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The Influence of ChatGPT Usage, Learning Content, and Digital Competence on Biology Students' Learning Motivation in the Digital Education Era: A Moderated Effect Analysis Model

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The Moderating Role of Digital Competence Effects Using ChatGPT and Learning Content on Students' Learning Motivation in Aceh

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Abstract

This study aims to analyze the impact of ChatGPT usage, learning content, and digital competence on students' learning motivation. A total of 366 respondents were obtained through stratified random sampling to ensure proportional representation across different student groups. Data were collected using a structured questionnaire measured on a Likert scale, and the study employs a Structural Equation Modeling (SEM) approach using Smart PLS to evaluate both the measurement model (validity and reliability) and the structural relationships among variables, including moderating effects. The results indicate that ChatGPT usage has a significant positive effect on students' learning motivation, confirming its role as an innovative learning support tool. However, its impact on digital competence is not statistically strong, suggesting that mere exposure to ChatGPT does not automatically enhance students' digital skills without guided use. Additionally, learning content has a significant and positive influence on both digital competence and learning motivation, indicating that relevant, interactive, and well-structured content is a critical driver of both skill development and student engagement. The analysis of moderating effects reveals that the interaction between ChatGPT usage and learning motivation is statistically significant, highlighting that the effectiveness of ChatGPT depends on how it is utilized within the learning process. Furthermore, digital competence significantly moderates the relationship between learning content and learning motivation, implying that students with higher digital competence are more capable of maximizing the benefits of high-quality learning content, thereby increasing their motivation. These findings highlight the important role of ChatGPT and well-designed learning content in enhancing students' learning motivation. Moreover, digital competence serves as a key moderating factor that strengthens the relationship between learning content and motivation. The study also confirms the robustness of the model through satisfactory goodness-of-fit indicators and substantial explanatory power, indicating that the proposed variables meaningfully explain variations in learning motivation.

Keywords: ChatGPT, learning motivation, digital competence, learning content, moderating effects.

1. Background of study

The incorporation of digital technologies into education has intensified markedly, especially with the rise of ChatGPT. In academic environments, ChatGPT serves as a powerful tool for personalized learning by facilitating students' comprehension of course materials, addressing their questions in real time, and providing instant, targeted feedback. Its multifaceted capabilities underscore a significant potential to improve learning outcomes when strategically embedded within well-designed pedagogical frameworks (Babu et al., 2021). ChatGPT has been widely adopted by students as a versatile tool to enhance their learning processes. Its use extends from supporting homework completion and academic assignments to facilitating the understanding of complex concepts and stimulating ideas for essay writing. The intensity, frequency, and manner of its use differ substantially across learners, shaped by individual needs and specific educational contexts. Therefore, a systematic examination of both the patterns and frequency of ChatGPT usage is essential to critically assess its overall influence on students' learning outcomes and cognitive development.

Students' interaction with learning materials through ChatGPT can provide valuable insights into the quality and intensity of their learning (Gamage et al., 2023). ChatGPT can assist students in finding additional resources, explaining complex material, and providing guidance in research projects (Purnama, Edi, Syahrul, et al., 2023). The quality of these interactions can significantly influence how effectively students utilize ChatGPT to achieve their learning goals. Optimal use of this technology can help improve students' understanding of learning materials and enable them to engage more actively in the learning process (Kumi-Yeboah et al., 2020). By offering tailored feedback and resources, ChatGPT can cater to individual learning styles and paces, promoting a more personalized and effective learning experience. A crucial factor is in determining how well they can utilize ChatGPT and other digital technologies for learning (Tiwari et al., 2024).

Students' levels of digital competence vary considerably, directly shaping how effectively ChatGPT functions as a learning support tool. Learners with advanced digital literacy are more capable of leveraging ChatGPT in a strategic, efficient, and academically meaningful manner. In contrast, those with limited technological proficiency may struggle to utilize its features optimally and therefore require targeted guidance or training to fully realize the educational benefits offered by this technology. This aspect highlights the importance of digital literacy programs that can equip students with the necessary skills to navigate and leverage digital tools effectively in their educational journey (Detlor et al., 2022)

In the context of using ChatGPT, learning motivation as a key factor influencing students on the academic success (Mega Hapsary et al., 2020). it is important to assess how this tool affects students' learning motivation. Learning motivation can be intrinsic, driven by an internal passion for the subject, or extrinsic, motivated by external factors such as grades or rewards (Morris et al., 2022, Akhyar et al., 2025). research aims to contribute to the broader discourse on the integration of technology in education.

While prior research has demonstrated the potential benefits of ChatGPT in education such as assisting with homework, clarifying complex concepts, inspiring writing, and facilitating research several important gaps remain (Deogaonkar, 2025; Ou et al., 2026; Sariakin et al., 2025). First, most studies have focused on descriptive accounts of the technology's capabilities rather

than empirically examining its impact on student learning outcomes, particularly learning motivation. Second, there is limited understanding of how variations in ChatGPT usage including frequency, duration, and type of interaction affect students' motivation to learn. Third, the role of digital competence in moderating the effectiveness of ChatGPT has not been systematically investigated. While it is assumed that digitally skilled students may use ChatGPT more effectively, there is little evidence on how differences in digital literacy influence motivational outcomes (Afzaal et al., 2025; Sariakin et al., 2023). prior studies often overlook contextual factors such as the students' learning environment, study discipline, and individual learning styles, which may affect how AI tools contribute to motivation (Purnamasari, 2023).

Thus, the existing literature provides limited guidance for educators and policymakers on how to integrate ChatGPT in ways that actively enhance students' motivation to learn, and under what conditions its use is most effective Addressing these gaps is crucial for leveraging AI tools in education to not just assist in learning, but also to foster engagement, autonomy, and intrinsic motivation among students.

