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Enhancing Digital Learning in Higher Education: The Mediating Role of Academic Self-Efficacy in Motivation and Engagement

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Abstract

This study investigates the impact of Relevant and Applicable Content (RAC) and Learner Support (LS) on Motivation and Engagement (ME) in digital learning, mediated by Academic Self-Efficacy (ASE). Higher education faces challenges in maintaining student motivation and engagement along with the rapid growth of digital learning technologies. However, limited research has explored the roles of RAC and LS in this context. This study aimed to address this gap by examining ASE's mediating influence. A quantitative approach was utilized, collecting data through self-report questionnaires from 375 university students. Structural Equation Modeling (SEM) was used to analyze the relationships among variables. The results revealed that RAC and LS positively influenced ME directly and indirectly through ASE. These findings emphasize the need for relevant content and robust learner support to design effective digital learning programs. Implementing these strategies can foster motivation, engagement, and student-centred learning outcomes in higher education.

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INTRODUCTION

In the digital transformation era, education has experienced significant changes, especially with the increasing technology adoption in the learning process (Al Faqih et al., 2023; Noor et al., 2022; Perdana et al., 2023). Adopting technology in education changes how the material is presented and influences interactions between educators and students (Huang et al., 2023; Oyetade et al., 2020). The rapid digital transformation has revolutionized education, expanding learning opportunities beyond traditional classrooms through digital platforms (Guo et al., 2023; Haque et al., 2023). However, this shift poses challenges, particularly in maintaining student motivation and engagement, as remote learning often limits direct interactions, reducing social presence—an essential element for effective learning experiences (Wulandari & Mustika, 2023). Low social interaction makes students feel less cared for or emotionally supported, affecting their sense of responsibility for the learning process (Collie, 2022). This is in line with the findings of (Yokoyama, 2019), who stated that low social interaction in online learning can reduce student motivation and engagement.

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Motivation and engagement are critical for digital and face-to-face learning (Sadikin & Hamidah, 2020; Valle et al., 2023). However, while previous studies have highlighted the detrimental impact of low social interaction on learning outcomes, there is a lack of comprehensive strategies specifically designed to address these issues in digital learning environments (Alamri & Tyler-Wood, 2017; Arroyo et al., 2017). Therefore, a deeper exploration of innovative and evidence-based strategies to overcome this challenge is needed to maintain and increase student motivation and engagement in online learning, bridging this critical gap in the literature. One promising approach involves three key factors: learning support, relevant content, and emotional connection. Learning support, characterized by effective teacher-student interactions, constructive feedback, and access to adequate resources, fosters an environment where students feel guided and empowered (Liu et al., 2023; Zariayufa et al., 2021). Relevant content—material aligned with students' needs, interests, and real-world applications—makes learning experiences more meaningful and engaging (Creţu, 2019). When combined with emotional support, these factors enhance students' motivation, foster a sense of belonging, and encourage active participation in the learning process.

Although many studies have addressed motivation and engagement in digital learning, the interaction between content, learning support, and motivation influencing students' learning outcomes has yet to be thoroughly explored. Most studies focus on the results of technology use without exploring how content relevance, learner support, and student motivation influence each other. For example, Li et al. (2024) found that digital literacy impacts student motivation but does not explain the interaction between teacher support and content relevance. Furthermore, Ilić et al. (2024) research on game-based digital learning positively impacts student motivation, but the mechanisms through which these elements interact still need further exploration. Soraya et al., (2023) also demonstrate that digital literacy affects learning outcomes through motivation but do not address the role of teacher support and content relevance in this context. Additionally, Azzahro et al. (2023) emphasize that digital literacy is related to students' cognitive learning outcomes but do not explore the interaction between teacher support and content relevance.

There are essential elements working together in digital learning, but the interaction between these factors has not been thoroughly understood. Recent studies have increasingly emphasized the importance of integrating various factors in digital learning to enhance students' learning outcomes. One of the most relevant aspects is learning motivation, which is influenced by digital literacy and other factors, such as teacher support and content relevance. For instance, Besonia et al. (2023) highlight that teacher feedback and creating a positive learning environment can significantly enhance student engagement. However, this study does not delve into how the interaction between teacher support and content relevance can synergistically improve student motivation, even though content relevance is crucial in capturing students' attention (Eden et al., 2024). Moreover, technology-based approaches, such as using AI in learning, have demonstrated significant potential in enhancing digital literacy and student motivation (Moybeka et al., 2023). However, this technology's effectiveness heavily relies on teachers' active involvement in providing appropriate guidance and feedback (Ratih & Kastuhandani, 2024). In other words, the success of technology in increasing content relevance can only be achieved if learning support is maintained at an optimal level. This underscores that technology and the role of teachers are not standalone elements but must complement each other to create an effective learning experience.

