

**INTERNATIONAL JOURNAL OF  
MODERN EDUCATION  
(IJMOE)**[www.gaexcellence.com/ijmoe](http://www.gaexcellence.com/ijmoe)**A MULTIDIMENSIONAL PERSPECTIVE ON HOW  
DIGITAL TOOL USE SHAPES STUDENT ENGAGEMENT  
IN HIGHER EDUCATION**

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**Article Info:****Article history:**

Received date: 05.04.2026

Revised date: 05.05.2026

Accepted date: 31.05.2026

Published date: 18.06.2026

**Abstract:**

Student engagement is widely recognized as a critical determinant of academic success in higher education, influencing achievement, retention, and overall learning quality. Despite its importance, sustaining meaningful engagement remains a persistent challenge in increasingly technology-mediated learning environments. Digital educational technologies, including learning management systems, collaborative platforms, video conferencing tools, and online learning applications, are now widely integrated into higher education to support interaction, flexibility, and access to learning resources, yet empirical evidence on how they shape different dimensions of student engagement remains limited. Addressing this gap, this study examines how digital tool use predicts behavioral, emotional, and cognitive engagement from a multidimensional perspective. A quantitative cross-

**To cite this document:**

Sabri, S. M., Khushairi, N. A. M., Ismail, I., Shafee, M. I. K., & Rahman, N. R. A. (2026). A Multidimensional Perspective on How Digital Tool Use Shapes Student Engagement in Higher Education. *International Journal of Modern Education*, 8(30), 454-476.

sectional design was employed, with data collected from 404 students at a Malaysian public university. Pearson correlation and multiple regression analyses were used to examine the predictive relationships between digital tool use and the three dimensions of student engagement. The findings show that digital tool use significantly and positively predicts all engagement dimensions, with the strongest influence on emotional engagement, followed by cognitive and behavioral engagement. These results suggest that while digital tools support active participation and deeper learning, their greatest contribution lies in strengthening students' motivation, enthusiasm, and sense of connection in the learning process. This study provides empirical evidence that digital tool use functions as a meaningful enabler of student engagement and highlights the importance of strategically integrating technology to foster more engaging and effective learning environments in higher education.

**DOI:** 10.35631/IJMOE.830030

**Keywords:**

Digital Tool Use, Higher Education, Multidimensional Engagement, Student Engagement, Technology-Enhanced Learning



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## Introduction

Student engagement has long been recognized as a cornerstone of effective higher education, playing a vital role in shaping students' learning outcomes and overall academic success. Engaged students are more likely to demonstrate consistent effort, participate actively in learning activities, and remain motivated to achieve their goals. Strong levels of engagement have been linked to improved academic performance, higher retention rates, and deeper learning experiences, making it a critical indicator of institutional quality and effectiveness (Redmond et al., 2020). Despite its importance, achieving and sustaining meaningful engagement remains a significant challenge in higher education institutions, where factors such as diverse student backgrounds, varying levels of motivation, and differences in teaching approaches can influence participation. As higher education becomes increasingly complex and competitive, institutions are under growing pressure to adopt strategies that not only deliver knowledge but also sustain active and meaningful engagement among students. Recognizing these challenges highlights the need for innovative approaches that can bridge the gap between instructional practices and students' evolving learning needs.

In recent years, the use of digital tools, such as learning management systems, collaborative platforms, and interactive applications has become increasingly central to higher education. These tools are not only reshaping access to knowledge but also creating new possibilities for interaction, collaboration, and personalization of learning (Bond et al., 2020; Sugden et al.,

2021). The integration of technology is frequently assumed to foster engagement, as it enables flexible participation and supports diverse learning strategies. Yet, while descriptive studies have highlighted students' positive perceptions and frequent use of such tools (Bedenlier et al., 2020; Doo & Bonk, 2020), less is known about the extent to which technology use actually predicts engagement across its different dimensions.

This gap is particularly relevant in the context of higher education institutions in Malaysia and the broader Asian region, where technology adoption has accelerated in the aftermath of the COVID-19 pandemic. Higher education institutions have made significant investments in online platforms and digital infrastructures, but students' experiences with these tools are shaped by factors such as internet connectivity, device accessibility, and readiness for online learning (Fawaz & Samaha, 2020; Teo et al., 2023). Research has shown that while many students adapted well to remote learning environments, disparities in digital access and self-regulation skills created challenges that influenced engagement levels (Annamalai, 2021). As higher education continues to embrace hybrid and technology-driven approaches, there is a pressing need for empirical evidence on how digital tools affect different forms of student engagement, and whether such impacts remain significant once demographic and access-related variables are considered.

To address this limitation, the present study employs multiple regression analysis to examine whether and how digital tool use predicts student engagement in higher education settings. By focusing on predictive relationships rather than descriptive trends, this study contributes to a deeper understanding of technology-driven learning. Specifically, it seeks to determine whether higher levels of digital tool usage are associated with stronger behavioral, emotional, and cognitive engagement, while accounting for demographic and access-related factors. The findings aim to enrich the literature on educational technology and student engagement, while also offering practical implications for educators and policymakers seeking to design effective, technology-enhanced learning environments.

## Literature Review

This section reviews the body of literature relevant to this study, focusing on student engagement and the role of digital tools in higher education. It begins by defining student engagement and outlining its theoretical foundations, particularly the behavioral, emotional, and cognitive dimensions that are widely recognized in literature. The review then examines how digital tools have been integrated into higher education to enhance engagement, highlighting both their benefits and limitations across different learning environments. It also addresses emerging challenges such as digital fatigue, unequal access, and disparities in digital literacy, which can influence the effectiveness of technology-based engagement strategies. By synthesizing recent studies and theoretical perspectives, this section provides a comprehensive understanding of the current state of knowledge while identifying gaps that this study seeks to address through empirical analysis.

