon, 2021). Such trends highlight the urgent need for innovative approaches to make mathematics more engaging and relatable.

One promising avenue to address these challenges is the integration of artificial intelligence (AI) and AI-powered tools into mathematics education (Holmes, 2021; Luckin, 2018). Tools like Kahoot!<sup>1</sup>, a game-based learning platform, have garnered attention for their ability to enhance student engagement by transforming mathematical concepts into interactive quizzes and tournaments. Kahoot! employs a gamified approach that fosters collaboration, critical thinking, and immediate feedback, making mathematics more approachable and enjoyable for students (Pellas, 2024; Altawalbeh, 2023; Wang, 2020; Prieto, 2019; Plumb, 2017; Wang 2015). The platform's user-friendly interface allows teachers to create customized assessments and adapt content to meet the diverse learning needs of their students. Moreover, its competitive yet collaborative environment motivates students to actively participate, boosting their confidence and interest in mathematics.

Beyond Kahoot!, AI-powered platforms like ChatGPT offer significant potential in revolutionizing mathematics education. ChatGPT provides personalized AI tutoring, enabling students to receive instant feedback, clarify complex concepts, and explore alternative problem-solving strategies at their own pace (Bettayeb, 2024; Atlas, 2023; Mondal, 2023). For instance, a student struggling with algebraic equations can interact with ChatGPT to break down the problem step-by-step, gaining a deeper understanding and overcoming learning barriers. These tools demonstrate the capacity of AI to address traditional challenges such as rote memorization, lack of real-world applications, and disengagement, which have long hindered mathematics education.

Educators are increasingly encouraged to harness the advantages of AI tools to improve student outcomes. Its integration can help teachers create more dynamic, inclusive, and effective learning environments. Kahoot! supports personalized assessments tailored to individual

learning needs, while ChatGPT facilitates independent learning by providing explanations and guidance outside regular class hours. Furthermore, these platforms complement traditional teaching methods by enriching the learning process, fostering active student participation, and promoting critical thinking (Pellas, 2024; Altawalbeh, 2023; Wang, 2020; Prieto, 2019; Plumb, 2017; Wang 2015; Bettayeb, 2024; Atlas, 2023; Mondal, 2023).

Despite the promise of these technologies, their adoption is not without challenges. In regions with limited infrastructure, such as parts of Africa, the implementation of AI tools like Kahoot! and ChatGPT can be hindered by unreliable electricity and internet access (Wang, 2023; Lukumon & Maharaj, 2022; Mukuni, 2019). Addressing these infrastructural barriers is crucial to ensuring equitable access to the benefits of AI-powered education (World Bank, 2016). Moreover, there is a need for professional development programs (Darling-Hammond, 2017; Marcelo, 2009; Bechtel, 2006) to equip teachers with the skills necessary to effectively integrate these tools into their teaching practices.

This study is informed by two major theoretical perspectives that help explain how AI-powered tools can shape students' engagement and perceptions in mathematics education: the Technology Acceptance Model (TAM) and Self-Determination Theory (SDT). Specifically, the Technology Acceptance Model (TAM) (Davis, 1989) suggests that learners' perceptions of a tool's usefulness and ease of use play a crucial role in determining whether they adopt it (Davis, 1989). In the context of this study, Kahoot!'s intuitive design and real-time feedback features likely contribute to its acceptance by students, especially those who may otherwise be disengaged in traditional math settings. In addition, Self-Determination Theory (SDT) (Deci & Ryan, 2000; 2012) provides a framework for understanding how gamified learning environments like Kahoot! may foster intrinsic motivation. By promoting autonomy, competence, and relatedness through competition, instant feedback, and peer interaction, such tools can create conditions under

<sup>1</sup> <https://kahoot.com/>

which students feel more empowered and motivated to engage with mathematical tasks.

While previous studies have largely reported positive effects of Kahoot! on engagement and academic performance, results have not always been consistent. For example, some research has noted a novelty or “wear-out” effect over time (Wang, 2015), suggesting that long-term motivational impacts may depend on how such tools are integrated into pedagogical practice. Theories such as Self-Determination Theory and the Technology Acceptance Model provide a useful lens for understanding these outcomes. However, few empirical studies have explicitly connected the use of Kahoot! to these frameworks, particularly in mathematics education in African contexts. This study aims to address that gap by exploring not only whether AI tools affect engagement, but also how such effects may be interpreted in light of motivational and adoption models.