This study aims to explore the relationships between Relevant and Applicable Content (RAC), Learner Support (LS), and Academic Self-Efficacy (ASE). Specifically, this study investigates how ASE mediates the relationship between RAC and LS on Motivation and Engagement (ME). By integrating these factors, this study offers a comprehensive framework to understand the interaction of these variables within the context of digital learning. In digital learning environments, relevant and applicable content plays a crucial role in capturing students' attention and enhancing their engagement. Adequate learner support, such as effective interactions between educators and students and constructive feedback, can strengthen students' motivation and confidence in completing academic tasks. However, the role of Academic Self-Efficacy (ASE) as a significant mediator between RAC and LS on ME has not been widely studied, making this study a novel contribution to the development of both theory and practice in digital learning.

This study examines how RAC, LS, and ASE interact and provides insights into the mechanisms driving digital learning success. The findings are expected to offer practical guidance for educators and digital learning developers in designing more effective and inclusive learning experiences by focusing on student motivation and engagement. Within the context of the ongoing transformation in educational technology, the contributions of this study ensure that digital learning fulfils its potential to create meaningful, productive, and sustainable learning experiences. The problem formulation that will be discussed in this study is:

1. How does relevant and applicable content impact student motivation and engagement in digital learning?
2. How does learning support impact student motivation and engagement in digital learning?
3. What is the connection between Academic Self-Efficacy and student motivation and engagement in the context of digital learning?
4. Is Academic Self-Efficacy a mediating factor in the relationship between relevant and applicable content, learner support, and student motivation and engagement in the context of digital learning?

METHOD

Research Methodology

This study adopted a quantitative approach utilizing a cross-sectional design, gathering data from respondents at a single point in time to explore the relationships between variables within the framework of technology-driven digital learning (Creswell, 2012). This approach was chosen because it was suitable for exploring the causal relationship between variables, namely Learner Support and Relevant Applicable Content through Academic Self-Efficacy and its impact on Motivation and Engagement in a digital learning environment. This design allowed the researchers to get a clear picture of the relationship between these variables in one time period so that the results could provide insight into the conditions of digital learning at the time the data was collected.

The research process followed a structured sequence, as depicted in the flowchart in Figure 1. It started with variable measurement, data collection, validity and reliability testing, structural model analysis, and mediation evaluation.

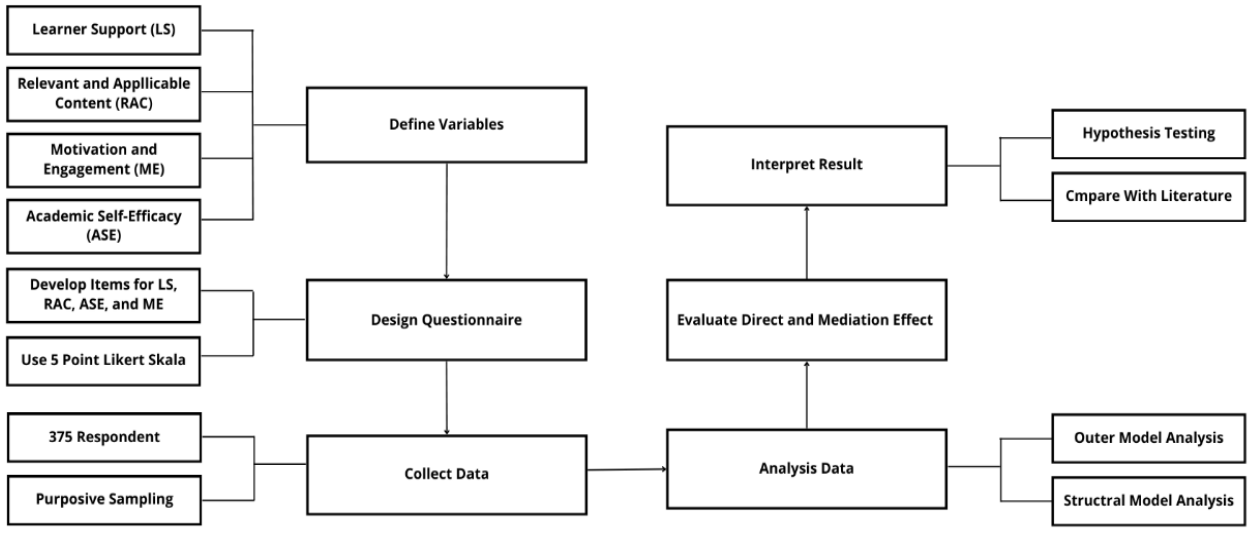

Figure 1. Flowchart of the Research Methodology

Data Collection Technique

The participants in this study consisted of students enrolled in technology-based learning programs at various higher education institutions in Indonesia, chosen for their diverse demographic composition and varying levels of technology adoption. This diversity provided a robust context for examining how students' experiences in technology-based learning environments shaped their motivation, engagement, and academic outcomes. The sample was selected using a purposive sampling technique, targeting students who actively used digital learning platforms and had substantial experience in technology-based learning (Zickar & Keith, 2023). Their familiarity with digital platforms offers significant insights into the relationships among variables, such as digital literacy, motivation, and learning outcomes**.** Several strategies were employed to address potential non-response bias. First, participants were reminded through multiple follow-ups via email and messaging platforms to encourage survey completion. Second, demographic characteristics, such as age, gender, and field of study, were compared between respondents and non-respondents to ensure the sample was representative.