1.1 Research Problems

1. To assess whether integrating ChatGPT into educational practices affects students' abilities to use digital tools and their motivation to learn.
2. To investigate the impact of different types of learning content on students' digital skills and their motivation to engage in learning activities.
3. To explore if students' digital competence influences their motivation to learn.
4. To determine if students' level of digital competence influences the effect of ChatGPT and learning content on their digital skills.

1.2 The Objective of Study

In this study, the objective of study that will be tested through the analysis of influence are as follows

1. Does the use of ChatGPT have a significant impact on students' digital competence and learning motivation?
2. How does the use of learning content affect students' digital competence and learning motivation?
3. Does digital competence affect students' learning motivation?
4. Does students' digital competence moderate the impact of using ChatGPT and learning content on their digital competence?

2. LITERATURE REVIEW

2.1 The role of ChatGPT in education

The integration of ChatGPT into education has fundamentally reshaped modern learning environments by improving accessibility, enabling personalized learning, and increasing instructional efficiency (Rasul et al., 2023). As an artificial intelligence–based conversational tool, ChatGPT supports students through individualized learning experiences, enabling them to receive immediate explanations, feedback, and guidance tailored to their level of understanding (Jiang & Hyland, 2025). Furthermore, ChatGPT supports educators in developing instructional materials,

designing assessments, and streamlining administrative tasks, enabling greater focus on meaningful pedagogical engagement. In academic writing, it enhances students' ability to organize ideas, refine language, and comprehend scholarly structures more effectively.

Moreover, its interactive and multilingual capabilities foster inclusive and engaging learning environments across diverse educational settings. However, Atlas, (2023) emphasizes that the use of ChatGPT also introduces critical challenges, including risks to academic integrity, potential over-reliance, and the necessity for careful evaluation of AI-generated content. Accordingly, its role in education should be framed as a complementary support tool that enhances rather than replaces the essential role of educators in fostering meaningful learning experiences.

The use of interactive digital tools, such as ChatGPT, underscores the importance of technology in both academic and practical contexts. Studies highlight the value of integrating AI-supported resources into education, fostering deeper engagement, personalized learning experiences, and a greater appreciation for the relevance of the content. Jeronen et al., (2017) emphasize that linking learning content to real-world challenges and practical applications strengthens student engagement by highlighting the relevance of academic study. In digital education contexts, tools such as ChatGPT can reinforce this connection by offering interactive and personalized learning experiences, enabling students to recognize the immediate value of what they learn.

Moreover, educational programs that incorporate experiential learning such as fieldwork and direct interaction with natural environments have shown significant benefits (Maskall, J., 2008). These approaches deepen students' understanding and foster a connection to the material, bridging theoretical knowledge with practical application. By engaging with digital learning tools and interactive content, students develop a greater appreciation for the complexity and relevance of the material, reinforcing their motivation to learn and apply knowledge in diverse academic and real-world contexts.

In this evolving educational landscape, AI tools like ChatGPT are increasingly recognized for their ability to complement traditional learning methods (Andleeb et al., 2023; Yu, 2023). By providing instant access to information, fostering interactive exploration, and offering personalized support, these tools have the potential to transform education. However, their effectiveness hinges on thoughtful integration into curricula that emphasize hands-on learning and the broader context of nature, ensuring a balanced and holistic approach to education.

The use of ChatGPT in educational contexts has garnered significant attention due to its ability to provide personalized and responsive learning assistance (Zhang & Tur, 2024). As an AI-based language model, ChatGPT can offer substantial support in various aspects of the learning process. Božić & Poola, (2023) stated that ChatGPT functions as an interactive tool that can answer questions, explain concepts, and support students in completing academic tasks. Through rapid, relevant, and personalized feedback, it enhances individualized learning experiences, while also promoting innovative learning approaches by providing supplementary materials, clarifying complex topics, and assisting with assignments. Aithal & Aithal, (2023) In his research indicated that interaction with AI-based tools like ChatGPT can enhance student engagement with learning materials by offering easy access to resources and additional information

Furthermore, Qawqzeh, (2024) mentioned ChatGPT can help develop problem-solving and critical thinking skills by providing detailed solutions and explanations to questions or problems faced by students. However, the integration of ChatGPT into learning also faces challenges. One major issue is ensuring the accuracy and relevance of the information provided by this AI system. Leng, (2024) pointed that ChatGPT does not always possess the most up-to-date knowledge or the specific context required to answer questions accurately. Therefore, it is crucial to use ChatGPT as a supplementary tool rather than a replacement for human interaction with teachers or more in-depth academic materials.

Some studies suggest that students might become overly reliant on this technology and practice basic skills like independent research and problem-solving less frequently (Cindy E. Hmelo-Silver, 2004). To address this Issues, it is important to implement balanced learning strategies where ChatGPT supports the learning process without replacing the active role of students in their education. The use of ChatGPT in education offers significant potential to enhance the learning experience by providing adaptive and responsive support. However, effective utilization requires attention to the accuracy of information and a balance between technology use and active student engagement in the learning process. Further research is needed to evaluate the long-term impact of ChatGPT use in educational contexts and to identify best practices for its integration.

2.2 Digital competence frameworks

Digital competence refers to the skills required to effectively use digital technology in the learning process (Balyk et al., 2020). It includes not only technical proficiency but also the ability to evaluate and apply digital information. As education becomes increasingly technology-driven, these capabilities are essential for accessing knowledge, engaging with peers, and adapting to evolving digital environments. This area highlights various aspects of digital competence that are important in modern education. Digital competence includes basic skills such as online information searches, using application software, and understanding and interacting with digital learning platforms (Pinto & Leite, 2020). According to Annarelli et al., (2021) digital competence not only involves the use of technological tools but also the ability to critically evaluate and utilize the information obtained.