### *The Current study*

Our study addressed the issue of transforming mathematics teaching and learning by providing robust evidence on the impact of AI-powered tools. We investigated whether incorporating AI-powered tools, such as Kahoot!, could enhance students' enjoyment of mathematics lessons and increase their willingness to participate in future classes. Participants were randomly assigned to one of two assessment methods: the traditional paper-and-pencil approach or the use of Kahoot!. Before the experiment commenced, participants in both groups completed a pre-test survey to assess their baseline levels of interest, motivation, and enjoyment in mathematics. This pre-test captured their initial attitudes and preferences towards mathematics.

Participants were tested on calculus. To maintain the integrity of the study, participants were kept unaware of the activities of the other group, preventing contamination of results and ensuring unbiased outcomes. After the assessments, participants from both groups were invited to complete a post-test survey. That survey evaluated their interest in mathematics,

motivation, and enjoyment following their respective assessments.

Below, we outline the methods and results of this investigation.

### **Methods**

**Open Science.** Sample sizes and statistical analyses were pre-registered. We report all manipulations and measures used in the study. No participants who completed the studies were excluded from the analysis. Pre-registrations, data, stimuli, and annotated R analysis scripts for each experiment are publicly available on OSF: <https://osf.io/aejkm/>.

**Ethical considerations.** Prior to participation, all students were informed about the purpose and procedures of the study, their right to withdraw at any time, and the voluntary nature of their involvement. The survey began with an informed consent page that clearly stated the conditions of participation, including the right to discontinue without penalty and the assurance that all data would remain anonymous. Participants could only proceed with the study after ticking a consent box affirming their agreement. A sample consent declaration read: “*Participation requires that you give your informed consent (below) before proceeding. Your privacy will be maintained in all published and written data resulting from this study. At any point, you may refuse to participate further without penalty*”. Data were collected anonymously. No names, contact details, or identifying information were gathered. Participants who did not complete the study or chose to withdraw were excluded from the analysis. All procedures adhered to ethical research standards and open science principles of the College of Accounting Sciences\_RERC, University of South Africa, Pretoria under the reference number: 10286.

**Participants.** The participants were first-year undergraduate students from Emmanuel Alayande University of Education, Oyo. To achieve 85% statistical power at a significance level of 0.05 for detecting a small effect size ( $d = 0.30$ ), we pre-registered a target sample size of 240 participants. However, due to logistical challenges in data collection (discussed further in the General

Discussion), we recorded a total of 98 participants (62 females, 35 males, and 1 participant who did not report their sex category; mean age = 21 years). The sample size was determined using the “pwr.anova.test” package in R and we excluded participants who didn’t complete the study.

**Materials.** Students were assessed with five multiple-choice questions on basic differentiation and integration with a time limit of five minutes (1 minute per question). The questions covered topics such as applying the standard derivatives. For example, one question asked, “What is the derivative of  $f(x) = e^{100}$ ? (a)  $100e^{99}$  (b) 0 (c)  $100 e^{100x}$  (d)  $\frac{1}{100} e^{100}$ ?” The full set of questions is available in the OSF folder; see link provided above.

**Procedures.** Before the experiment commenced, participants were randomly assigned to one of two groups: a traditional assessment group and a Kahoot! assessment group. Both groups completed a pre-test survey to measure their baseline levels of interest, motivation, and enjoyment in mathematics. This pre-test served to capture participants' initial attitudes and preferences. Thereafter, participants answered the five questions on paper, using a pen to mark their responses. For the second group, participants used the Kahoot! platform for their assessment. Each participant received a PIN to join the session and answered the same five questions in an interactive, gamified format that included immediate feedback. To prevent cross-contamination and maintain the integrity of the study, participants were kept unaware of the activities of the other group.

After completing their assessments, all participants were invited to take a post-test survey. This survey evaluated their interest in mathematics, motivation, and enjoyment following their respective assessment experiences. Below are the measures

**Measures.** We assessed several variables before and after the assessment, as indicated in the following:

**Enjoyment.** Students rated their enjoyment of learning mathematics in class by responding to the question, “How much do you

enjoy learning mathematics in class?” on a 7-point Likert scale (1 = Not Enjoyable at All; 7 = Extremely Enjoyable). That measure assessed their perception of how enjoyable math concepts were.

