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Reinvigorating Math Learning: Exploring Student Engagement in the Digital Classroom

Jennifer Dela Torre-Sayco
Higher Colleges of Technology – Fujairah Campuses, United Arab Emirates
E-mail: jdelatorre@hct.ac.ae

Abstract
This study investigates first-year college students' engagement in the digital mathematics classroom by examining their experience, comfort level, and perceived usefulness of digital tools. Survey data from 127 students show that tools such as Kahoot and Nearpod are particularly effective in promoting understanding, motivation, and enjoyment. Cognitive and emotional engagement emerged as the strongest dimensions, with students reporting that digital tools enhance their comprehension of mathematical concepts and make learning more interesting. While overall engagement levels were high, perceptions of collaboration and peer interaction were slightly lower, suggesting the need for more structured opportunities for social engagement. Students also expressed a strong sense of comfort and control when using familiar digital platforms, indicating that prior exposure plays a key role in effective digital learning. The findings highlight the importance of selecting purposeful, interactive tools and designing digital tasks that promote autonomy, critical thinking, and meaningful engagement in mathematics.
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1. Introduction

The landscape of mathematics education is undergoing a significant transformation, with technology playing an increasingly central role in fostering student engagement. Traditional lecture-based pedagogy, while foundational in higher education, often falls short in addressing the diverse learning styles and needs of all students. This limitation is particularly evident in first-year college mathematics courses, where students may encounter increased difficulty and decreased motivation. Recent research indicates that passive learning environments, such as traditional lectures, do not effectively capture students' attention, leading to reduced engagement and learning efficacy. Consequently, many educational institutions are transitioning towards active learning strategies that leverage digital technologies to create more engaging and personalized learning experiences (Ascione, 2024). In response to this evolving landscape, educators are turning to a variety of digital tools and platforms to create dynamic and interactive learning environments.

These digital tools offer a potential solution by introducing interactive elements, gamification, game-based learning, and opportunities for personalized learning experiences. Platforms like Nearpod allow for the seamless integration of multimedia content, quizzes, collaborative activities, and interactive polls within a single lesson. Kahoot's gamified approach fosters a competitive yet collaborative learning environment, promoting knowledge retention and providing immediate feedback (Anane, 2024). Microsoft Teams and Blackboard Learn provide virtual spaces for communication, collaboration, file sharing, and access to learning materials, creating a more interactive and flexible learning environment.

While the potential benefits of these digital tools are evident, a comprehensive understanding requires a balanced perspective that examines both the positive and negative impacts on student engagement in the digital mathematics classroom.

2. Related Literature and Studies

Mathematics education is currently experiencing a significant transformation, driven by the integration of digital technologies that enhance student engagement and learning outcomes. Recent studies highlight that the incorporation of online mathematics tools has positively influenced student performance and engagement, particularly in the context of the Fourth Industrial Revolution, where digital, physical, and biological spheres converge to reshape educational practices (Alzahrani et al., 2023). Furthermore, the use of digital technologies in mathematics education has been shown to foster greater student engagement and exploration, leading to improved learning outcomes (Nurafifah et al., 2024). This literature review explores how student experience

with digital tools, perceptions of engagement in the digital math classroom, and overall engagement with specific tools contribute to a more invigorating learning experience.

Student experience with digital tools continues to play a pivotal role in fostering engagement within digital classrooms. Recent studies emphasize that students' digital literacy and self-efficacy significantly influence their online learning engagement. For instance, Getenet et al. (2024) found that students with higher digital literacy and positive attitudes towards technology exhibited greater self-efficacy, which in turn enhanced their engagement across various dimensions, including cognitive, behavioral, and emotional aspects. This underscores the importance of equipping students with robust digital skills to navigate and adapt to new learning tools effectively. Moreover, providing clear instructions and opportunities for exploration within digital platforms can alleviate anxiety and promote active participation, as students feel more confident and in control of their learning processes.

Moving beyond students' comfort level, the perceived usefulness of digital tools for learning mathematics emerges as another critical factor in student engagement (Jang & Jee, 2019). Research by Clark and Mayer (2016) highlights that well-designed digital tools can significantly enhance understanding by providing interactive visualizations, gamification elements, and opportunities for self-paced learning. Similarly, Liu and Wang (2018) found that digital tools can promote collaboration and peer interaction, fostering a more engaging and dynamic learning environment in the mathematics classroom.