The sample size for this study consisted of 375 respondents, determined based on the Structural Equation Modeling (SEM) approach, which requires a minimum of 5 to 10 times the number of indicators analyzed (Hair et al., 2019). This sample size ensured the statistical power needed to derive valid and reliable findings.

Instrument and Measures

This study employed a questionnaire as the primary instrument to gather data on the variables under investigation. The questionnaire utilized a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree) to facilitate respondents in evaluating each statement based on their perceptions. The use of a 5-point Likert scale was chosen for its simplicity and ease of understanding, particularly for the target population in the local context. Prior studies have shown that a 5-point scale reduces cognitive load for respondents, especially in non-Western settings, while yielding reliable and valid results (Dawes, 2008). However, it is acknowledged that alternative scales, such as a 7-point Likert scale, might offer greater sensitivity in capturing nuanced responses, which can be considered for future research.

This study includes four main variables consisting of two independent variables, namely Relevant and Applicable Content which refers to learning material that suits students' needs, interests or practical situations and can be directly applied in real life (Kumar et al., 2021). This variable is measured through five indicators (RAC1, RAC2, RAC3, RAC4, RAC5); Learner Support which refers to the support provided to students to help them succeed in learning (Rajabalee & Santally, 2021). This variable is measured through five indicators (LS1, LS2, LS3, L4, LS5). One mediating variable is Academic Self-Efficacy, which pertains to students' confidence in their ability to plan, perform, and finish academic tasks to accomplish their learning objectives (Meng & Zhang, 2023). This variable is measured through 5 indicators (ASE1, ASE2, ASE3, ASE4, ASE5). One dependent variable is Motivation and Engagement, which refers to students' internal drive to learn (motivation) and their active participation and attention in the learning process (Anyichie & Butler, 2023). This variable is measured through five indicators, namely (ME1, ME2, ME3, ME4, ME5).

While self-reported data provides valuable insights, potential limitations must be acknowledged. Responses may be influenced by social desirability bias, where participants provide answers they believe are favourable rather than reflective of their true perceptions. Additionally, recall bias may affect accuracy, particularly when reflecting on past learning experiences. Participants were assured of anonymity and confidentiality, and the questionnaire was designed to minimize leading or suggestive items.

Data Analysis

Structural Equation Modeling (SEM) with Partial Least Squares (PLS) was used for data analysis, implemented through SmartPLS version 3 software. This method was selected for its capability to assess the connections between unobservable latent variables and their measurable indicators (Cepeda-Carrion et al., 2019). The analysis procedure involves two key phases: assessing the measurement model (outer model) to verify the indicators' validity and reliability and

examining the structural model (inner model) to evaluate the strength of associations between latent constructs (Juliandi, 2018).

Outer Model

In Partial Least Squares Structural Equation Modeling (PLS-SEM) analysis, the evaluation of the outer model focuses on determining the validity and reliability of the indicators that represent the latent variables (Khalil et al., 2023). In this context, indicators refer to directly measurable variables, whereas latent variables represent concepts that cannot be directly measured (Hussain et al., 2018). Assessing the outer model includes examining convergent validity, discriminant validity, and the reliability of the constructs.

The convergent validity test was carried out to assess the extent to which the reflexive indicators can represent the construct (Romadhan et al., 2019). In PLS-SEM, convergent validity can be tested through several metrics: Factor Loading and Average Variance Extracted (AVE) (Lian et al., 2022). The loading factor measures the relationship between indicators and latent constructs (Mahuda, 2023). The loading factor considered to meet the criteria for convergent validity is a value > 0.7, indicating that the indicator has a significant contribution to the measured construct (Hananto, 2023). The Average Variance Extracted (AVE) represents the share of total variance in the indicators accounted for by the construct under evaluation. An AVE value exceeding 0.50 implies that the construct explains over 50% of the variance in its indicators (Teoh et al., 2022). Discriminant validity evaluates the extent to which different constructs are not highly correlated with each other (Afthanorhan et al., 2021). Discriminant validity is evaluated using the Fornell-Larcker Criterion, which mandates that the square root of a construct's AVE surpasses its correlations with all other constructs (Szakos et al., 2021).

Construct Reliability refers to the consistency and stability of construct measurements used in research (Amanda et al., 2020). In the PLS-SEM context, construct reliability can be measured through several metrics. Composite Reliability (CR) is employed to evaluate the internal consistency of the indicators that measure a construct (Judijanto et al., 2023). A Composite Reliability (CR) value exceeding 0.70 signifies the construct's reliability (Henseler et al., 2014). In addition, Cronbach's Alpha is utilized to assess a construct's internal consistency, namely the extent to which indicators in one construct cover each other consistently (Hu & Alsaqqaf, 2020). A Cronbach's Alpha value exceeding 0.7 signifies the construct's reliability (Varathan et al., 2023).