#### **Willingness/Motivation to Participate.**

To gauge students' willingness to engage in future classes, they answered the question, “Are you motivated to participate in future classes?” on a 7-point Likert scale (1 = Not Willing at All; 7 = Very Willing).

#### **Math Perception (Phobia vs. Fun).**

Students described their overall feelings about math by answering, “Currently, how would you describe your overall feeling about math?” Responses were recorded on a 7-point Likert scale (1 = Phobia-Inducing, 2 = Mostly Dislike, 3 = Neutral, 4 = Somewhat Enjoyable, 5 = Enjoyable, 6 = Mostly Fun, 7 = Extremely Fun).

**Quiz Participation Intention.** To evaluate students' interest in future quizzes, they responded to the question, “Would you still like to have a short quiz next class?” on a 7-point scale (1 = Definitely Not; 7 = Definitely Will).

**Demographics.** Participants provided demographic information, including sex, age, and other relevant details.

Figure 1 presents Bar chart comparison of students' attitudes: enjoyment, willingness or motivation to participate, math perception (phobia vs. fun), and quiz participation intention between the AI-powered group (red) and the traditional group (green) across pre-test and post-test assessments. Each set of bars represents the trend for a specific attitudinal measure over time. While none of the group differences were statistically significant, the AI-powered group consistently showed upward trends across all measures, suggesting a potential positive influence of gamified assessments on student engagement and math perception. These trends are exploratory and should be interpreted with caution due to the reduced sample size.

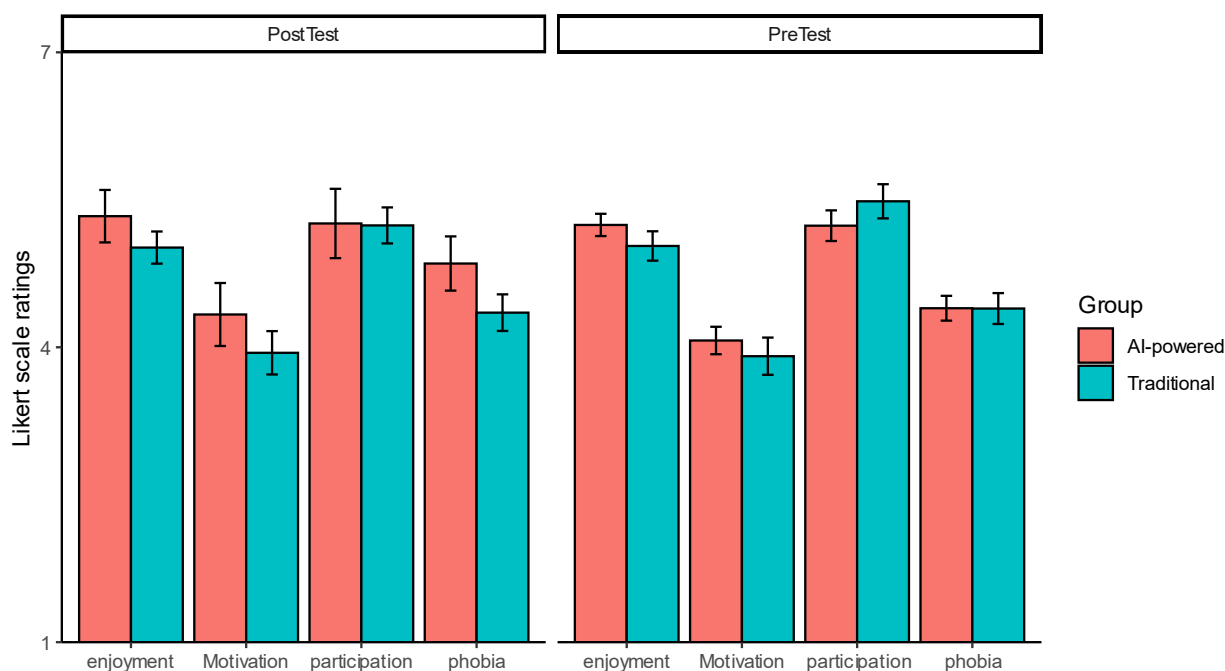
## **Results**

An independent-samples t-test was conducted to compare measures of enjoyment,

willingness/motivation to participate, math perception (phobia vs. fun), and quiz participation intention between the AI-powered group and the

traditional group, both pre-test and post-test. The results of the analyses are provided below.