Student perceptions of engagement within the digital mathematics classroom are multifaceted, encompassing motivation, autonomy, and active participation. Recent research underscores that digital tools can significantly enhance intrinsic motivation by enabling students to make choices, set personalized goals, and receive immediate feedback. For instance, Saat et al. (2024) found that integrating digital technologies in mathematics education fosters greater student engagement and exploration, leading to improved learning outcomes. Furthermore, these tools empower students to take ownership of their learning journey by providing opportunities for exploration and discovery, thereby promoting a sense of autonomy and control over their educational experiences.

Collaboration and peer interaction are foundational elements of an engaging and effective learning environment. Recent research underscores that collaborative learning not only enhances students' academic performance but also fosters critical thinking, problem-solving skills, and a sense of community among learners. For instance, Zitha, Mokganya, and Sinthumule (2023) found that implementing innovative collaborative strategies in higher education significantly improved student engagement and learning outcomes. Similarly, Turyamureeba (2024) highlighted that well-structured collaborative learning environments promote deeper understanding and active participation, especially in STEM education. These findings emphasize the importance of integrating collaborative practices to create stimulating and inclusive educational experiences.

Research highlights the potential of digital tools to facilitate communication and collaboration among students, fostering a sense of community and shared learning experiences (Chen & Liu, 2019). Additionally, the ability to utilize digital tools for critical thinking and problem-solving can enhance student engagement (Aydin & Ozcelik, 2018). Studies demonstrate that well-designed digital activities can challenge students to think critically, analyze information, and develop problem-solving skills in a more engaging way compared to traditional methods (Polly et al., 2019).

Overall student engagement in the digital classroom is a complex concept encompassing a multitude of factors explored throughout this review. Research by Fredricks et al. (2016) emphasizes the importance of a holistic approach to measuring student engagement, considering not only their cognitive engagement with the content but also their emotional and behavioral engagement with the learning process.

When assessing the efficacy of specific digital tools, it's essential to acknowledge that different tools cater to diverse learning preferences and styles. Recent research emphasizes that digital tools offering various content delivery methods - such as videos, interactive simulations, and audio - can accommodate visual, auditory, and kinesthetic learners, thereby enhancing engagement and learning outcomes (AIScreen, 2025). Studies by Boschman et al. (2019) and Zheng (2019) suggest that a well-balanced approach utilizing a variety of digital tools can cater to a wider range of student needs and learning styles, ultimately leading to a more engaging and effective learning experience.

These literature and studies underscore the promising potential of digital tools to revitalize math learning. These tools can enhance student experience, foster positive perceptions of engagement within the digital classroom environment, and promote overall engagement with specific tools. By carefully considering students' prior experience, comfort level, and perceived usefulness of the tools, educators can create a more engaging and

effective learning environment that empowers students to take ownership of their mathematical journeys.

3. Research Rationale and Objectives

This research investigates the experiences and perceived effectiveness of digital tools on student engagement in a first-year college mathematics classroom. Understanding these factors will provide valuable insights into how educators can leverage the power of technology to create a more engaging and effective learning experience for their students.

The research is guided by the following key objectives:

- *Exploring Student Experience with Digital Tools:* This study assessed student experience with the chosen digital tools through a survey. The survey gathered data on students' prior experience using these tools, their current level of comfort in using them, and their perceived usefulness for engaging with mathematical concepts.
- *Perceptions of Engagement in the Digital Math Classroom:* Building upon the concept of student experience, the research delved deeper into students' perceptions of their engagement within the digital mathematics classroom environment. This was achieved by asking students to rate their agreement with statements related to their motivation, understanding, interest, collaboration, and problem-solving experiences within the digital classroom setting.
- *Overall Engagement and Specific Tool Efficacy:* Finally, the research measured students' overall engagement in the digital mathematics classroom environment and their engagement with specific tools utilized throughout the course. By collecting this data, the study aimed to identify the tools that students find most beneficial for their learning and engagement.