### *Conceptualizing Student Engagement*

Student engagement can be broadly defined as the level of attention, curiosity, interest, optimism, and passion that students show when they are learning, which extends to the motivation they have to progress in their education (Fredricks et al., 2004). More recently, it has been described as “the energy and effort that students invest in their learning, which is

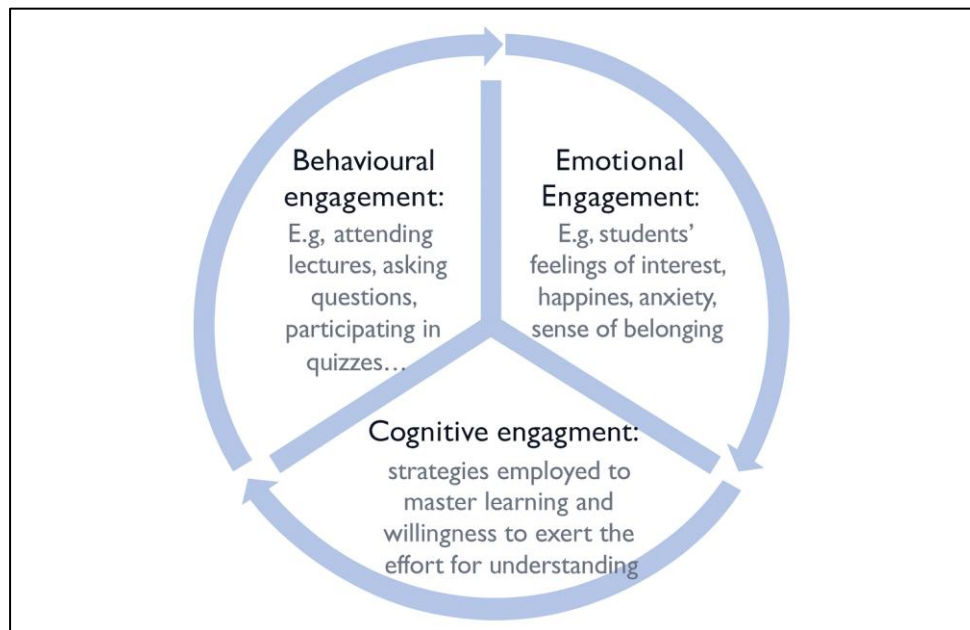
directed towards achieving academic outcomes and personal growth” (Kahu & Nelson, 2018). Similarly, Redmond et al. (2020) define engagement as “a dynamic process involving students’ interaction with learning activities, peers, and instructors that leads to meaningful learning experiences.” These alternative perspectives highlight that engagement is not a static trait, but an ongoing process shaped by institutional context, instructional practices, and the broader learning environment.

Student engagement has become a central construct in educational research, widely regarded as a reliable indicator of learning quality and academic success. When students are highly engaged, they are more likely to persist in their studies, perform better academically, and demonstrate higher satisfaction with their learning environment (Redmond et al., 2020). Conversely, disengagement often manifests as absenteeism, low motivation, and poor performance, making it a pressing concern for educators and institutions alike (Bond et al., 2020). As higher education becomes increasingly complex and competitive, institutions are under growing pressure to adopt strategies that not only deliver knowledge but also sustain active and meaningful engagement among students. Recognizing these challenges highlights the need for innovative approaches that can bridge the gap between instructional practices and students’ evolving learning needs.

One of the most influential frameworks for understanding student engagement is the model proposed by Fredricks, Blumenfeld and Paris (2004), which conceptualizes engagement as a multidimensional construct comprising three interrelated domains: behavioral engagement, emotional engagement, and cognitive engagement. This model remains highly relevant and continues to guide research on engagement in contemporary higher education (Fredricks et al., 2021). The model defines each component as below.

- **Behavioral engagement** reflects students’ participation and involvement in academic activities such as attending lectures, contributing to discussions, and completing assignments. It is often considered the most visible dimension of engagement because it can be observed directly in students’ actions. High levels of behavioral engagement are strongly associated with academic persistence and achievement (Kahu & Nelson, 2018).
- **Emotional engagement** captures the affective side of learning, including students’ sense of belonging, enthusiasm, and overall attitude toward their studies. Emotionally engaged students are more motivated, show greater resilience in overcoming difficulties, and develop stronger relationships with peers and instructors (Adlington et al., 2024).
- **Cognitive engagement** refers to the degree of psychological investment in learning, characterized by the use of deep learning strategies, critical thinking, and self-regulation. Students with strong cognitive engagement go beyond surface-level memorization, striving to connect ideas, apply knowledge, and reflect critically on their understanding (Deng et al., 2020).

To illustrate this multidimensional perspective, Figure 1 below presents the Three-Dimensional Framework of Student Engagement proposed by Fredricks et al. (2004). The framework visually summarizes the interrelated behavioral, emotional, and cognitive dimensions that together shape students’ overall engagement in the learning process. It provides a useful conceptual lens for understanding how engagement operates as a complex and dynamic construct in higher education.



**Figure 1: Three-Dimensional Framework of Student Engagement (Fredricks et al., 2004)**

Together, these three dimensions provide a holistic understanding of student engagement, capturing not only what students do but also how they feel and how they think in relation to learning. This multidimensional perspective highlights the complexity of engagement and underscores its importance as both a process and an outcome in higher education. The model of Fredricks et al. (2004) continues to serve as a foundation for contemporary studies, making it a useful lens through which to explore how new variables, such as the use of digital tools, can influence engagement in today's technology-driven learning environments.

Recent studies have further highlighted the challenges of sustaining student engagement in the changing landscape of higher education. The shift to online and blended learning during and after the COVID-19 pandemic has amplified issues such as digital fatigue, uneven levels of self-regulation, and disparities in access to reliable internet and devices (Annamalai, 2021; Zhao & Watterston, 2021). Moreover, the increasing complexity of learning environments, characterized by constant connectivity and competing digital distractions, has made it more difficult for students to remain consistently engaged. These challenges underscore the importance of identifying innovative and evidence-based strategies that not only foster engagement but also sustain it over time. In this regard, the integration of digital tools in higher education has been proposed as a promising pathway for addressing engagement-related challenges.

### ***The Role of Digital Tools in Higher Education***

Digital tools can be broadly defined as technological applications and platforms that support teaching, learning, and communication in educational contexts (Nguyen et al., 2021). These include learning management systems e.g., Moodle, Blackboard, video conferencing platforms e.g., Zoom, Microsoft Teams, collaborative tools e.g., Google Workspace, Padlet, and interactive applications e.g., Kahoot, Mentimeter. Such tools are designed to facilitate access

to resources, enhance interactivity, and enable collaboration between students and instructors in both face-to-face and online environments. In higher education, digital tools are no longer supplementary; they have become integral components of instructional delivery and student engagement strategies (Bedenlier et al., 2020).

The adoption of digital tools in higher education institutions has been accelerated by the global shift toward online and blended learning, particularly in the aftermath of the COVID-19 pandemic. Their widespread use reflects not only the demand for flexible learning environments but also the recognition that digital platforms can provide meaningful opportunities for interaction, personalization, and self-directed learning (Bond et al., 2020; Sugden et al., 2021). By supporting real-time communication, offering diverse content delivery formats, and enabling collaborative knowledge-building, digital tools are increasingly viewed as catalysts for enhancing student engagement and improving learning outcomes.