The impact of AI-powered tools in mathematics classes



**Figure 1:** Comparison of students’ attitudes between the AI-powered and traditional groups across pre- and post-tests, showing trends in enjoyment, motivation, math perception, and quiz participation intentions. Although no differences were statistically significant, the AI group showed consistent positive shifts across all measures.

**Enjoyment.**

**Pre-test results:** There was no significant difference in enjoyment scores between the two groups,  $t(46) = 1.14, p = .30$ . The AI-powered group ( $M = 5.24, SD = 1.30$ ) reported enjoyment levels roughly similar to those of the traditional group ( $M = 5.03, SD = 1.49$ ).

**Post-test results:** Similarly, no significant difference was observed between the groups,  $t(46) = 1.01, p = .31$ . However, the enjoyment scores for the AI-powered group ( $M = 5.33, SD = 1.39$ ) were slightly higher than those for the traditional group ( $M = 5.01, SD = 1.38$ ). This is illustrated in Figure 1.

**Willingness/Motivation to Participate.**

**Pre-test results:** Willingness/motivation scores did not differ significantly between the AI-powered group and the traditional group,  $t(52) =$

$0.68, p = 0.50$ . The AI-powered group ( $M = 4.07, SD = 1.60$ ) reported similar levels of willingness/motivation compared to the traditional group ( $M = 3.91, SD = 1.88$ ).

**Post-test results:** Likewise, no significant difference in willingness/motivation scores was found between the groups,  $t(52) = 1.00, p = 0.32$ . The AI-powered group ( $M = 4.33, SD = 1.66$ ) showed slightly higher enjoyment scores compared to the traditional group ( $M = 3.94, SD = 1.86$ ). These results are visualized in Figure 1.

**Math Perception (Phobia vs. Fun).**

**Pre-test results:** Math perception scores (phobia vs. fun) showed no significant difference between the AI-powered group and the traditional group,  $t(51) = 0.01, p = 0.98$ . Both groups reported similar levels, with the AI-powered group ( $M = 4.40, SD = 1.44$ ) and the traditional group ( $M = 4.40, SD = 1.56$ ) having identical mean scores.

**Post-test results:** Similarly, there was no statistically significant difference in math perception scores between the groups,  $t(51) = 1.51$ ,  $p = 0.13$ . However, the AI-powered group ( $M = 4.85$ ,  $SD = 1.43$ ) reported slightly higher scores compared to the traditional group ( $M = 4.35$ ,  $SD = 1.57$ ). These results are depicted in Figure 1.

### Quiz Participation Intention.

**Pre-test results:** Quiz Participation Intention scores did not differ significantly between the AI-powered group and the traditional group,  $t(11) = -1.06$ ,  $p = 0.29$ . The AI-powered group ( $M = 5.24$ ,  $SD = 1.78$ ) reported similar scores to the traditional group ( $M = 5.48$ ,  $SD = 1.72$ ).

**Post-test results:** Likewise, no significant difference was found between the groups,  $t(41) = 0.04$ ,  $p = 0.96$ . However, the Quiz Participation Intention scores for the AI-powered group ( $M = 5.26$ ,  $SD = 1.83$ ) were slightly equal for the traditional group ( $M = 5.24$ ,  $SD = 1.54$ ). These results are shown in Figure 1 below.

**Note on Statistical Power.** While the above analyses followed the pre-registered plan, it is important to note that the final sample size ( $N = 98$ ) fell significantly short of the target ( $N = 240$ ) needed to achieve 85% power for detecting small effects ( $d = 0.30$ ). This limitation (with detailed discussion in the “Limitation” section) likely contributed to the absence of statistically significant differences across the measured variables, despite observable trends. As such, these results should be interpreted with caution, and future studies with larger samples are needed to validate these findings.

### Discussion

Although no statistically significant differences were observed between the AI-powered and traditional groups, the results revealed consistent positive trends across all four measured outcomes: enjoyment, willingness/motivation to participate, math perception, and quiz participation intention. For instance, in the post-test enjoyment scores, the AI-powered group ( $M = 5.33$ ) showed a slight increase over the traditional group ( $M = 5.01$ ), mirroring similar upward trends in math

perception and motivation. While these differences did not reach statistical significance likely due to limited statistical power, they suggest that students may perceive AI-powered tools more favorably in terms of classroom engagement. These observed patterns support existing literature on the motivational potential of gamified and AI-supported learning tools, particularly when framed within theories such as the Technology Acceptance Model and Self-Determination Theory. Future research with a larger sample size is essential to determine whether these trends represent meaningful and replicable effects