4. Methodology

This section outlines the methodology employed in this study. Following a qualitative research design with descriptive analytical approach, the study investigated student perceptions and engagement with the digital resources utilized in a first-year college mathematics course.

Qualitative research offers a valuable lens for exploring subjective experiences and perceptions (Creswell & Creswell, 2018). In this study, the focus lies on understanding how students perceive and engage with digital tools (Nearpod, Kahoot, Microsoft Teams, and Blackboard Learn) within the mathematics classroom environment. A descriptive analytical approach allows us to delve deeper into these experiences, categorize them, and identify recurring themes and patterns (Denzin & Lincoln, 2018).

The primary data collection method for this research was a survey instrument which was divided into two key parts: Part 1 which is about the students' experience and perceived usefulness of digital tools and Part 2 on their perceived engagement in the digital mathematics classroom. The survey concluded by asking students to rate their overall engagement in the digital mathematics classroom and with specific tools utilized throughout the course. It was designed to be anonymous, encouraging honest responses from the participants who may be hesitant to express their opinions openly.

To ensure the survey's effectiveness, a pilot test was conducted with a small group of students. This pilot assessed the instrument's clarity, comprehensiveness, and response time. Additionally, Cronbach's Alpha was calculated for each survey section to evaluate its internal consistency. Acceptable levels were achieved, with alpha values of 0.71 and 0.75 for parts 1 and 2, respectively. Part 3, containing fewer items, yielded a Cronbach's Alpha of 0.65, which was still considered acceptable in this context. Based on the pilot test results, minor revisions were made to the instrument to enhance its clarity and flow.

The instrument was administered online through Microsoft Forms.

In addition to the survey, semi-structured interviews were conducted with a smaller sample of students. The interview data served as a valuable supplement to the survey findings, offering a more nuanced perspective on student perceptions and engagement.

Among the 140 students in my class who had over ten weeks of experience using the selected digital tools (Nearpod, Kahoot, Microsoft Teams, and Blackboard Learn), 127 responded to the survey. Given the manageable class size, a census sampling approach was employed, inviting all enrolled students to participate in the study. This method ensured comprehensive coverage of the target population, enhancing the accuracy and

representativeness of the findings. Census sampling is particularly effective in educational research when the population is accessible and the goal is to capture the full range of perspectives within a specific context (Mertler, 2021).

The data collected from the survey were analyzed using descriptive statistics, including frequencies, percentages, and means, to summarize student responses to closed-ended questions. Descriptive statistical analysis is a fundamental tool in educational research, providing a clear overview of data trends and patterns without inferring causality (Creswell & Creswell, 2023). These statistics provided a clear picture of student experience with the digital tools, their perceived usefulness for learning mathematics, and their overall engagement levels within the digital classroom environment.

The criterion which served as the basis for the interpretation of the mean ratings are as follows:

Mean Ratings	Descriptive Interpretation		
	Comfort Level	*Perceived Usefulness*	*Perceived Engagement*
4.51 – 5.00	Extremely comfortable	Extremely useful	Very high/ Strongly agree
3.51 – 4.50	Very comfortable	Very useful	High/Agree
2.51 – 3.50	Moderately comfortable	Moderately useful	Medium/Neutral
1.51 – 2.50	A Little comfortable	A little useful	Low/Disagree
1.00 – 1.50	Not comfortable	Not useful	Very low/Strongly disagree

The open-ended interview questions were analyzed using a reflexive thematic analysis approach, following the updated framework by Braun and Clarke (2021). This method emphasizes the researcher's active role in identifying, analyzing, and interpreting patterns of meaning within qualitative data, allowing for a nuanced and flexible exploration of participants' experiences.

By triangulating the data collected from the survey and interviews, a more comprehensive and nuanced understanding of student engagement with digital tools in the mathematics classroom was obtained.

5. Findings and Discussion

Table 1 presents the students' prior experience, comfort, and perceived usefulness of digital tools, perceptions of engagement, and the effectiveness of specific digital tools in promoting overall engagement.