Monteiro & Leite, (2021) identify that students' digital skills include the ability to use various digital tools such as educational applications, learning management systems, and digital communication tools. Good digital competence is associated with academic success and student engagement in learning (Avcı & Ergün, 2022). Digital literacy, which includes understanding how technology works and how it can be used effectively, plays a crucial role in the learning process (Liu et al., 2020). Several studies show that students with strong digital skills can more easily access information, collaborate with peers, and adapt to various technologies used in education. These skills also allow students to leverage digital resources to delve deeper into subject matter and enhance their learning experiences.

Several factors shape students' digital competence, including their educational background, access to technological resources, and the extent of training they have received (Cabero-Almenara et al., 2022). Access to adequate technological devices and internet connections are key factors in enhancing students' digital skills(Manco-Chavez et al., 2020). Additionally, training and

educational programs designed to improve students' digital skills also contribute to their ability to use technology effectively (Bernacki et al., 2002). According to research by Bernacki et al., (2020) students with good digital skills tend to be more motivated to learn and more effective in completing academic tasks involving technology. Good digital skills can enhance students' learning experiences and improve their ability to access and use technology to support learning (Pinto & Leite, 2020).

Furthermore, digital competence encompasses not just technical skills but also the cognitive and socio-emotional skills required to navigate the digital landscape effectively (Hasse et al., 2020). Bongomin et al., (2020) stated that Students need to be proficient in critical thinking, problem-solving, and ethical understanding when interacting with digital content. Therefore, educators must prioritize the development of digital competence alongside technical skills. The rapid pace of technological advancement demands continuous learning and adaptability, requiring students to become lifelong learners capable of integrating emerging technologies into their academic and professional lives. Consequently, educational institutions should provide sustained training and adequate resources to ensure students remain current with ongoing digital developments (Qureshi et al., 2021). The role of educators is pivotal in developing students' digital capabilities. (Fitria & Suminah, 2020) argued that educators must be proficient in digital literacy and serve as role models for their students. Professional development programs should be in place to equip educators with the necessary skills and knowledge to integrate technology effectively into their teaching practices.

2.3 Influence on Learning Motivation

Theories of Intrinsic and Extrinsic Motivation, as well as Attribution Theory, explain how internal factors and students' perceptions influence their motivation (Morris et al., 2022; Ryan & Deci, 2020a). The Theory of Intrinsic and Extrinsic Motivation, Leo et al., (2022) emphasizes the importance of psychological needs such as autonomy, competence, and relatedness in motivating students. The learning environment and social support also play significant roles in influencing students' learning motivation (Meşe et al., 2019). A positive learning environment, where students feel valued and supported, can enhance their motivation to actively participate in the learning process (Oyserman & Dawson, 2021). Support from teachers, family, and peers contributes to students' extrinsic motivation, helping them feel more motivated to achieve their academic goals. Students' learning motivation significantly impacts their academic performance (Rafiola et al., 2020). These studies indicate that students with strong intrinsic motivation demonstrate higher academic performance and deeper engagement in learning than those driven primarily by extrinsic factors. Understanding these dynamics is crucial for designing effective interventions that enhance both student motivation and overall learning outcomes.

Students' learning motivation is a crucial factor that influences their level of engagement and academic achievement (Raza et al., 2020). Motivation can be divided into two main categories: intrinsic and extrinsic (Ramalingam & Kee Jiar, 2022). Intrinsic motivation comes from internal drives within students, such as curiosity, personal interest, and the satisfaction gained from the learning process itself (Ramalingam & Jiar, 2022). Students who are intrinsically motivated typically engage more deeply in learning activities because they find fulfillment and meaning in the subject matter, not just because of external rewards (Ryan & Deci, 2020b).

In contrast, extrinsic motivation involves external factors such as rewards, praise, or demands from parents and teachers (Togay et al., 2022). External factors can motivate students to work harder and achieve specific goals, such as earning high grades or gaining recognition. However, although extrinsic motivation can stimulate learning behavior, it is generally less effective than intrinsic motivation in fostering deep and sustained engagement.

2.4 Learning motivation theories

Learning content is a core component of education, representing the material students engage with, interact with, and apply throughout the learning process. Its quality, relevance, and presentation play a critical role in shaping students' motivation, influencing both their intrinsic interest and extrinsic engagement with academic tasks (Filgona et al., 2020). The quality and structure of this content directly influence learning outcomes and student engagement. Technological advancements, integrating tools like ChatGPT into education offers new ways to enhance the quality of content and student interaction with learning materials. Learning content involves information, concepts, and skills conveyed in the educational process (Chew & Cerbin, 2021). ChatGPT can play a crucial role in enriching learning content by providing additional explanations, answering students' questions, and offering relevant resources tailored to their individual needs (Rasul et al., 2023). By supporting personalized learning and adaptive engagement, ChatGPT helps students interact more deeply with the material, which can enhance understanding, foster curiosity, and strengthen learning motivation.