One of the main benefits of digital tools lies in their capacity to foster active participation and provide personalized learning experiences. For example, online discussion forums and collaborative platforms allow students to share ideas, exchange feedback, and reflect on course content at their own pace, thereby encouraging deeper engagement (Martin et al., 2020). Gamified applications and interactive quizzes can also increase student motivation by introducing elements of competition and immediate feedback, making learning more dynamic and enjoyable (Korkmaz & Toraman, 2020). These tools not only create more interactive classrooms but also support inclusivity by giving quieter or more reserved students opportunities to contribute to digital spaces where they may feel more comfortable.

Despite their advantages, digital tools also pose several challenges. Some students report experiencing digital fatigue due to prolonged screen time and continuous reliance on online platforms (Zhao & Watterston, 2021). Access to reliable internet and devices remains uneven, particularly in developing countries and rural areas, creating disparities that affect participation and equity in learning opportunities (Annamalai, 2021). Furthermore, differences in digital literacy mean that not all students are equally prepared to use educational technologies effectively, which can hinder rather than support their learning (Doo & Bonk, 2020). These limitations highlight that while digital tools hold great promise for improving engagement, their effectiveness depends on careful integration into pedagogy and consideration of contextual challenges.

Overall, empirical studies suggest a generally positive relationship between the use of digital tools and student engagement. However, much of this research remains descriptive or correlational, often focusing on students' perceptions of technology or patterns of use rather than predictive analyses of learning outcomes (Bedenlier et al., 2020; Doo & Bonk, 2020). This presents a clear gap in the literature, as there is limited evidence on how digital tool usage predicts behavioral, emotional, and cognitive engagement. While previous studies have often been descriptive or correlational, fewer have applied predictive approaches such as regression analysis, particularly in diverse higher education contexts. Addressing this gap is essential to developing a more nuanced understanding of how technology-driven learning environments can be designed to support sustained student engagement.

In this study, digital tools refer to technology-based educational applications and platforms that support teaching, communication, collaboration, assessment, and learning activities in higher education settings. The construct encompasses various categories of educational technologies,

including learning management systems, video conferencing and collaboration platforms, artificial intelligence-based learning applications, e-assessment tools, cloud-based learning technologies, interactive whiteboards, as well as virtual and augmented reality applications. These tools are increasingly integrated into university teaching practices to facilitate accessibility, interaction, flexibility, and student-centered learning experiences.

### ***Theoretical Frameworks Linking Digital Tool and Engagement***

The relationship between digital tool use and student engagement can be better understood through established theoretical perspectives that explain how technology influences learning processes. This study draws on three key frameworks, which are 1) Constructivist Learning Theory, 2) the Technology Acceptance Model (TAM), and 3) Self-Determination Theory (SDT), to provide a conceptual foundation for examining the predictive role of digital tools in higher education.

#### ***Constructivist Learning Theory***

Constructivism posits that learners actively construct knowledge through interaction with their environment, peers, and instructors, rather than passively receiving information (Piaget, 1972; Vygotsky, 1978). In higher education, digital tools create environments that align with constructivist principles by enabling collaborative activities, discussion forums, simulations, and interactive applications. These tools provide students with opportunities to engage actively in meaning-making, problem-solving, and peer learning, which are essential for deeper understanding (Kimmons, 2020). From this perspective, digital tools are not merely delivery mechanisms but active facilitators of engagement that can support behavioral, emotional, and cognitive involvement in the learning process.

#### ***Technology Acceptance Model (TAM)***

The Technology Acceptance Model (Davis, 1989) suggests that users' acceptance of technology is determined primarily by its perceived usefulness and perceived ease of use. In educational contexts, when students perceive digital tools as helpful for learning and easy to use, they are more likely to adopt them consistently and integrate them into their study practices (Teo, 2011). This adoption, in turn, fosters engagement by encouraging participation in digital activities, enhancing motivation, and supporting self-regulation. Numerous studies have confirmed that perceived usefulness of educational technologies positively correlates with students' engagement and satisfaction (Sayaf et al., 2022). Thus, TAM provides a valuable framework for understanding how students' perceptions of digital tools translate into actual engagement behaviors.

#### ***Self-Determination Theory (SDT)***

Self-Determination Theory emphasizes the importance of fulfilling three basic psychological needs i.e. autonomy, competence, and relatedness, to foster intrinsic motivation and engagement (Deci & Ryan, 2000). Digital tools can support these needs by offering flexibility and choice (autonomy), enabling skill development through interactive learning activities (competence), and fostering social connections through online collaboration and communication (relatedness). When these needs are met, students are more likely to experience intrinsic motivation, which drives sustained engagement in their studies (Hartnett, 2020). In

this way, SDT highlights the motivational mechanisms through which digital tool enhance not only participation but also deeper forms of learning engagement.

Together, these theoretical perspectives provide a strong conceptual foundation for this study. Constructivist Learning Theory highlights the active role of students in creating knowledge through digital platforms, TAM explains how students' perceptions influence their adoption and use of digital tools, and SDT demonstrates how digital environments can fulfill psychological needs that sustain engagement. By integrating these frameworks, this study develops a comprehensive basis for examining whether and how digital tool use predict student engagement in higher education settings.

### ***Empirical Evidence and Hypotheses Development***

Empirical studies over the past decade consistently suggest that digital tools can enhance student engagement in higher education. For instance, interactive platforms and online learning management systems have been found to improve participation, foster collaboration, and support self-regulated learning (Martin et al., 2020; Sugden et al., 2021). Similarly, gamified applications such as Kahoot and Quizizz have been shown to increase motivation and enjoyment, contributing to greater involvement in learning tasks (Korkmaz & Toraman, 2020). These findings align with constructivist and motivational perspectives, suggesting that technology can act as a facilitator of both academic and social dimensions of engagement.

More recent studies conducted after the COVID-19 pandemic further highlight the role of digital tools in sustaining engagement during online and blended learning. For example, Sayaf et al. (2022) reported that students perceived usefulness of digital platforms strongly predicted their satisfaction and willingness to participate in online classes. Likewise, Doo and Bonk (2020) found that digital tools played a critical role in maintaining students' sense of connection and motivation during remote learning, particularly when platforms supported collaborative learning activities. These studies suggest that the effectiveness of digital tools lies not only in their availability but in how they are integrated to support meaningful learning experiences.