Table 1 – Students' Experience, Perceived Usefulness of Digital Tools and their Engagement in the Digital Mathematics Classroom

Digital Tools	**Percentage of students who have prior experience in using the tools (n = 127)**	**Level of Comfort in Using the Digital Tools**		**Perceived Usefulness of Digital Tools**		**Perceived Engagement in the Digital Math Classroom**	
		Mean (S.D.)	***Descriptive Interpretation***	***Mean (S.D.)***	***Descriptive Interpretation***	***Mean (S.D.)***	***Descriptive Interpretation***
Nearpod	86%	4.17 (1.0845)	Very Comfortable	4.14 (1.0670)	Very Useful	4.25 (1.0015)	High Engagement
Kahoot	93%	4.40 (0.8661)	Very Comfortable	4.39 (0.8466)	Very Useful	4.47 (0.8621)	High Engagement
MS Teams	71%	3.98 (1.1983)	Very Comfortable	4.06 (1.1220)	Very Useful	4.047 (1.1259)	High Engagement
BbL Collaborate	74%	4.20 (0.9681)	Very Comfortable	4.20 (0.9287)	Very Useful	4.23 (0.9360)	High Engagement
BbL Resources	49%	4.06 (1.0564)	Very Comfortable	4.14 (1.0136)	Very Useful	4.19 (0.9655)	High Engagement
Others	6%	**Overall Engagement**				**3.97 (0.9995)**	**High Engagement**

The findings indicate that a substantial majority of students had prior experience using key digital tools, with Kahoot (93%) and Nearpod (86%) being the most familiar. MS Teams (71%) and BbL Collaborate (74%) also showed widespread use, while BbL Resources (49%) and other tools (6%) were less commonly encountered. This distribution suggests that most students entered the course with a strong foundation in using interactive and mainstream digital platforms. The high levels of prior usage reflect the integration of these tools into students' earlier academic experiences, particularly during high school or periods of remote learning. This familiarity appears to contribute to greater comfort and confidence in their use, reinforcing the idea that familiarity breeds engagement.

Comfort levels were consistently high across all platforms, with mean scores ranging from 3.98 for MS Teams to 4.40 for Kahoot, indicating that students generally felt confident using the tools. Perceived usefulness closely mirrored comfort ratings, with all tools evaluated as "Very Useful" – ranging from 4.06 (MS Teams) to 4.39 (Kahoot). This alignment suggests that ease of use enhances students' perceptions of a tool's value in supporting their learning. First-year students likely appreciated tools with intuitive interfaces and simple navigation. Kahoot stands out for its engaging quiz-based format and immediate feedback, which may explain its consistently high ratings across comfort, usefulness, and engagement. These results support the Technology Acceptance Model, as expanded by Barz, Benick, Dörrenbächer-Ulrich, and Perels (2024), which highlights the influence of perceived ease of use and usefulness on user adoption. Additionally, they align with Mayer's (2021) updated Cognitive Theory of Multimedia Learning, which emphasizes the importance of well-designed multimedia instructional messages that consider human cognitive architecture to enhance meaningful learning.

All five core tools in the study were perceived as academically valuable, with Kahoot again leading in perceived usefulness (4.39), followed by BbL Collaborate (4.20) and Nearpod (4.14). Students recognized the effectiveness of digital tools in providing real-time feedback, facilitating peer interaction, and dynamically visualizing mathematical concepts. Kahoot, for example, has been shown to significantly enhance student engagement, motivation, and academic performance through its gamified assessment features and instant feedback capabilities (Baszuk & Heath, 2020). The use of Kahoot in classroom settings supports formative assessment practices and helps maintain student focus during review sessions (Kahoot!, 2020). Likewise, Nearpod promotes active participation and real-time formative assessment through interactive features such as quizzes, polls, collaborative boards, and live lesson tracking. These functionalities have been found to boost student engagement and improve the overall learning experience in online and hybrid mathematics instruction (Nearpod, 2021; Nearpod, 2023).