High-quality content promotes student understanding and more active engagement (Kim et al., 2021). ChatGPT can enhance the quality of learning content by providing dynamic and adaptive interactions (Baskara, 2023). ChatGPT helps maintain the relevance and connection of content to students' levels of understanding (Chinonso et al., 2023). Furthermore, he stated that Integrating technology into education allows for the delivery of more diverse and interactive content. As an AI-based tool, ChatGPT can complement other educational technologies by providing deep, real-time interactions. ChatGPT can facilitate learning by explaining complex concepts, providing practice problems, and directing students to additional resources, thereby enhancing the dynamics and variety in content delivery (Li, 2024). Regular content updates are essential to ensure that material remains relevant and accurate (Javed et al., 2021). ChatGPT can assist educators by identifying areas where students struggle and suggesting updates to learning materials based on interaction feedback.

ChatGPT provides opportunities for in-depth exploration of material and offers immediate feedback, helping students feel more engaged and motivated in the learning process (Aktay et al., 2023) Personalized content through interactions with ChatGPT can encourage students to invest more deeply in their learning and achieve better outcomes. By integrating ChatGPT, learning content becomes not only more adaptive and responsive to students' needs but also more dynamic and interactive. This supports better academic achievement and enhances the overall learning experience for students.

2.5 Operational Variables

Independent Variable: Use of ChatGPT

The use of ChatGPT in the learning context is defined through three main dimensions: frequency, duration, and manner of use by students. The frequency refers to how often students use the ChatGPT within a week, while duration indicates the total time spent in each usage session.

Manner of use includes various types of activities performed by students, such as answering questions, assisting with assignments, and seeking explanations for learning concepts. Measurement is conducted by counting the number of usage sessions per week, the time spent per session, and the types of activities performed. This approach provides a comprehensive overview of ChatGPT usage and enables further analysis of its impact on student learning motivation.

Independent Variable: Learning Content

Learning content in this study is operationalized as the quality and intensity of students' interactions with instructional materials facilitated by ChatGPT. *Interaction quality* refers to the extent to which these interactions support higher-order learning processes, including conceptual understanding, clarification of complex material, critical thinking, and application of knowledge. *Interaction intensity* refers to the frequency and duration of students' engagement with learning materials through ChatGPT.

Moderator Variable: Students' Digital Competence

Students' digital competence in this study is defined as the level of students' proficiency in using digital technology for the learning process. Measurement of this variable is done through scores on tests or questionnaires that evaluate students' digital skills, including their ability to search for information online, use digital learning tools, and interact with learning platforms. By measuring these digital skills, the study can explore how students' digital competence moderates the impact of ChatGPT usage and learning content on their learning motivation.

Dependent Variable: Student Learning Motivation

Student learning motivation in this study is defined as the level of students' desire and enthusiasm in the learning process, encompassing both intrinsic and extrinsic motivation. This variable is measured through scores on a learning motivation questionnaire that assesses several key aspects, including students' interest in the learning material, the effort they put into studying, and their drive to achieve academic success.

By measuring these three aspects, the study aimed to evaluate the extent to which factors such as the use of ChatGPT and the quality of learning content influence students' learning motivation, from both internal and external perspectives.

2.6 Hypothesis Development

The hypotheses of this research are formulated based on the research problem and aim to empirically test the relationships between ChatGPT usage, learning content, learning motivation, and the moderating role of digital competence. Drawing from existing literature on digital learning, AI-assisted education, and motivation theories, the following hypotheses are proposed:

- **H1a:** Using ChatGPT has a positive and significant effect on students' digital competence.
- **H1b:** Learning content has a positive and significant effect on students' digital competence.
- **H2a:** Using ChatGPT has a positive and significant effect on students' learning motivation.
- **H2b:** Learning content has a positive and significant effect on students' learning motivation.

- **H3:** Digital competence has a positive and significant effect on students' learning motivation.

- **H4a:** Digital competence moderates the effect of ChatGPT usage on students' learning motivation.
- **H4b:** Digital competence moderates the effect of learning content on students' learning motivation.