Despite these promising findings, the existing body of research also reveals notable limitations. Many studies remain descriptive, focusing on perceptions, attitudes, or general patterns of adoption of technology (Bedenlier et al., 2020; Doo & Bonk, 2020). While these insights are valuable, they provide limited evidence about the predictive relationships between digital tool use and student engagement across its behavioral, emotional, and cognitive dimensions. Furthermore, relatively few studies have incorporated demographic and contextual variables into their analyses, leaving questions about whether the effects of digital tools hold true across diverse student populations. This gap points to the need for empirical investigations that employ predictive statistical models, such as multiple regression, to more precisely determine the impact of digital tool use on engagement outcomes.

Drawing on the theoretical frameworks outlined earlier, and the gaps identified in the literature, this study proposes the following hypotheses:

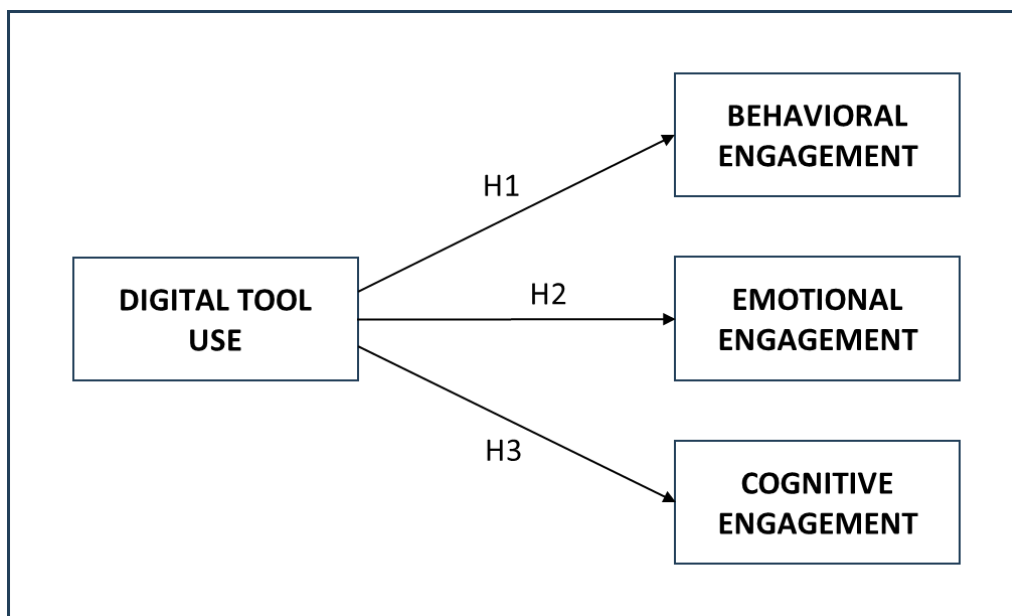
H1: Digital tools positively predict behavioral engagement among students in higher education institutions.

H2: Digital tools are used positively and predicts emotional engagement among students in higher education institutions.

H3: Digital tool use positively predicts cognitive engagement among students in higher education institutions.

By testing these hypotheses, this study aims to extend the existing body of research by moving beyond descriptive accounts toward predictive analysis, thereby providing stronger evidence of the role of digital tools in shaping student engagement in higher education.

Unlike prior studies that primarily relied on descriptive statistics or correlational analysis, this study employs a series of regression models to establish predictive relationships between digital tool use and each dimension of student engagement. By disaggregating engagement into behavioral, emotional, and cognitive components, the study provides more precise empirical insight into which aspects of engagement are most strongly influenced by technology use, thereby offering a more nuanced contribution to the educational technology literature.



**Figure 2: Research Framework**

The framework illustrates the hypothesized relationships between digital tool use (independent variable) and the three dimensions of student engagement (dependent variables): behavioral, emotional, and cognitive engagement.

This research framework summarizes the proposed model developed from the literature review and theoretical perspectives. It positions digital tool use as the independent variable expected to positively influence behavioral engagement, emotional engagement, and cognitive engagement among students in higher education institutions. The framework provides the basis for the study's hypotheses and guides the subsequent empirical analysis, where a series of regression models were employed to test the predictive relationships between digital tools and the three dimensions of student engagement.

## Methodology

This section describes the research methodology employed in the study, including the research design, participants, instruments, data collection procedures, and data analysis techniques. A quantitative, cross-sectional survey design was adopted, as it enables the systematic collection of data from a large number of respondents and allows for the use of statistical techniques to test predictive relationships. This approach is well suited to the study's objective of examining how digital tool use influences different dimensions of student engagement in higher education.

### *Research Design*

As illustrated in Figure 2, this study investigates the predictive relationship between digital tool use (independent variable) and student engagement across its three dimensions: behavioral, emotional, and cognitive (dependent variables). To achieve this, a quantitative, cross-sectional research design was adopted, using a structured survey to collect data from students in higher education institutions. A survey approach is suitable as it enables the systematic collection of standardized data from a large sample, making it possible to test the hypothesized relationships using multiple regression analysis. This design is also consistent with prior studies examining technology adoption and student engagement in higher education (Sayaf et al., 2022; Doo & Bonk, 2020).

### *Participants*

The study sample consisted of 404 university students enrolled in various academic programs at a Malaysian public university. Participants were recruited using convenience sampling, reflecting diverse demographic characteristics such as gender, age, level of study, and semester of enrollment. Efforts were made to ensure representation across different faculties and study levels, thereby providing a broad view of student experiences with digital tool use and engagement in the higher education context.

### *Instruments*

Data were collected using a structured questionnaire adapted from validated scales in literature. The survey comprised three main sections:

- Demographic information - gender, age group, academic level, semester, type of device used, and frequency of internet use.
- Digital tool use - measured using a 10-item scale assessing the extent of students' use of various educational technologies (e.g., LMS, online collaboration platforms, interactive applications). The items demonstrated high internal consistency (Cronbach's  $\alpha = .928$ ).
- Student engagement - measured across three dimensions: behavioral engagement (10 items,  $\alpha = .899$ ), emotional engagement (10 items,  $\alpha = .950$ ), and cognitive engagement (10 items,  $\alpha = .929$ ). These items were adapted from established engagement frameworks (Fredricks et al., 2004; Redmond et al., 2020) and were rated on a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree").