### Challenges in Data Collection

One possible explanation for the absence of statistically significant differences lies in the sample size limitation. Although we pre-registered a target of 240 participants to detect a small effect size ( $d = 0.30$ ) with 85% statistical power, only 98 students completed the full study due to logistical challenges and incomplete responses. This reduced sample size substantially weakened the power of our analyses, making it more difficult to detect subtle but potentially meaningful effects. Data collection coincided with the end of the semester at the Department of Mathematics at Emmanuel Alayande University of Education, further limiting our ability to recruit additional participants. Despite these constraints, trends across several measures (e.g., enjoyment, motivation) suggest the potential of AI-powered tools to improve student attitudes toward mathematics. Future studies with larger and more diverse samples are essential to validate these preliminary findings and better understand the impact of such interventions.

### *The Role of AI-Powered Tools in Mathematics Education*

AI-powered tools like Kahoot! and platforms such as ChatGPT offer unique advantages that traditional methods may lack, including real-time feedback, gamification, and personalized learning experiences. These tools can create an engaging, collaborative, and competitive environment that encourage students to actively participate and rethink their perceptions of mathematics. Although the current study did not observe significant short-term impacts, the trends

suggest that prolonged and consistent use of these tools could lead to meaningful improvements in students' attitudes and learning outcomes. This aligns with results of (Pellas, 2024; Altawalbeh, 2023; Wang, 2020; Prieto, 2019; Plumb, 2017; Wang 2015).

### ***Policy Implications for Educational Technology Integration***

The findings from our study, although not statistically significant, reveal consistent trends suggesting that AI-powered tools such as Kahoot! may improve student engagement, motivation, and perceptions of mathematics. However, due to the limited sample size and reduced statistical power, these results should be interpreted as preliminary and exploratory. Still, they offer valuable early insights into the potential role of educational technology in transforming mathematics instruction. Based on these observations, we outline below several considerations that may guide future policy development.

First of all, infrastructure improvements must be prioritized in our schools. Challenges such as unreliable internet connectivity, lack of access to devices, and inadequate laboratory facilities as observed in this study and in other prior related studies (e.g., Lukumon and Maharaj, 2022) can hinder the effective adoption of AI-powered tools. Policymakers should invest in building robust technological infrastructure, particularly in rural areas, to ensure that all students and educators have the tools necessary for seamless integration of technology into teaching and learning.

Secondly, professional development programs for educators are essential. Integrating AI-powered tools into classrooms requires teachers to be proficient in using these technologies and in understanding how to leverage their capabilities to improve learning outcomes. Given that many teachers may lack digital literacy skills, policies should support ongoing training programs that empower educators to adopt and use AI tools confidently and effectively.

Thirdly, educational policies should encourage the incorporation of AI-powered

assessments as a complement to traditional methods. While AI tools provide immediate feedback and foster engagement, they should not replace teacher-student interaction. Instead, a balanced hybrid model that combines the strengths of both AI-powered and conventional teaching practices should be promoted.

Finally, this study emphasizes the need for further research into the long-term effects of AI-powered tools on learning outcomes. Policymakers should prioritize funding for longitudinal studies and well-powered randomized controlled trials to generate robust, evidence-based strategies for implementing AI tools across diverse educational settings.

### ***Practical Application in Community Engagement.***

The corresponding and first author, Dr. Gafari Lukumon, has actively applied insights from this research through a grassroots educational outreach initiative titled *Math with Lukgaf*, which seeks to demystify mathematics by teaching it in Yorùbá, an indigenous Nigerian language. Central to this initiative is a weekly program called Alé Ìşirò (math night), where students engage in gamified mathematics quizzes via the Kahoot! platform. Since the integration of AI-powered tools like Kahoot! and the inclusion of modest monetary incentives, the program has recorded a significant increase in student engagement, participation, and enthusiasm for mathematics. These real-world applications directly reflect and reinforce the findings of this study. Episodes demonstrating this transformation can be accessed from Episode 25 onward in the Alé Ìşirò YouTube playlist<sup>2</sup>. This practical case stresses the potential of AI-powered tools to improve mathematics engagement especially within linguistically and culturally diverse contexts by blending technology with relatable pedagogy.