2.6 Research Framework

The framework of this research can be illustrated as follows in Figure 1

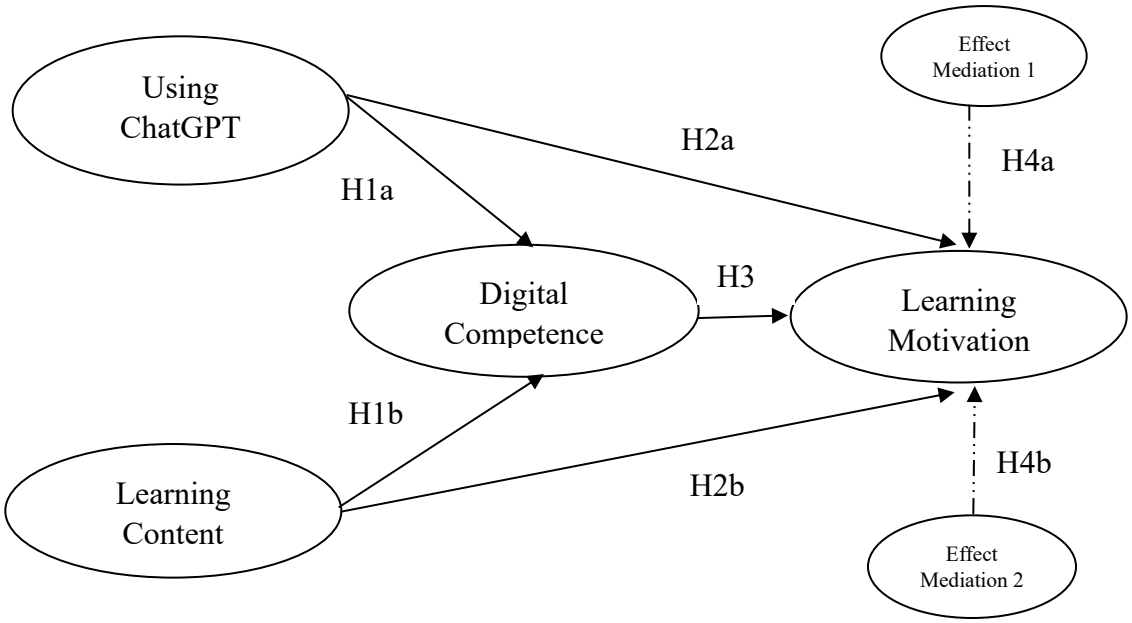


Figure 1. Research Framework

Information

——————— : Direct Effect

– · – · – · – · – : Moderation Effect

3. RESEARCH METHOD

This study employed a quantitative research design to investigate the influence of ChatGPT usage, learning content, and digital competence on student learning motivation by employing SEM-PLS, the study attains reliable statistical power to evaluate complex relationships among variables (Hair, Joseph F. Hair, et al., 2021). Furthermore, a structured questionnaire was utilized to obtain standardized numerical data, enabling hypothesis testing and the examination of moderating relationships among the variables. Given the study's emphasis on digital competence and the effects of instructional materials, the quantitative approach was selected because of its capacity to support systematic hypothesis testing and the exploration of complex causal and moderating relationships using numerical evidence.

3.1 Measurement Instruments

The study employed a structured questionnaire to measure four principal constructs: ChatGPT usage, learning content, digital competence, and learning motivation. The instrument was developed through a rigorous, multi-stage process to ensure clarity, validity, and reliability. Initially, a comprehensive review of prior literature was conducted to identify relevant theoretical frameworks and previously validated measurement scales. Based on this review, several items were adapted from established instruments, while others were newly developed to reflect the specific context of digital learning and ChatGPT use. All items were then refined to ensure conceptual alignment and contextual relevance.

The questionnaire consisted of multiple indicators for each construct. ChatGPT usage (X1.1–X1.4) captured students' frequency, duration, and patterns of use for academic purposes. Learning content (X2.1–X2.4) assessed students' perceptions of the clarity, relevance, and engagement level of instructional materials. Digital competence (X3.1–X3.5) evaluated students' technical and cognitive skills in using digital tools, navigating online learning platforms, and critically evaluating information sources. Learning motivation (X4.1–X4.4) measured both intrinsic and extrinsic motivational dimensions within digital learning environments. All items were rated using a Likert scale to capture the intensity of respondents' perceptions.

To ensure content validity, the initial questionnaire draft was reviewed by subject-matter experts in education and educational technology, who evaluated the relevance, clarity, and representativeness of each item. Following this, a pilot study was conducted with a subset of respondents to identify potential ambiguities and improve item wording. Construct validity was assessed using factor analysis to confirm that each item loaded appropriately onto its intended construct. Reliability was evaluated using internal consistency measures, such as Cronbach's alpha, to ensure that all constructs met acceptable thresholds.

All items were measured using a 5-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. The questionnaire was pilot-tested to ensure clarity, reliability, and validity, with Cronbach's Alpha (CA) values exceeding 0.70 for all constructs, indicating satisfactory internal consistency (Afthanorhan et al., 2020; Hair, et al., 2021). Furthermore, construct validity and reliability were reinforced through Average Variance Extracted (AVE) and Composite Reliability (CR) assessments, According to Hair et al. (2022, Jr et al., 2021), a widely recognized reference in PLS-SEM analysis, the Average Variance Extracted (AVE) is used to assess convergent validity, with a minimum acceptable threshold of 0.50. This indicates that the latent construct should explain at least 50% of the variance of its indicators to be considered adequate, thereby confirming acceptable convergent validity in the measurement model. where AVE values above 0.50 confirmed convergent validity and CR values above 0.70 demonstrated strong construct reliability. These results confirm that the instrument is both consistent and suitable for data collection.

3.2 Research Population

The research population consisted of undergraduate students at Universitas Syiah Kuala, focusing on the Faculty of Teacher Training and Education. Students in semesters 4 to 8 were specifically targeted, as they were considered to have the necessary academic maturity and sufficient experience with both university-level learning and technology integration. This population was chosen because it reflects learners actively engaged in digital-based education, thus making them relevant subjects for investigating the role of ChatGPT in shaping motivation.

A total of 366 respondents were obtained through stratified random sampling. In the methods section, stratified random sampling should be explained as follows: the study population was first divided into relevant subgroups (strata) based on predetermined characteristics such as gender, academic year, or field of study. This step ensured that each subgroup was adequately represented in the sample. After categorizing the population into strata, a random sampling technique was applied within each subgroup to select participants. The number of samples drawn from each stratum was determined proportionally to its size in the population to maintain representativeness. This approach was employed to enhance the accuracy and generalizability of the findings by ensuring balanced representation across key population segments

This technique was selected to ensure representation across diverse majors within the faculty, thereby reducing sampling bias and increasing the credibility of the results. The sample size exceeded the minimum requirement of 200 cases for SEM-PLS ensuring robust statistical power (Hair, Joseph F. Hair, et al., 2021). Furthermore, stratification enhanced proportional representation, thereby improving the reliability of findings and their applicability across the faculty.

3.3 Data Collection Techniques

The primary instrument was a structured questionnaire with items measured using a four-point Likert scale. The questionnaire addressed ChatGPT usage (frequency, duration, and mode), digital competence (technological skills and confidence), and learning motivation. To minimize single-source bias, triangulation was employed through classroom observations and the review of relevant secondary data, such as academic reports and institutional records.