The questionnaire measured students' engagement with a broad range of educational technologies commonly used in higher education. These included learning management systems, virtual meeting platforms, collaborative tools, artificial intelligence applications, e-assessment technologies, cloud-based learning systems, and interactive learning platforms.

### ***Data Collection Procedure***

The survey was distributed online through institutional communication channels. Participation was voluntary, and informed consent was obtained before respondents completed the questionnaire. To ensure confidentiality, responses were anonymized and stored securely. Data screening was conducted to identify missing values and outliers before analysis.

### ***Data Analysis***

Data were analyzed using SPSS (Statistical Package for the Social Sciences) version 29.0. Descriptive statistics were computed to summarize demographic information and overall trends in digital tool use and engagement. Reliability analyses were conducted to confirm the internal consistency of the scales. Pearson correlation analysis was used to examine bivariate relationships among variables.

To address the study objectives, multiple regression analysis was performed in three separate models:

- Model 1: Digital tool use predicting behavioral engagement,
- Model 2: Digital tool use predicting emotional engagement,
- Model 3: Digital tool use predicting cognitive engagement.

Since student engagement is conceptualized as a multidimensional construct, the three models were analyzed separately, with each dimension i.e. behavioral, emotional, and cognitive, treated as an outcome in turn. This approach provides a clearer understanding of how digital tool use influences each specific aspect of engagement, rather than collapsing them into a single composite score. Analyzing the models separately also avoids potential multicollinearity among the engagement dimensions, which are strongly correlated with each other, thereby ensuring more reliable estimates of the predictive relationships. In each model, regression assumptions, including linearity, independence of errors, multicollinearity, homoscedasticity, and normality of residuals were checked to ensure the validity of the findings.

### **Results and Discussion**

This section presents the findings of the study derived from both descriptive and inferential analyses of the collected data. The descriptive results outline the demographic characteristics of the respondents, their usage patterns of digital tools, and their levels of engagement in the learning process. Following this, the inferential analysis using multiple regression examines the predictive relationships between digital tool use and the three dimensions of student engagement i.e. behavioral, emotional, and cognitive. Together, these findings provide a comprehensive understanding of how digital tools influence student engagement within the context of higher education. The results are further interpreted in light of existing literature to draw meaningful implications for teaching and learning practices.

### Reliability Test

The internal consistency of the measurement scales was assessed using Cronbach’s Alpha. All constructs demonstrated strong reliability, with values well above the recommended threshold of 0.70. Specifically, Digital Tool Use ( $\alpha = .928$ ), Behavioral Engagement ( $\alpha = .899$ ), Emotional Engagement ( $\alpha = .950$ ), and Cognitive Engagement ( $\alpha = .929$ ) each showed excellent internal consistency. Emotional Engagement recorded the highest reliability, indicating strong coherence among the items measuring this construct. These results confirm that the survey instruments used in this study are both consistent and dependable, providing a solid basis for subsequent analyses. A summary of the reliability results is presented in Table 1 below.

**Table 1: Reliability Test Result**

	Cronbach’s Alpha	N of Items	Reliability Level
Digital Tool Use (TU)	.928	10	Strong
Behavioral Engagement (BE)	.899	10	Strong
Emotional Engagement (EE)	.950	10	Strong
Cognitive Engagement (CE)	.929	10	Strong

### Findings and Analysis of Demographic Data

The demographic profile of respondents is summarized in Table 2 below. The demographic data collected provides insights into the characteristics of the respondents, including gender, age, academic level, semester of study, device ownership, and internet usage patterns.

**Table 2: Summary of Demographic Data**

Demographic	Subject	Frequency	Percent
Gender	Male	90	22.28
	Female	314	77.72
Age	18–21 years old	220	54.46
	22–25 years old	142	35.15
	Above 25 years old	42	10.40
Academic Level	Diploma	86	21.29
	Bachelor’s degree	285	70.54
	Master’s degree	24	5.94
Current Semester	Doctorate	9	2.23
	Semester 1	129	31.93
	Semester 2	37	9.16
	Semester 3	48	11.88
	Semester 4	18	4.46
	Semester 5	117	28.96
	Semester 6	29	7.18
	Semester 7	16	3.96
Own Computer	Semester 8	10	2.48
	No	1	0.25
Type of Device	Yes	403	99.75
	Laptop	283	70.05

Demographic	Subject	Frequency	Percent
	Smartphone	72	17.82
	Tablet	47	11.63
	Desktop	1	0.25
	Other	1	0.25
Use Internet Frequency	1-5 times	29	7.18
	5-10 times	90	22.28
	10-15 times	55	13.61
	More than 15 times	230	56.93

Out of 404 respondents, the majority were female (77.72%,  $n = 314$ ), while male students accounted for 22.28% ( $n = 90$ ). This gender distribution shows that female students were more dominant in the sample, which is consistent with enrollment trends in many Malaysian higher education programs.

In terms of age, more than half of the respondents (54.46%,  $n = 220$ ) were between 18 and 21 years old, followed by 22-25 years old (35.15%,  $n = 142$ ), with a smaller group above 25 years old (10.40%,  $n = 42$ ). This distribution reflects the typical demographic composition of undergraduate populations.

The majority of students were pursuing a bachelor's degree (70.54%,  $n = 285$ ), with diploma students representing 21.29% ( $n = 86$ ). A smaller proportion were postgraduate students, comprising 5.94% ( $n = 24$ ) at the master's level and 2.23% ( $n = 9$ ) at the doctoral level. This indicates that the sample is largely composed of undergraduates.

With regard to semester of study, the largest groups of respondents were in Semester 1 (31.93%,  $n = 129$ ) and Semester 5 (28.96%,  $n = 117$ ). Smaller proportions were in Semester 2 (9.16%,  $n = 37$ ), Semester 3 (11.88%,  $n = 48$ ), and Semester 6 (7.18%,  $n = 29$ ). The least represented groups were Semester 7 (3.96%,  $n = 16$ ) and Semester 8 (2.48%,  $n = 10$ ). This suggests that the sample was skewed toward students in the earlier stages of their programs.

Nearly all respondents (99.75%,  $n = 403$ ) reported owning a computer, underscoring the widespread access to digital devices essential for academic work. Among these devices, laptops were the most common (70.05%,  $n = 283$ ), followed by smartphones (17.82%,  $n = 72$ ) and tablets (11.63%,  $n = 47$ ). Only one respondent used a desktop computer, and another used a different device (0.25% each), indicating that laptops are the preferred medium for academic and digital engagement.