Inner Model

In Partial Least Squares Structural Equation Modeling (PLS-SEM) analysis, the inner model or structural model tests the relationship between latent constructs in accordance with the research hypothesis (Sciarelli et al., 2020). First, the coefficient of determination (R^2) is utilized to evaluate the extent to which independent variables predict dependent variables, with an R^2 value of 0.25 or higher regarded as relatively strong. Second, path coefficients were assessed to determine the strength and direction of the relationships between constructs, with significance indicated by a p-value less than 0.05. Effect size (f^2) is used as the third measure to determine the influence of each construct, with $f^2 > 0.02$ signifying a small effect, $f^2 > 0.15$ a moderate effect, and $f^2 > 0.35$ a substantial effect. Fourth, predictive relevance (Q^2) is evaluated to ensure predictive ability; Q2> 0 indicates predictive relevance (Sciarelli et al., 2020). The model proposed in this study describes the relationship between latent constructs, including independent and dependent variables, and mediating or moderating roles per the research hypothesis. Figure 2 represents the proposed model.

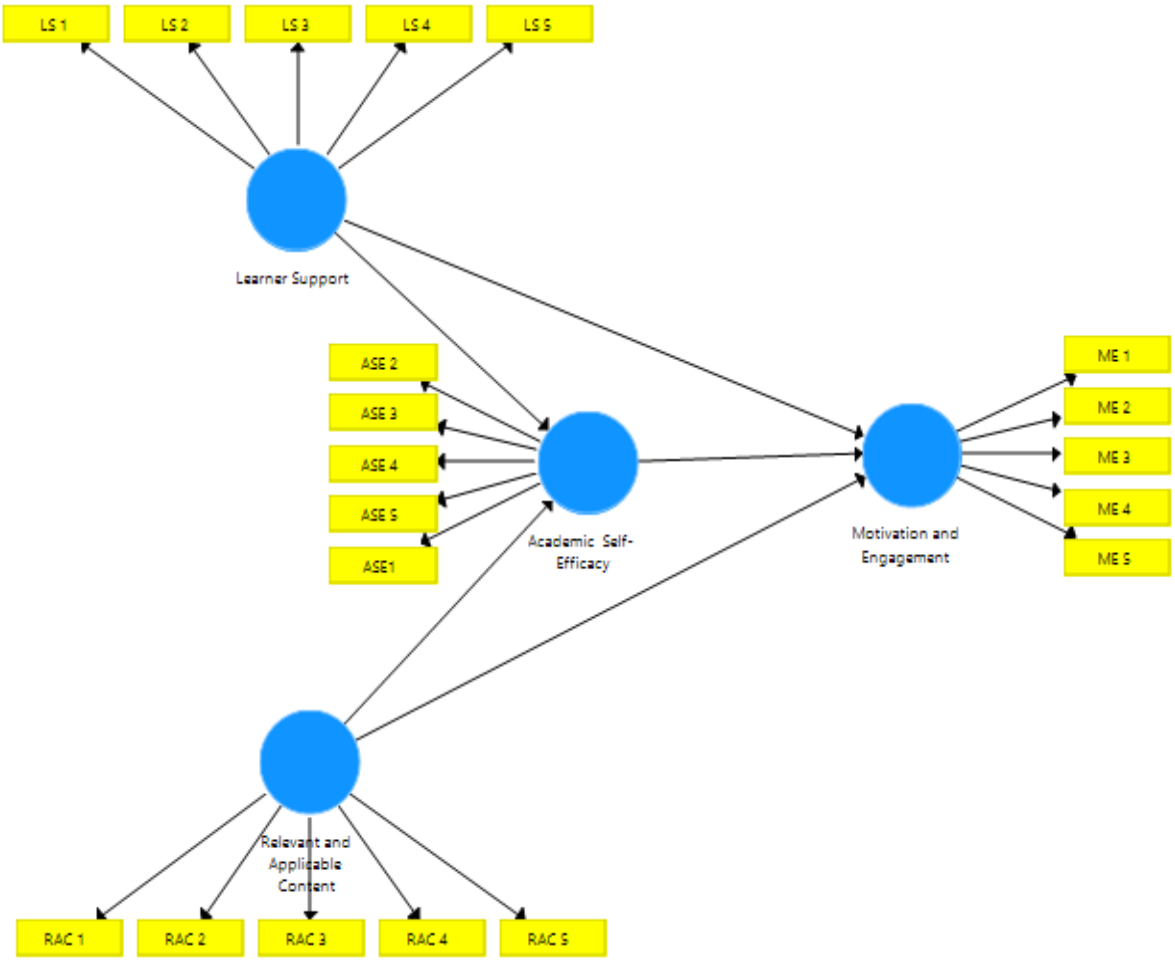

Figure 2. Model Proposed in This Study

Hypothesis:

H_1: Relevant and Applicable Content has a significant positive influence on Academic Self-Efficacy as well as on Motivation and Engagement