3.4 Data Analysis Techniques

Data were analyzed using Structural Equation Modeling with Partial Least Squares (SEM-PLS) in SmartPLS. This technique was chosen because it is particularly effective for testing predictive models with complex relationships, including moderation effects, and is suitable for studies with moderate sample sizes. Descriptive statistics were applied to summarize respondent characteristics, while bootstrapping (5,000 resamples) was used to test the significance of path coefficients.

Because all variables were measured using self-report questionnaires, this study explicitly addressed the potential for common method bias through both procedural and statistical approaches. Procedurally, several steps were taken to minimize bias, including assuring respondents of anonymity and confidentiality, reducing evaluation apprehension, and carefully designing the questionnaire to use clear, concise, and non-leading items. In addition, items measuring different constructs were organized systematically to reduce respondents' tendency to provide consistent or patterned answers.

Statistically, common method bias was assessed using Harman's single-factor test, in which all measurement items were entered into an exploratory factor analysis to determine whether a single dominant factor accounted for the majority of the variance. The results indicated that no single factor explained a substantial portion of the total variance, suggesting that common method bias was not a serious concern in this study. These combined procedural and statistical remedies enhance the robustness and credibility of the research findings.

3.5 Validity and Reliability Testing

Instrument quality was examined through pilot testing and subsequent analysis. Internal consistency was verified using Cronbach's Alpha (>0.70), construct reliability was measured through Composite Reliability (CR) (>0.70), and Average Variance Extracted (AVE) (>0.50) confirmed convergent validity. Discriminant validity was established using the Fornell–Larcker criterion.

4. 3.6 Measurement and Structural Model

The measurement model specifies the relationships between latent constructs and their observed indicators as follows:

- ChatGPT usage → frequency, duration, and mode of use in learning activities.
- Learning content → perceived relevance, quality, and interaction intensity.
- Digital competence → technological skills, confidence, and adaptability in using digital tools.
- Learning motivation → intrinsic and extrinsic motivational drivers.

The structural model is developed in accordance with the proposed hypotheses. Specifically, H1a and H1b examine the direct effects of ChatGPT usage and learning content on digital competence. H2a and H2b test the direct effects of ChatGPT usage and learning content on students' learning motivation. H3 evaluates the direct effect of digital competence on learning motivation. Furthermore, H4a and H4b assess the moderating role of digital competence in influencing the relationships between ChatGPT usage and learning motivation, as well as between learning content and learning motivation.

3.7 Generalizability of Findings

Although the study was conducted at a single university, several strategies were employed to enhance generalizability:

1. Stratified sampling across multiple majors ensured diverse academic backgrounds within the faculty.
2. The sample size was sufficiently large for SEM-PLS, strengthening the stability of results.
3. The focus on technology-mediated learning contexts provides insights applicable to other universities in Indonesia and similar educational environments globally.
4. By transparently addressing potential biases and methodological constraints, the findings remain cautiously generalizable to contexts where digital competence and AI-assisted tools are becoming integral to higher education.

4 RESULTS AND DISCUSSION

4.1 Demographic Statistics of Respondents

Statistical analysis of demographics was conducted to describe the characteristics of the study respondents. The following are some of the demographic details presented in Table 1.

Table 1. Demographic Respondents

Demographics	Distributions	n= 366 (100%)
Gender	Male	165 respondents (45%)
	Female	201 respondents (55%)

Age	18-20 years old	128 respondents (35%)
	21-23 years old	183 respondents (50%)
	24 years old >	55 respondents (15%)
Course	Physical Education	128 respondents (35%)
	English Education	92 respondents (25%)
	Psychology education	73 respondents (20%)
	Mathematic Education	73 respondents (20%)
Level of Education	Semester 4	128 respondents (35%)
	Semester 6	183 respondents (50%)
	Semester 8	55 respondents (15%)

Source: (Data Analysis Smart-PLS 2024)

This study involved 366 respondents with various demographic characteristics. Based on gender, 165 respondents (45%) are male, and 201 respondents (55%) are female, indicating a higher number of female respondents compared to male. In terms of age, the majority of respondents are in the 21-23 age group, with 183 respondents (50%). The 18-20 age group consists of 128 respondents (35%), while the 24 years and above age group includes 55 respondents (15%). This age distribution is fairly typical, reflecting the common age range of students during their undergraduate studies.

Regarding educational majors, the majority of respondents are from the Physical Education and Health major, totaling 128 respondents (35%). There are 92 respondents (25%) from the English Education major, while the Psychology Education and Mathematics Education majors each have 73 respondents (20%). In terms of academic stage, respondents are divided into three major groups: 128 respondents (35%) are in Semester 4, 183 respondents (50%) are in Semester 6, and 55 respondents (15%) are in Semester 8. This distribution provides a clear view of the demographic characteristics of the student population involved in this study.

4.2 Measurement Model analysis

The measurement model evaluates the quality and validity of the research instruments used to measure the constructs under investigation. Measurement model analysis includes examining both the validity and reliability of the constructs. Convergent validity assesses the extent to which indicators measuring the same construct are highly correlated with each other.

As mentioned by Hair et al., (2021) Each item within a construct should have a factor loading greater than 0.7 to indicate that it effectively measures the construct. Additionally, the Average Variance Extracted (AVE) should be greater than 0.5 to demonstrate adequate convergent validity, meaning that more than half of the variance in the indicators is explained by the construct. Finally, Composite Reliability (CR) should be greater than 0.7 to indicate good internal reliability, reflecting the internal consistency of the measured construct. Detailed results of the measurement model analysis are shown in Table 2.