Patterns of internet use further highlight the strong digital presence of students. More than half of the respondents (56.93%,  $n = 230$ ) reported accessing the internet more than 15 times per day, while 22.28% ( $n = 90$ ) used it 5–10 times daily. Another 13.61% ( $n = 55$ ) used the internet 10–15 times daily, and a small group (7.18%,  $n = 29$ ) reported 1–5 times per day. These results illustrate students' high dependence on the internet for academic and personal purposes.

In summary, the demographic profile indicates that most respondents were young female undergraduates with high digital accessibility through laptops and frequent internet usage. This context provides a strong foundation for analyzing the impact of digital tools on student engagement in higher education.

### Correlation Analysis

The correlation analysis was carried out to explore the relationships between the key constructs in this study: Digital Tool Use, Behavioral Engagement, Emotional Engagement, and Cognitive Engagement. Pearson correlation coefficients were computed to assess the strength and direction of the associations among these variables. As presented in Table 3, all correlations were statistically significant at the 0.01 level (2-tailed), suggesting meaningful positive relationships between digital tool use and the three dimensions of student engagement, as well as strong interconnections among the engagement dimensions themselves.

**Table 3: Correlational Analysis Results**

		Mean DTU	Mean BE	Mean CE	Mean EE
Mean_DTU	Pearson	1	.680**	.742**	.783**
	Correlation				
	Sig. (2-tailed)		<.001	<.001	<.001
	N	404	404	404	404
Mean_BE	Pearson	.680**	1	.760**	.625**
	Correlation				
	Sig. (2-tailed)	<.001		<.001	<.001
	N	404	404	404	404
Mean_CE	Pearson	.742**	.760**	1	.690**
	Correlation				
	Sig. (2-tailed)	<.001	<.001		<.001
	N	404	404	404	404
Mean_EE	Pearson	.783**	.625**	.690**	1
	Correlation				
	Sig. (2-tailed)	<.001	<.001	<.001	
	N	404	404	404	404

\*\* . Correlation is significant at the 0.01 level (2-tailed).

Digital Tool Use shows strong positive correlations with Emotional Engagement ( $r = .783$ ,  $p < .001$ ) and Cognitive Engagement ( $r = .742$ ,  $p < .001$ ), and a moderate–strong correlation with Behavioral Engagement ( $r = .680$ ,  $p < .001$ ). This indicates that students who report greater use of digital tools tend to feel more positive and connected in their learning, apply deeper cognitive strategies, and participate more actively in academic activities.

Behavioral Engagement is strongly related to Cognitive Engagement ( $r = .760$ ,  $p < .001$ ) and moderate–strongly related to Emotional Engagement ( $r = .625$ ,  $p < .001$ ). It is also moderate–strongly associated with Digital Tool Use ( $r = .680$ ,  $p < .001$ ). This suggests that students who participate more actively in academic tasks are also more likely to think deeply, feel positively about learning, and use digital tools regularly.

Cognitive Engagement demonstrates strong correlations with Behavioral Engagement ( $r = .760$ ,  $p < .001$ ) and Digital Tool Use ( $r = .742$ ,  $p < .001$ ), as well as a moderate–strong correlation with Emotional Engagement ( $r = .690$ ,  $p < .001$ ). This indicates that students who invest more mental effort in learning also tend to participate actively, feel more motivated, and rely on digital tools to support deeper learning.

Emotional Engagement has the strongest association with Digital Tool Use ( $r = .783, p < .001$ ), followed by Cognitive Engagement ( $r = .690, p < .001$ ) and Behavioral Engagement ( $r = .625, p < .001$ ). This shows that students who feel enthusiastic, interested, and connected in their studies are also the ones who report higher technology use, deeper thinking, and stronger participation.

In summary, the correlation analysis reveals that digital tool use is significantly and positively associated with all three dimensions of student engagement, with the strongest link observed with emotional engagement. The engagement dimensions are also highly interrelated, reinforcing the multidimensional nature of engagement. These findings provide preliminary support for the study's hypotheses and justify further testing through multiple regression analysis.

### ***Multiple Regression Analysis***

To further examine the predictive power of digital tool use on student engagement, multiple regression analysis was conducted. Since engagement is conceptualized as a multidimensional construct, the analysis was structured into three separate models, with digital tool use entered as the independent variable and each engagement dimension i.e. behavioral, emotional, and cognitive, as the dependent variable in turn. This approach allows for a more precise assessment of how digital tools influence each aspect of engagement individually, while avoiding complications related to multicollinearity that could arise if all dimensions were combined into a single model. The results of the regression analyses are presented in the following subsections.

#### ***Model 1: Digital Tool Use and Behavioral Engagement***

The first regression model examined the extent to which digital tool use predicts behavioral engagement. As shown in Table X, the model was statistically significant,  $F(1, 402) = 345.04, p < .001$ , with an  $R^2$  value of .462 (Adjusted  $R^2 = .461$ ). This indicates that digital tool use accounts for approximately 46.2% of the variance in behavioral engagement. The coefficients further demonstrate that digital tool use is a strong, positive predictor of behavioral engagement ( $B = .601, \beta = .680, t = 18.58, p < .001$ ). This suggests that students who report greater digital tool use are more likely to demonstrate higher levels of participation and effort in academic activities, such as attending classes, completing assignments, and contributing to discussions. The strength of the standardized coefficient ( $\beta = .680$ ) highlights digital tool use as an important driver of behavioral aspects of student engagement in higher education institutions settings. In summary, the findings from Model 1 provide clear support for Hypothesis 1 (H1), which posited that digital tool use positively predicts behavioral engagement among students.

#### ***Model 2: Digital Tool Use and Emotional Engagement***

The second model tested whether digital tool use predicts emotional engagement. As shown in Table X, the model was statistically significant,  $F(1, 402) = 637.54, p < .001$ , with  $R = .783$  and  $R^2 = .613$  (Adjusted  $R^2 = .612$ ). Thus, digital tool use explains 61.3% of the variance in emotional engagement. The coefficients indicate a strong positive effect of digital tool use on emotional engagement ( $B = .826, \beta = .783, t = 25.25, p < .001$ ). In practical terms, students reporting greater use of digital tool also report higher levels of interest, enthusiasm, and sense of connection in their learning. In summary, the findings from Model 2 provide robust support

for Hypothesis 2 (H2), confirming that digital tool use is a significant predictor of emotional engagement among students.