H_{1a}: Relevant and Applicable Content has a significant positive influence on Academic Self-Efficacy

H_{1b}: Relevant and Applicable Content has a significant positive influence on motivation and Engagement

H_2: Learner Support has a significant positive influence on Academic Self-Efficacy as well as on Motivation and Engagement

H_{2a}: Lerner Support has a significant positive influence on Academic Self-Efficacy

H_{2b}: Learner support has a significant positive influence on Motivation and Engagement

H_3: Academic Self-Efficacy has a significant positive influence on Motivation and Engagement

H_4: Academic Self-Efficacy mediates the effect of Learner Support as well as Relevant and Applicable Content on Motivation and Engagement

H_{4a}: Academic Self-Efficacy mediates the effect of Learner Support on Motivation and Engagement

H_{4b}: Academi Self-Efficacy mediates the effect of Relevant and Applicable Content on Motivation and Engagement

RESULTS AND DISCUSSION

The overall sample size for this study consisted of 375 respondents. The respondents' demographic information is summarized in the table below, which includes information regarding gender, age, semester, class year, study program, and level of digital technology skills.

Table1. Demographic Data of the Respondents

No.	Category	Description	Percentage (%)
1.	Gender	Male	50.7%
		Female	49.3%
2.	Age	17 Years	3.7%
		18 Years	4.3%
		19 Years	45.6%
		20 Years	18.7%
		21 Years	27.7%
3.	Class Year	2020	0.3%
		2021	0.5%
		2022	67.5%
		2023	31.7%
4.	Major	STEM	69.6%
		Non-STEM	30.4%
5.	Digital Technology Skills	Medium Level	61.6%
		Advanced Level	20.8%
		Less Advanced	13.3%
		Very Advanced	3.7%
		Not Proficient	0.5%

Based on Table 1, the respondents' participation in this study showed an almost balanced gender distribution. This distribution reflects a relatively equal gender representation, providing more inclusive and unbiased results. In terms of age, it indicates that the primary population of the study consisted of late adolescents to young adults, which aligned with the context of higher education. Most respondents indicated a focus on new or intermediate-level students who were actively involved in this study. Regarding majors, the dominance shows a stronger focus on populations with backgrounds in science, technology, engineering, and mathematics (STEM), which may be relevant to the research theme.

Regarding digital technology skills, it demonstrates that most respondents were quite familiar with digital technology, which likely supports active participation in technology-based studies. Overall, the profile of respondents reflected a relatively young, STEM-oriented group with medium to advanced levels of digital technology skills. However, the uneven distribution across academic years and majors could be a limitation in generalizing the findings to a broader population. This combination of characteristics provides relevant insights for understanding student engagement in the context of education increasingly supported by digital technology.

Outer Model

Convergent Validity and Construct Reliability

Table 2 presents the evaluation results for several latent constructs in the PLS-SEM model, including Learner Support (LS), Motivation and Engagement (ME), Academic Self-Efficacy (ASE), and Relevant and Applicable Content (RAC). Each construct is represented by a series of indicators, which are analyzed based on outer loadings, rho_A value, Composite Reliability (CR), and Average Variance Extracted (AVE).

Table 2. Convergent Validity and Construct Reliability Evaluation Results

Construct	Items	Outer Loadings	Cronbach's Alpha	Rho_A	Composite Reliability (CR)	Average Variance Extracted (AVE)
Relevant and Applicable Content	RAC1	0.825	0.881	0.884	0.913	0.678
	RAC2	0.821				
	RAC3	0.780				
	RAC4	0.844				

Construct	Items	Outer Loadings	Cronbach's Alpha	Rho_A	Composite Reliability (CR)	Average Variance Extracted (AVE)
	RAC5	0.846				
Learner Support	LS1	0.839	0.891	0.892	0.920	0.697
	LS2	0.828				
	LS3	0.823				
	LS4	0.844				
	LS5	0.841				
Academic Self-Efficacy	ASE1	0.822	0.902	0.904	0.928	0.720
	ASE2	0.857				
	ASE3	0.856				
	ASE4	0.885				
	ASE5	0.819				
Motivation and Engagement	ME1	0.818	0.877	0.878	0.911	0.671
	ME2	0.847				
	ME3	0.790				
	ME4	0.801				
	ME5	0.839				

The outer loading value for all indicators is less than 0.70, indicating a significant contribution to the respective constructs. In the RAC construct, the Cronbach's Alpha value is 0.881, the Composite Reliability (CR) is 0.913 (>0.7), and the Average Variance Extracted (AVE) is 0.678 (>0.5), indicating adequate internal reliability and convergent validity. The LS construct has a Cronbach's Alpha of 0.891, a CR of 0.920, and an AVE of 0.697, reflecting excellent reliability and validity. The ASE construct shows a Cronbach's Alpha value of 0.902, a CR of 0.928, and an AVE of 0.720, far exceeding the minimum criteria. Meanwhile, the ME construct has a Cronbach's Alpha of 0.877, a CR of 0.911, and an AVE of 0.671, also meeting the required criteria.