Tabel 2 Construct Analysis result

No	Construct	Item	F L	Cronbach Alpha	Composite Reliability	AVE
1	Using ChatGPT	X1.1	0.836	0.772	0.853	0.594
		X1.2	0.816			
		X1.3	0.719			

		X1.4	0.702			
2	Learning Content	X2.1	0.791	0.888	0.923	0.750
		X2.2	0.900			
		X2.3	0.899			
		X2.4	0.871			
3	Digital Competence	X3.1	0.701	0.813	0.870	0.572
		X3.2	0.791			
		X3.3	0.784			
		X3.4	0.752			
		X3.5	0.751			
4	Motivation Learn	X4.1	0.821	0.739	0.834	0.560
		X4.2	0.751			
		X4.3	0.608			
		X4.4	0.797			

Source: (Data Analysis Smart-PLS 2024)

The factor loadings for the ChatGPT Usage construct for items X1.1 through X1.4 are 0.836, 0.816, 0.719, and 0.702, respectively. The Cronbach's Alpha value of 0.772 indicates adequate internal consistency. The Composite Reliability (CR) is 0.853, and the Average Variance Extracted (AVE) is 0.594, showing that more than half of the variance in the indicators is explained by this construct, indicating good convergent validity. For the Learning Content construct, the factor loadings for items X2.1 through X2.4 are 0.791, 0.900, 0.899, and 0.871, respectively. The Cronbach's Alpha value of 0.888 demonstrates very good internal consistency. The Composite Reliability (CR) is 0.923, and the Average Variance Extracted (AVE) is 0.750, indicating excellent convergent validity and reliability for this construct. The following are some of the distributed details presented in figure 2.

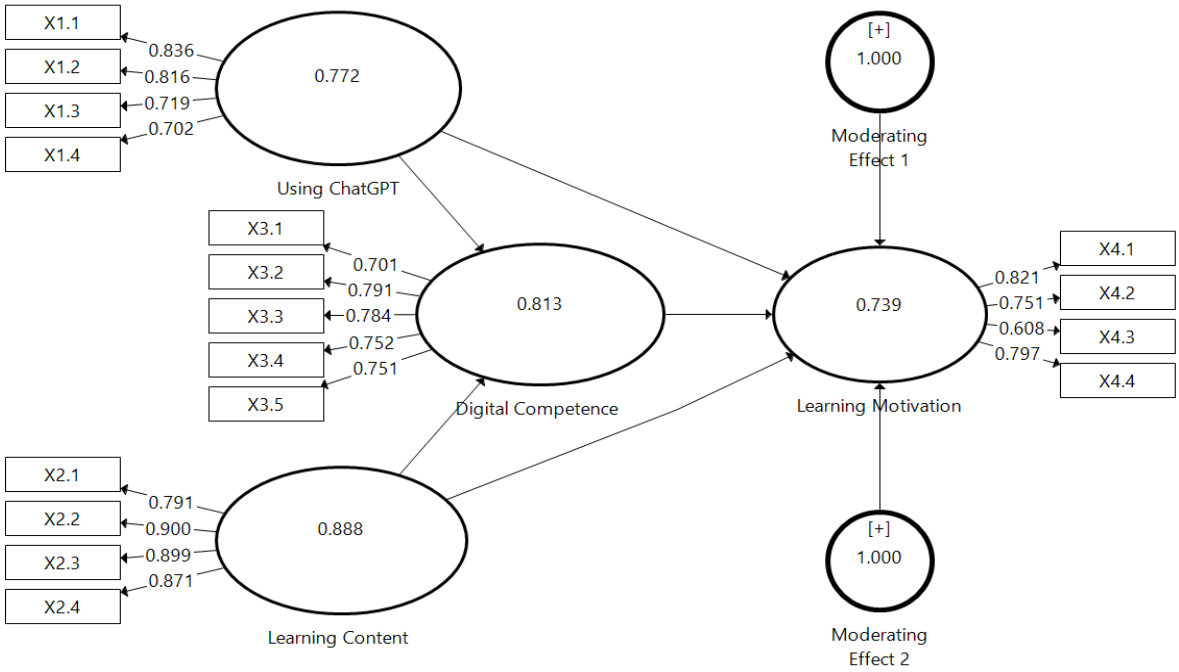


Figure 2. Construct Analysis model

The loadings factor of the Digital Competency construct, for items X3.1 through X3.5 are 0.701, 0.791, 0.784, 0.752, and 0.751, respectively. The Cronbach's Alpha value of 0.813 indicates good internal consistency. The Composite Reliability (CR) is 0.870, and the Average Variance Extracted (AVE) is 0.572, showing adequate convergent validity.

The factor loadings for the Student Motivation construct for items X4.1 through X4.4 are 0.821, 0.751, 0.608, and 0.797, respectively. The Cronbach's Alpha value of 0.739 indicates adequate internal consistency. The Composite Reliability (CR) is 0.834, and the Average Variance Extracted (AVE) is 0.560, showing adequate convergent validity. The results of the measurement model analysis indicate that the instruments used to measure the constructs of ChatGPT Usage, Learning Content, Digital Competency, and Student Motivation meet the criteria for good validity and reliability

4.3 Discriminant Validity

The discriminant validity matrix based on the Fornell-Larcker criterion for the measured constructs is presented in Table 3. This table displays the AVE values on the diagonal and the squared correlations between constructs off the diagonal. The AVE values should be higher than the squared correlations to confirm that the constructs are distinct. Detailed results of the Discriminant Validity Matrix are shown in Table 3.