### **Future Directions**

While our study focused exclusively on mathematics and a single teaching and learning process; namely, assessment; future research could broaden this scope by investigating the impact of

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<sup>2</sup><https://www.youtube.com/playlist?list=PLn0ZvdWhZVXdU2suT1YmnJo4dFrpKhpsU>

AI-powered tools in other subjects, such as science, language arts, or social studies. Additionally, future studies should examine the effectiveness of these tools in other teaching and learning processes, such as questioning strategies, lesson preparation, and assignments. This would provide a more comprehensive understanding of the versatility and applicability of AI-powered tools across diverse educational contexts.

Moreover, while this study was conducted with undergraduate students, future research could explore the use of AI-powered tools with other populations, including younger students in K-12 or secondary education or adult learners in continuing education programs. Such investigations would help determine whether the effects observed in this study generalize to different age groups and educational settings.

Finally, during the study, we observed that in the AI-powered condition, students often cheered among themselves when their marks appeared on the leaderboard. That cheering and social interaction may have had an unexamined impact on motivation and engagement. Future studies could investigate the effects of such social dynamics, potentially isolating and examining how cheering and peer encouragement influence outcomes in AI-powered learning environments. Moreover, longitudinal studies would be beneficial in assessing the long-term effects of these tools on academic performance, problem-solving skills, and retention of mathematical concepts.

### **Limitations and Implications**

The study's limitations, including a reduced sample size, lack of laboratory facilities, reliance on smartphones, and short duration, highlight the need for careful planning and sustained efforts in future research. Additionally, incorporating qualitative methods, such as student interviews or classroom observations, could provide deeper insights into how AI tools influence learning behaviors and engagement. Addressing infrastructural barriers, such as unreliable internet connections, and equipping educators and students with the necessary resources could be critical to maximizing the potential of these tools in diverse educational

contexts as opined by (Wang, 2023; Lukumon & Maharaj, 2022; Mukuni, 2019).

### **Conclusion**

The integration of AI-powered tools into mathematics education represents a promising approach to addressing challenges in traditional teaching methods. While this study found no significant differences in short-term attitudinal measures, the trends and anecdotal observations suggest potential benefits that warrant further investigation. Expanding research into other subjects, teaching processes, and student populations, coupled with addressing logistical and infrastructural challenges, could pave the way for a more comprehensive understanding of the transformative potential of AI-powered tools. With thoughtful planning, sufficient resources, and a focus on fostering positive social interactions, these technologies could play a vital role in making education more engaging, inclusive, and effective.

The integration of AI-powered tools into mathematics education offers a promising pathway for addressing long-standing challenges in traditional teaching and learning. Although this study did not yield statistically significant differences in short-term attitudinal outcomes, the consistent trends observed alongside qualitative insights indicate potential benefits that merit further exploration. Future research should expand beyond mathematics to examine the effectiveness of AI-powered tools across diverse subjects, instructional processes, and learner populations. In particular, studies with larger sample sizes and longer intervention periods are needed to validate and deepen our understanding of these trends. Moreover, addressing infrastructural limitations such as unreliable internet access and limited device availability remains critical to ensuring equitable implementation, especially in under-resourced settings. Our practical experience with the “*Math with Lukgaf*” initiative further illustrates how culturally contextualized, gamified learning platforms can enhance student motivation and participation when thoughtfully applied.

With sustained research, adequate investment, and intentional design, AI-powered technologies hold the potential to transform

learning environments making education more interactive, inclusive, and engaging for all learners.

### Disclosure

Conflict of interest

The authors declare no conflict of interest

### ORCID

GA Lukumon: <https://orcid.org/0000-0001-7195-0327>

A Maharaj: <https://orcid.org/0000-0003-4808-551X>

KA Salaudeen: <https://orcid.org/0009-0001-2760-6024>

LO Aselebe: <https://orcid.org/0009-0009-9626-170X>

SO Sangoniyi: <https://orcid.org/0009-0002-4000-3858>

AM Gbolagade: <https://orcid.org/0009-0008-5256-8083>

TM Asiru: <https://orcid.org/0000-0002-9214-9376>

PI Farayola: <https://orcid.org/0000-0002-9845-4814>

AA Waheed: <https://orcid.org/0009-0008-7742-2590>

OO Fadara: <https://orcid.org/0009-0000-2621-4881>

KO Aselebe: <https://orcid.org/0000-0001-6263-1367>

SD Ogundiran: <https://orcid.org/0009-0006-7689-679X>

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