Validity and reliability testing is essential to ensure that the measurement instruments used in the study accurately and consistently capture the constructs under investigation. Validity confirms that the indicators effectively represent the underlying constructs, while reliability ensures consistency in responses across different participants and contexts. By meeting the established thresholds for outer loading values, Cronbach's Alpha, Composite Reliability, and AVE, the instruments used in this study are confirmed to be robust and trustworthy, providing a solid foundation for the interpretation of research findings. Overall, these results indicate that all instruments used in this study were valid and reliable, meeting the criteria suggested in the literature. According to Hair et al. (2019), outer loading values above 0.70, Cronbach's Alpha and Composite Reliability values exceeding 0.70, and AVE values greater than 0.50 reflect acceptable reliability and convergent validity levels in structural equation modelling.

Discriminant Validity

Table 3 presents the results of the discriminant validity test using the Fornell-Larcker Criterion in the PLS-SEM model. This table includes the four latent constructs tested, namely Learner Support (LS), Motivation and Engagement (ME), Academic Self-Efficacy (ASE), and Relevant and Applicable Content (RAC). In the table, each construct's square root of the Average Variance Extracted (AVE) is contrasted with its correlations with other constructs. The analysis results show that discriminant validity has been met, with each construct having a higher square root AVE value than the correlation between other constructs. The detailed results of discriminant validity testing, following the Fornell-Larcker Criteria, are outlined in Table 3.

Table 3. Results of the Fornell-Lacker Criterion Validity Test

	Academic Self-Efficacy	Learner Support	Motivation and Engagement	Relevant and Applicable Content
Academic Self-Efficacy	$\sqrt{AVE_{ASE}} = 0.720$			
Learner Support	0.699	$\sqrt{AVE_{LS}} = 0.833$		
Motivation and Engagement	0.766	0.798	$\sqrt{AVE_{ME}} = 0.819$	
Relevant and Applicable Content	0.770	0.779	0.804	$\sqrt{AVE_{RAC}} = 0.823$

The results of the discriminant validity test using the Fornell-Larcker Criterion show that all constructs in the model have good discriminant validity. Each latent construct, namely Academic Self-Efficacy (ASE), Learner Support (LS), Motivation and Engagement (ME), and Relevant and Applicable Content (RAC), has a square root value of AVE (Average Variance Extracted) that is greater than the correlation between constructs. Academic Self-Efficacy (ASE) has an AVE root of 0.720, which is greater than its correlation with other constructs (0.699, 0.766, and 0.770). Learner Support (LS) has an AVE root of 0.833, greater than the correlation with other constructs (0.699, 0.798, and 0.779). Motivation and Engagement (ME) has an AVE root of 0.819, greater than the correlation with other constructs (0.766, 0.798, and 0.804). Relevant and Applicable Content (RAC) has an AVE root of 0.823, greater than its correlation with other constructs (0.770, 0.779, and 0.804). These results confirm that each construct can be well-differentiated from the other constructs, meeting the requirements for discriminant validity in PLS-SEM analysis. Discriminant validity is essential in this context to ensure that each construct measures a distinct aspect of the research framework and is not overly influenced by other constructs. This validation provides confidence that the observed relationships among constructs reflect true theoretical associations rather than methodological overlaps or redundancy.

By establishing discriminant validity, the model demonstrates sufficient measurement quality to proceed with further analysis, which involves structural model evaluation within the PLS-SEM framework. This next stage focuses on examining the relationships among the latent constructs by assessing path coefficients, which indicate the strength and direction of hypothesized relationships. This analysis provides a thorough understanding of the integrity of the structural model and the dynamics between constructs within the research framework.

Inner Model

Table 4 presents the findings of hypothesis testing conducted through PLS-SEM analysis, offering insights into the relationships between latent constructs based on Path Coefficients, T-Statistics, and P-Values, as well as the final decision regarding the significance and positive direction of this relationship (Alianti et al., 2023).

Table 4. Result of Testing the Relationship between Latent Constructs

	Hypothesis	Path Coef	T Statistics	P Values	Decision
H1a	RAC -> ASE	0.572	8.788	0.000	Positive and Significant
H1b	RAC -> ME	0.307	5.048	0.000	Positive and Significant
H2a	LS -> ASE	0.254	3.664	0.000	Positive and Significant
H2b	LS -> ME	0.369	6.143	0.000	Positive and Significant
H3	ASE -> ME	0.271	5..153	0.000	Positive and Significant
H4a	LS -> ASE -> ME	0.069	2.851	0.005	Positive and Significant
H4b	RAC -> ASE -> ME	0.155	4.378	0.000	Positive and Significant