When asked about their overall engagement in the digital mathematics classroom, students reported a high average engagement score of 3.97. Among the tools, Kahoot again received the highest engagement rating (M = 4.47), followed by Nearpod (4.25), BbL Collaborate (4.23), and BbL Resources (4.19). MS Teams, while still falling within the "High Engagement" category, had the lowest score (4.05). These findings highlight Kahoot and Nearpod as particularly effective in fostering engagement – likely due to their interactive, gamified, and visually stimulating features. Conversely, the relatively low engagement for MS Teams may be attributed to its design as a communication and management platform, rather than a pedagogically robust tool for delivering interactive instruction. This distinction echoes the findings of Maryana et al. (2024), who demonstrated that gamification in mathematics education significantly improved student engagement and learning outcomes, and Li et al. (2023), found that gamification positively influences student motivation, engagement, and learning outcomes across various educational settings.

Student engagement was further validated through Likert-scale responses as shown in Figure 1 which presents the perceived engagement of 127 first-year college students in the digital mathematics classroom, based on seven indicators related to motivation, understanding, interest, collaboration, ownership, critical thinking, and overall engagement.

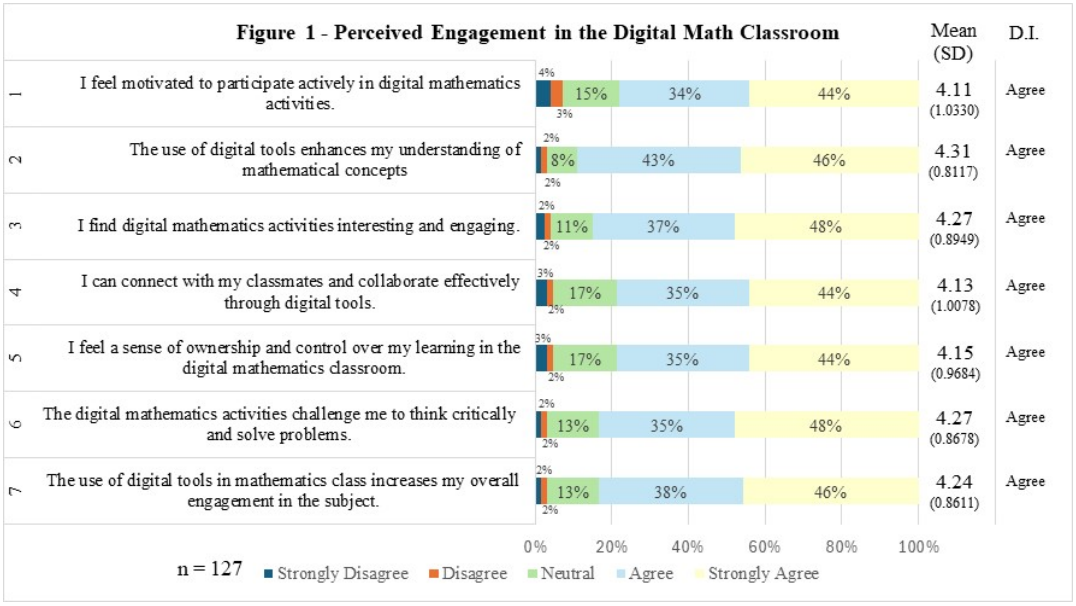
The data, gathered through a Likert-scale survey, reveals that students generally perceive digital tools as highly engaging and beneficial to their learning experience, with all mean scores ranging from 4.11 to 4.31—indicating agreement or strong agreement across all areas.

The highest-rated item was "The use of digital tools enhances my understanding of mathematical concepts" (M = 4.31, SD = 0.81), confirming that students see digital tools as effective in supporting cognitive engagement. This finding aligns with Mayer's (2021) updated Cognitive Theory of Multimedia Learning, which emphasizes that well-designed multimedia instructional messages - integrating visual and interactive elements - enhance comprehension by facilitating meaningful learning through active cognitive processing. Similarly, students rated highly their agreement that digital mathematics activities challenge them to think critically and solve problems (M = 4.27), as well as finding those activities interesting and engaging (M = 4.27). These results reflect strong emotional and intellectual engagement, likely influenced by the use of interactive and gamified tools such as

Kahoot and Nearpod. Recent research by Lampropoulos and Sidiropoulos (2024) found that gamification in educational settings significantly enhances both intrinsic and extrinsic motivation, thereby creating a more engaging and motivating learning environment.