### ***Model 3: Digital Tool Use and Cognitive Engagement***

The third model assessed the influence of digital tool use on cognitive engagement. As shown in Table X, the model was statistically significant,  $F(1, 402) = 491.90$ ,  $p < .001$ , with  $R = .742$  and  $R^2 = .550$  (Adjusted  $R^2 = .549$ ). This indicates that digital tool use explains 55.0% of the variance in cognitive engagement. The coefficients reveal a strong, positive effect of digital tool use on cognitive engagement ( $B = .733$ ,  $\beta = .742$ ,  $t = 22.18$ ,  $p < .001$ ). This suggests that students who make greater use of digital tools are more likely to engage in deep learning strategies, such as critical thinking, self-regulation, and problem-solving. In summary, the findings from Model 3 provide strong support for Hypothesis 3 (H3), confirming that digital tool use is a significant predictor of cognitive engagement in higher education settings.

Table 4 presents the results of the three regression models examining the predictive effect of digital tool use on behavioral, emotional, and cognitive engagement. Across all models, digital tool use was found to be a strong and statistically significant predictor of student engagement ( $p < .001$ ). The explanatory power of the models varied, with emotional engagement showing the highest proportion of variance explained ( $R^2 = .613$ ), followed by cognitive engagement ( $R^2 = .550$ ), and behavioral engagement ( $R^2 = .462$ ). These findings reinforce the critical role of digital tools in shaping different dimensions of engagement, with the strongest effect observed on students' emotional connection to learning.

**Table 4: Summary of Regression Analysis Results**

Dependent Variable	<i>B</i>	SE	$\beta$	<i>t</i>	<i>p</i>	<i>R</i> <sup>2</sup>	Adj. <i>R</i> <sup>2</sup>	<i>F</i>	Sig.
Behavioral Engagement	0.601	0.032	0.68	18.575	<.001	0.462	0.461	345.039	<.001
Emotional Engagement	0.826	0.033	0.783	25.249	<.001	0.613	0.612	637.536	<.001
Cognitive Engagement	0.733	0.033	0.742	22.179	<.001	0.55	0.549	491.904	<.001

### **Regression Equations**

Based on the results of the regression analyses, the predictive equations for each dimension of student engagement are as follows:

Model 1 (Behavioral Engagement):  $BE = 1.751 + 0.601(DTU)$

Model 2 (Emotional Engagement):  $EE = 0.635 + 0.826(DTU)$

Model 3 (Cognitive Engagement):  $CE = 1.075 + 0.733(DTU)$

where BE = Behavioral Engagement, EE = Emotional Engagement, CE = Cognitive Engagement, and DTU = Digital Tool Use.

These equations indicate that for each one-unit increase in digital tool use, behavioral engagement increases by 0.601 units, emotional engagement by 0.826 units, and cognitive engagement by 0.733 units, holding other factors constant. The results emphasize that digital tool use exerts the greatest predictive effect on emotional engagement, followed by cognitive and behavioral engagement.

### **Summary of Regression Findings**

Across all three models, digital tool use emerged as a strong and significant predictor of student engagement. The predictive effect was highest for emotional engagement ( $R^2 = .613$ ), followed by cognitive engagement ( $R^2 = .550$ ), and behavioral engagement ( $R^2 = .462$ ). These results suggest that while digital tools enhance all dimensions of engagement, their strongest influence lies in shaping students' motivation, enthusiasm, and sense of connection, which reflects the emotional component of learning. This may be because digital platforms often provide interactive and collaborative experiences that stimulate students' interest and foster a sense of belonging. The results for cognitive engagement also indicate that digital tools play a substantial role in supporting deep learning strategies such as critical thinking, problem-solving, and self-regulation. By providing access to diverse resources and interactive learning environments, technology appears to facilitate the kinds of learning behaviors associated with higher-order thinking. The influence on behavioral engagement, while slightly lower, remains notable, suggesting that digital tools also encourage students to participate actively, complete tasks, and engage consistently with course activities.

Collectively, these findings provide robust empirical support for the proposed hypotheses (H1–H3) and highlight the critical role of digital tool in fostering meaningful engagement in higher education. More importantly, the results extend previous descriptive research by offering predictive evidence of how technology use directly influences different dimensions of engagement. This strengthens the argument that digital tools, when integrated effectively, can serve as powerful enablers of student engagement across emotional, cognitive, and behavioral domains.

### **Discussions**

This study set out to examine the predictive effect of digital tool use on student engagement in higher education, focusing on its three dimensions: behavioral, emotional, and cognitive engagement. The results provide clear evidence that digital tools significantly and positively influence all aspects of engagement, with the strongest effect observed on emotional engagement, followed by cognitive and behavioral engagement. These findings extend previous descriptive studies by offering predictive evidence that highlights the critical role of digital tools in shaping how students participate, feel, and think in their learning environments.

#### ***Digital Tool Use and Behavioral Engagement***

The findings show that digital tool use significantly predicts behavioral engagement, accounting for 46.2% of its variance. This indicates that students who actively use digital tools are more likely to participate in learning activities, complete assignments, and remain consistent in their academic efforts. This result aligns with prior studies such as Sugden et al. (2021) and Martin et al. (2020), who emphasized that online platforms and interactive applications encourage active participation and sustained involvement in coursework. From a

theoretical perspective, constructivist learning theory supports this outcome, as digital tools provide opportunities for interaction and collaboration that promote student participation. Although the predictive effect on behavioral engagement was somewhat lower compared to other dimensions, this may be due to contextual factors such as digital fatigue or the structured nature of coursework, where behavioral participation is influenced not only by technology but also by institutional expectations.

### ***Digital Tool Use and Emotional Engagement***

Emotional engagement recorded the strongest predictive relationship, with digital tool use explaining 61.3% of its variance. This suggests that digital tools are particularly effective in fostering students' interest, enthusiasm, and sense of belonging in the learning process. These results are consistent with Doo and Bonk (2020), who found that technology-mediated platforms helped sustain students' motivation and connection during online learning, particularly in times of limited physical interaction. The findings also align with Self-Determination Theory (Deci & Ryan, 2000), which emphasizes that digital tools can meet students' needs for autonomy, competence, and relatedness, thereby enhancing intrinsic motivation. The strong influence on emotional engagement highlights the role of technology not only as an instructional aid but also as a means of cultivating positive emotional experiences that keep students motivated and connected.