The hypothesis testing results obtained through PLS-SEM analysis indicate that all relationships in the model are positive and statistically significant. According to Table IV, the hypothesis test reveals that Relevant and Applicable Content (RAC) significantly and positively impacts Academic Self-Efficacy (ASE), with a path coefficient of 0.572, T-Statistics of 8.788, and P-Values of 0.000 (thus, H1a is accepted). These results show that relevant and applicable learning content significantly contributes to building students' self-confidence in their academic abilities. This is reinforced by research showing that well-designed content can increase student engagement and, in particular, increase their self-efficacy in learning. (Abdusakkir et al., 2023). Other research shows that good digital literacy enables more effective implementation of learning content in supporting the development of student self-efficacy (Muflihin & Makhshun, 2020). This aligns with other findings showing that self-efficacy significantly contributes to students' academic adjustment during courageous learning (Nisa et al., 2022). Research also shows that relevant and interesting content can increase students' self-efficacy, ultimately contributing to their learning experience. Independence and success (Valentin & Hadi, 2018). Thus, it can be concluded that relevant and applicable content significantly influences academic self-efficacy in digital learning. Increasing self-efficacy through appropriate content can help students achieve better academic achievements.

This study also found that Relevant and Applicable Content (RAC) positively influences Motivation and Engagement (ME) with a path coefficient of 0.307, T-Statistics 5.048, and P-Values 0.000 (H1b accepted). This shows students are more motivated and engaged when learning content aligns with their real-life experiences and future career aspirations. This finding is consistent with Hendriyani et al. (2022) who argue that when students perceive the content as directly applicable to their lives, their motivation to learn increases. Likewise, Alfiaturrohmaniah et al. (2022) highlight that adapting content to students' needs increases their interest and active participation in learning activities. By aligning learning content with students' interests and practical needs, educators can significantly increase student motivation, as confirmed by Fakhri et al. (2022) and Rachmavita (2020), reinforcing the importance of relevant content in encouraging student engagement. Thus, these results emphasize the importance of developing learning content that is relevant and based on student needs, especially in the context of digital learning.

Learning Support (LS) also plays an important role in increasing Academic Self Efficacy (ASE), with a path coefficient of 0.254, T-Statistics of 3.664, and P-Value of 0.000 (H2a accepted). These results indicate that various forms of support, such as instructor guidance, access to learning resources, and a conducive learning environment, increase students' confidence in their academic abilities. This is supported by Wei (2024), who highlights that teachers' emotional, cognitive and autonomous support positively influences students' academic self-efficacy. Apart from that, Naseer & Rafique (2021) also stated that peer and teacher support strengthens self-efficacy, increasing motivation and academic performance. Apart from support from teachers, support from peers also significantly influences academic self-efficacy. Research shows that positive interactions with peers can increase students' self-confidence in their academic abilities (Dogan et al., 2023). This is reinforced by research that says when students feel that they have a strong social support network, they are more likely to take risks in learning and face academic challenges, which increases their self-efficacy (Daemi et al., 2017). These results highlight the significance of developing a strong learning support system in supporting student academic success.

Further analysis reveals that Learner Support (LS) has a meaningful and statistically significant impact on Motivation and Engagement (ME), with a path coefficient of 0.369, T-Statistic of 6.143, and P-Value of 0.000 (H2b accepted). This underscores the important role that technical and emotional support plays in increasing student motivation and engagement. Research by Chaw & Tang (2023) shows that a strong support system fosters greater motivation and active participation in the learning process, which ultimately improves learning outcomes. When students feel that their instructors care and provide necessary support, they tend to actively participate in the learning process (Sharp, 2018). Other research also shows that support from teachers, such as constructive feedback, attention to student needs, and provision of adequate resources, has fostered greater student motivation in learning (Martin & Bolliger, 2018). This study supports these findings, emphasizing that providing accessible resources, responsive instructors, and an inclusive learning environment is critical in increasing student motivation and engagement.

The analysis also shows that Academic Self-Efficacy (ASE) influences Motivation and Engagement (ME) positively, with a path coefficient of 0.271, T-Statistics of 5.153, and P-Values of 0.000 (H3 is accepted). This shows that students' beliefs about their academic abilities directly influence their motivation to learn. This aligns with Akanni (2022), who found that students with strong self-efficacy are more motivated to participate actively in learning tasks and strive for academic achievement. Likewise, Shamdas (2023) contends that students with confidence in their abilities are more inclined to take the initiative in their studies and stay actively involved in academic activities. Students who have high self-efficacy tend to be more resilient and able to overcome difficulties, which contributes to increasing their motivation and engagement (İnce, 2023). This study highlights the importance of cultivating self-efficacy as a key component in increasing student motivation and engagement, especially in digital learning environments.