Students also reported feeling a sense of ownership and control over their learning (M = 4.15), reflecting a healthy level of autonomy in digital environments. This finding aligns with recent research emphasizing the importance of autonomy in enhancing student motivation and engagement. For instance, a study by Jang (2023) demonstrated that providing students with a clear rationale for assignments significantly increased their interest and engagement, highlighting the role of autonomy in learning.

While students generally felt motivated to participate in digital math activities (M = 4.11), this was one of the slightly lower-rated items, suggesting that while most students are engaged, their motivational experiences may vary depending on how digital tools are implemented.



Notably, the lowest-rated item was related to collaboration: "I can connect with my classmates and collaborate effectively through digital tools" (M = 4.13, SD = 1.01). Although the score still reflects agreement, it indicates that students perceive slightly less engagement in terms of social interaction. This finding is consistent with the research of Li et al. (2023), which demonstrated that structured online peer interactions significantly enhance student motivation and engagement, leading to improved learning outcomes. This suggests that while platforms like Microsoft Teams and Blackboard Collaborate offer collaborative features, their potential may not be fully realized in current instructional practices. It may suggest that while tools like MS Teams and BbL Collaborate are available, their collaborative potential may not be fully leveraged in current instructional practices.

Overall, the data shows that cognitive and emotional engagement are the strongest dimensions in the digital math classroom. Students find digital tools helpful in understanding mathematical concepts, solving problems, and maintaining interest in the subject. Social engagement and consistent motivation are also present but slightly more reserved, indicating areas for growth. These findings affirm the value of digital tools in supporting a rich learning experience but also highlight the importance of thoughtful instructional design – especially in promoting collaboration and autonomy.

6. Conclusion and Recommendations

This study investigated first-year college students' engagement in the digital mathematics classroom, focusing on their prior experience with digital tools, their comfort in using them, and their perceptions of their usefulness. The findings demonstrate a clear and consistent relationship: prior experience, comfort level, and perceived usefulness are strong predictors of student engagement in digital learning environments. Students enter higher

education with growing familiarity with mainstream educational technologies and show readiness to engage with platforms that are interactive, purposeful, and user-friendly.

The data also affirms that digital tools are not merely supplementary but instrumental in promoting motivation, conceptual understanding, and critical thinking. Students feel at ease using these tools and recognize their positive impact on their learning outcomes. The most prominent aspects of engagement observed were cognitive (e.g., problem-solving, comprehension) and emotional (e.g., interest, enjoyment). While social engagement - particularly peer collaboration - was also positively rated, it received slightly lower endorsements, suggesting the need for stronger integration of collaborative and communication features.

To further strengthen student engagement in the digital mathematics classroom, educators are encouraged to leverage familiar and well-received platforms such as Kahoot and Nearpod, which students identified as highly engaging and effective. At the same time, there is a need to enhance collaborative learning experiences through platforms like MS Teams and BbL Collaborate, by integrating group-oriented and student-led tasks. Additionally, expanding the digital ecosystem to include underutilized but powerful tools such as Desmos, GeoGebra, and other math-specific applications can enrich the learning experience and cater to diverse learning preferences.

Digital learning activities should be designed not only to reinforce knowledge but also to foster autonomy, decision-making, and higher-order thinking. Institutions and instructional leaders must support this goal by offering structured training and professional development for faculty in both synchronous and asynchronous teaching strategies. Evaluations of digital tool effectiveness should go beyond technical functionality, focusing instead on their impact on student engagement and learning outcomes. Incorporating student feedback into instructional planning will ensure that technology integration remains responsive and learner-centered.

Finally, this study recommends further research into why certain widely used tools may yield lower engagement, despite their accessibility or institutional preference. It also highlights the need to explore how digital engagement differs across student demographics, prior digital fluency, and academic backgrounds. Longitudinal research would be particularly valuable in assessing how sustained digital engagement correlates with mathematics achievement, self-efficacy, and retention in STEM-related disciplines.

In sum, this study confirms that when thoughtfully implemented, digital tools can serve as a powerful catalyst for deep, meaningful, and sustained engagement in mathematics learning. The challenge and opportunity lie in ensuring that digital practices are both pedagogically sound and aligned with the evolving needs of today's learners.

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