### ***Digital Tool Use and Cognitive Engagement***

Cognitive engagement was also strongly predicted by digital tool use, accounting for 55.0% of the variance. This indicates that digital tool support deeper learning strategies such as critical thinking, problem-solving, and self-regulation. Previous studies by Bedenlier et al. (2020) and Sayaf et al. (2022) have similarly reported that digital technologies enhance students' ability to engage with complex tasks, analyze information, and apply knowledge in meaningful ways. Constructivist learning theory also explains this outcome, as digital platforms provide environments for exploration and knowledge construction. Moreover, the Technology Acceptance Model proposed by Davis (1989) helps clarify this result, since students who perceive digital tool as useful are more likely to adopt them for higher-order cognitive activities. Although slightly lower than emotional engagement, the strong predictive effect on cognitive engagement confirms the value of digital tool in fostering deep and sustained learning.

### ***Theoretical Implications***

The findings of this study contribute to theory by confirming that digital tools are effective in stimulating engagement through multiple mechanisms. Constructivist learning theory is reinforced by the evidence that technology creates environments for interaction and knowledge-building. The Technology Acceptance Model (TAM) is supported by strong predictive relationships, highlighting that students' use of digital tools translates into meaningful engagement outcomes. Finally, Self-Determination Theory (SDT) provides insight into why emotional engagement was most strongly predicted, digital tools satisfy students' psychological needs for autonomy, competence, and relatedness, thereby sustaining motivation. Together, these findings demonstrate the value of integrating multiple theoretical perspectives to explain how technology drives engagement. More importantly, the findings suggest that digital tool use should not be viewed merely as a supplementary instructional aid,

but as a strategic mechanism for activating motivational, cognitive, and participatory processes in higher education. This shifts the conversation from technology adoption toward technology optimization, emphasizing how digital environments can be intentionally designed to maximize engagement outcomes.

### ***Practical Implications***

From a practical standpoint, the results underscore the importance of leveraging digital tools strategically in higher education. Since emotional engagement has shown the strongest effect, educators should design technology-enhanced learning experiences that foster enthusiasm, motivation, and a sense of belonging. For example, incorporating interactive platforms, collaborative online discussions, and gamified applications can stimulate students' emotional connection to learning. At the same time, cognitive engagement can be strengthened by using tools that promote critical thinking and problem-solving, such as simulations, digital case studies, and adaptive learning platforms. Higher education institutions and policymakers should also invest in infrastructure and training to ensure that students have both access to and the skills required for effective use of digital tools. In the context of rapid digital transformation in higher education, these findings provide empirical justification for continued investment in technology-enhanced learning ecosystems. Institutions that strategically integrate digital tool into pedagogy may gain a competitive advantage by fostering higher levels of student motivation, participation, and deep learning, which ultimately contribute to improved academic performance and institutional sustainability.

### **Limitations and Future Research**

While this study provides meaningful insights into the relationship between digital tool use and student engagement, several limitations should be acknowledged. First, the study was conducted within a single public higher education institution in Malaysia, which may limit the generalizability of the findings to other educational contexts or student populations. Future research could involve multiple institutions or cross-country comparisons to provide broader perspectives on the role of digital technologies in higher education. Second, the study relied on self-reported survey responses, which may be influenced by students' subjective perceptions and response tendencies. Future studies may benefit from incorporating alternative data sources, such as learning analytics, classroom observations, or academic performance records, to provide a more comprehensive understanding of student engagement. Third, the cross-sectional nature of the study limits the ability to establish causal relationships between digital tool use and student engagement over time. Longitudinal or experimental research designs would offer stronger evidence regarding the long-term effects of digital technologies on student learning experiences. Finally, this study examined digital tool use as a broad educational technology construct and did not differentiate the specific effects of individual digital platforms or applications. Future research may explore how particular categories of digital tools, such as artificial intelligence applications, collaborative platforms, learning management systems, or immersive technologies, uniquely influence behavioral, emotional, and cognitive engagement among students.

### **Conclusions**

This study examined the impact of digital tool use on student engagement in higher education, focusing on behavioral, emotional, and cognitive dimensions. The results demonstrated that

digital tools are significant predictors of engagement across all three dimensions, with the strongest influence on emotional engagement, followed by cognitive and behavioral engagement. These findings provide robust evidence that digital tools play a crucial role in shaping how students participate, feel, and think in their academic experiences. The study contributes to theory by reinforcing constructivist, TAM, and SDT perspectives, showing how technology fosters active learning, supports adoption through perceived usefulness, and enhances motivation by meeting psychological needs. Practically, the results emphasize the importance of designing and integrating digital tools that not only facilitate learning tasks but also stimulate emotional connection and cognitive involvement. Institutions should continue investing in technology-enhanced learning strategies that maximize engagement and improve educational outcomes.

Although limited by its single-institution, cross-sectional design, the study offers predictive evidence that extends beyond previous descriptive work. Future research should broaden the scope to include multiple contexts, employ longitudinal designs, and examine additional moderating factors such as pedagogy, digital literacy, and institutional support. Overall, the findings highlight that when used effectively, digital tools are not simply supplements to learning but powerful enablers of meaningful and sustained student engagement in higher education. As higher education institutions continue to navigate technology-driven transformation, understanding the predictive influence of digital tools on engagement becomes critical for designing resilient and future-ready learning environments.

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- Acknowledgements:** The authors would like to express their gratitude to the students of Universiti Teknologi MARA (UiTM) who participated in this study. Their valuable time and responses made this research possible. The authors also acknowledge the support of the Faculty of Business and Management, UiTM Cawangan Perlis for providing the necessary academic environment to conduct this research.
- Funding Statement:** No Funding
- Conflict of Interest Statement:** The authors declare that there is no conflict of interest regarding the publication of this paper. All authors have contributed to this work and approved the final version of the manuscript for submission to the International Journal of Modern Education (IJMOE).
- Ethics Statement:** This study did not involve any human participants, animals, or sensitive data requiring ethical approval. The authors confirm that the research was conducted in accordance with accepted academic integrity and ethical publishing standards.
- Author Contribution Statement:** All authors contributed substantially to this work. Sabiroh conceptualized and designed the study, supervised the research process, conducted the data collection and statistical analysis, and drafted the original manuscript. Ismalaili contributed to the literature review, theoretical development, and critical revision of the manuscript. Sabiroh and Normy Rafida assisted in data preparation, interpretation of results, and manuscript editing. Mohd Imran supported the research instrument development and contributed to data validation and review of the findings. Noor Azreen and Sabiroh contributed to manuscript refinement, formatting, and final proofreading. All authors reviewed, approved, and agreed to the final version of the manuscript.
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