The test results further found that Learner Support (LS) demonstrated a strong and statistically significant impact on Motivation and Engagement (ME) through Academic Self-Efficacy (ASE), with a mediation effect of 0.069, T-Statistics 2.851, and P-Values 0.005 (H4a was accepted). In this context, the mediator, Academic Self-Efficacy (ASE), plays a critical role in elucidating the underlying mechanism through which Learner Support (LS) influences Motivation and Engagement (ME). The mediating effect indicates that LS indirectly affects ME by first enhancing ASE, which subsequently drives motivation and engagement. This reveals that while LS directly contributes to ME, its impact is amplified when students develop higher confidence in their academic abilities, as ASE represents. These results indicate that the learning support provided not only has a direct impact on students' motivation and engagement but also has an influence through increasing their self-efficacy. This is supported by research showing that the support students receive contributes to increased self-efficacy, which positively impacts their motivation and engagement in the learning process (Wu et al., 2020). When students perceive adequate support, they tend to have greater confidence in their ability to succeed in academic tasks, which subsequently enhances their motivation to actively participate in learning (Portento et al., 2022). Furthermore, Liu et al. (2023) found that self-efficacy acts as a strong mediator between learning support and student motivation, where students who feel supported tend to have higher self-efficacy and are more involved in the learning process. These results highlight the critical role of developing a well-structured and consistent learning support system, as it enhances students' self-efficacy, thereby indirectly boosting their motivation and engagement.

Finally, it was found that Academic Self-Efficacy (ASE) succeeded in mediating Relevant and Applicable Content (RAC) on Motivation and Engagement (ME) positively and significantly with a mediation effect of 0.155, T-Statistics 4.378, and P-Values 0.000 (H4b accepted). These results indicate that relevant and applicable learning content not only directly increases students' motivation and engagement but also provides an indirect influence by increasing their self-efficacy. This is supported by research that says when students feel that they can relate what they are learning to their life experiences, their self-efficacy tends to increase, which in turn increases motivation to engage more deeply in the learning process (Wang et al., 2023). Other research also shows that positive interactions with teachers and peers can increase students' self-confidence, making them more motivated to participate actively in academic activities (Assante & Lişman, 2023). Besonia et al. (2023) also confirm that content relevance strengthens self-efficacy, fostering increased learning participation. This study highlights the importance of creating content that aligns with students' experiences and needs, as it enhances their self-efficacy and encourages deeper engagement with the learning material.

The results and discussion of this study provide significant findings regarding technology-based digital learning, particularly in the context of how learning support, material relevance, and student motivation are interconnected through academic self-efficacy. However, it should be noted that this study has several limitations that may affect the generalizability of the results. First, this study focuses on technology-based learning in higher education, so the results may not fully apply to other digital learning contexts, such as distance learning at the secondary school level. This study did not delve deeper into individual differences in response to learning support and relevant materials. For example, demographic characteristics or personal factors, such as age and academic background, influence the relationship between these variables. Lastly, although this study uses a mediation model to examine the role of Academic Self-Efficacy, this study has not discussed in

depth other factors that can mediate the relationship between the main variables, such as students' anxiety levels or other emotional factors, which are likely to influence motivation and their involvement in digital learning.

LIMITATIONS

Several limitations in this study need to be addressed. First, the data were collected from a single population of students enrolled in technology-based learning programs at higher education institutions. This limits the generalizability of the findings to other regions or educational contexts, such as secondary or vocational education. Second, the study employed a cross-sectional design, restricting the ability to conclude causal relationships or variable changes over time. Additionally, the study did not thoroughly explore individual differences in responses to learning support and relevant materials. For example, demographic characteristics or personal factors such as age and academic background may influence the relationships between the variables examined. Lastly, although the study utilized a mediation model to investigate the role of Academic Self-Efficacy, other factors that may potentially act as mediators or moderators, such as students' anxiety levels or other emotional factors, have not been analyzed. These factors will likely influence students' motivation and engagement in digital learning.

CONCLUSION

In conclusion, this study highlights the significant role of Relevant and Applicable Content (RAC) and Learner Support (LS) in shaping Motivation and Engagement (ME) through the mediating effect of Academic Self-Efficacy (ASE) within digital learning environments, particularly in higher education. The findings demonstrate that ASE serves as a critical bridge, amplifying the influence of RAC and LS on ME. Specifically, relevant content and effective learner support directly enhance motivation and engagement and indirectly increase students' confidence in their ability to succeed academically. For practitioners, this study underscores the need to design digital learning programs that prioritize developing meaningful content and structured support systems. For policymakers, investments in teacher training and the provision of digital tools are essential to foster self-efficacy and engagement among learners. Future digital learning strategies should integrate these findings to create evidence-based programs that drive student motivation, engagement, and improved learning outcomes. Future research should adopt longitudinal designs to explore how RAC, LS, and ASE evolve in influencing ME. Additionally, mixed-method approaches can provide deeper insights into how demographic, technological, or contextual factors interact with these variables. Such studies would help refine strategies for improving digital learning effectiveness and learner outcomes.

AUTHOR CONTRIBUTIONS

NA led the conceptualization, methodology development, and initial manuscript preparation. AW contributed to supporting methodology development and providing feedback for refining the research. MA played a key role in methodology development, investigation, resource provision, and the combined tasks of formal analysis, data analysis, and data visualization. WHM assisted in the investigation and interpretation of results. S provided resources and contributed to the oversight of the research process. S was responsible for overall supervision, manuscript review and editing, and providing strategic input for the conclusion section. All authors have read and approved the final manuscript.

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