Table 3: Discriminant Validity Matrix

Variables	Digital Competency	Learning Content	Student Motivation	ChatGPT Usage
Digital Competency	0.756			
Learning Content	0.277	0.866		
Student Motivation	0.255	0.843	0.749	
ChatGPT Usage	0.270	0.726	0.820	0.771

Source: (Data Analysis Smart-PLS 2024)

The discriminant validity of the constructs in this study was assessed using the Fornell-Larcker criterion, which compares the Average Variance Extracted (AVE) with the squared correlations between constructs. Table 3 presents the discriminant validity matrix, where the diagonal values represent the square root of the AVE for each construct, while the off-diagonal values show the squared correlations between constructs. For each construct, the diagonal values are greater than the off-diagonal values, indicating that the constructs are distinct and measure different concepts.

The AVE for Digital Competency is 0.756, which is higher than its squared correlations with other constructs, confirming adequate discriminant validity. Similarly, Learning Content (AVE = 0.866), Student Motivation (AVE = 0.749), and ChatGPT Usage (AVE = 0.771) also demonstrate sufficient discriminant validity, as their AVE values surpass the squared correlations. This confirms that each construct is uniquely measured and not significantly overlapping with others, thereby supporting the robustness of the research model.

4.4 Structural Model analysis

Structural model analysis aims to test the relationships between constructs that have been hypothesized in the study. The following are the steps of the results of the structural model analysis in Table 4.

Tabel 4. Direct and Moderating Effect

Hypothesis	Variable Relationship	β values	STD	T Value	P Values	Result
H1a	Using ChatGPT -> Digital Competence	0.146	0.080	1.833	0.067*	Significantly supported
H1b	Using ChatGPT -> Learning Motivation	0.422	0.049	8.613	0.000***	Significantly supported
H2	Digital Competence -> Learning Motivation	-0.005	0.024	0.198	0.843	Not Supported
H3a	Learning Content -> Digital Competence	0.171	0.079	2.176	0.030**	Significantly supported
H3b	Learning Content -> Learning Motivation	0.550	0.047	11.680	0.000***	Significantly supported
H4a	Moderating Effect 1 -> Learning Motivation	-0.091	0.042	2.148	0.032**	Significantly supported
H4b	Moderating Effect 2 -> Learning Motivation	0.132	0.058	2.271	0.024**	Significantly supported

	R Square	R Square Adjusted
Digital Competence	0.087	0.082
Learning Motivation	0.813	0.811

Source: (Data Analysis Smart-PLS 2024)

*** Indicated that the relationship was highly significant

** Shown that the relationship was statistically significant

*the relationship was statistically significant in 90%

The results of the direct effect analysis using SmartPLS provide important insights into the relationships among variables in the model. Overall, most hypotheses are supported, indicating that both the use of ChatGPT and learning content play significant roles in influencing digital competence and learning motivation, although with varying strengths.

First, the effect of ChatGPT usage on digital competence (H1a) shows a positive coefficient ($\beta = 0.146$) with a p-value of 0.067, indicating a marginally significant effect at the 10% level. This finding suggests that ChatGPT usage tends to improve students' digital competence, although the effect remains relatively weak. The positive relationship may be explained by the interactive nature of ChatGPT, which encourages students to engage with digital platforms, AI-based systems, and online information retrieval processes. Through continuous interaction, students may develop digital literacy, problem-solving abilities, and technological adaptability that are increasingly important in modern education. Previous studies similarly reported that generative AI technologies

contribute to the development of AI literacy, self-regulated learning, and digital competence among students (Indriani et al., 2024; Yang, 2026). However, the relatively small coefficient indicates that digital competence is also influenced by other factors such as technological experience, institutional support, and learning infrastructure. In addition, excessive dependence on AI tools may reduce students' critical thinking and cognitive engagement if not accompanied by reflective learning strategies.

In contrast, ChatGPT usage has a strong and highly significant effect on learning motivation (H1b) ($\beta = 0.422$; $p < 0.001$), indicating that students who frequently use ChatGPT tend to be more motivated in their learning process. This stronger effect may occur because ChatGPT provides immediate feedback, personalized explanations, and flexible learning support that increase students' engagement and confidence. The accessibility and responsiveness of AI tools create a more interactive and enjoyable learning experience, which can strengthen both intrinsic and extrinsic motivation (Lee et al., 2026; Ansori et al., 2025). These findings are also consistent with Self-Determination Theory, which explains that learning motivation increases when students experience autonomy and competence in the learning process (Chiu, 2024).

Second, digital competence does not significantly influence learning motivation (H2), as indicated by a very small coefficient ($\beta = -0.005$) and a high p-value (0.843). This finding suggests that possessing digital skills alone is not sufficient to enhance students' learning motivation. A more rigorous interpretation of this result indicates that digital competence functions primarily as an enabling capability rather than a motivational driver in itself. In other words, students may have adequate digital abilities, but these competencies do not automatically generate enthusiasm, engagement, or persistence in learning activities. Previous studies have similarly argued that digital competence mainly supports students' ability to access and utilize technology effectively, while motivation is more strongly influenced by psychological, pedagogical, and environmental factors such as learning autonomy, teacher support, interaction quality, and perceived usefulness of learning tools (Chiu, 2024; Lee et al., 2026).

Furthermore, the insignificant relationship may indicate that students already perceive digital competence as a basic or routine skill in contemporary education, reducing its potential to directly stimulate motivation. This finding is also consistent with prior research showing that technical proficiency alone does not necessarily increase intrinsic learning motivation unless accompanied by meaningful learning experiences, interactive pedagogical approaches, and emotionally engaging educational environments (Indriani et al., 2024; Yang, 2026). While digital competence equips students with the technical capacity to access, navigate, and utilize digital tools, it does not inherently shape their willingness, interest, or persistence in learning tasks (Ryan & Deci, 2020b). In other words, students may be highly skilled in using technology, but this does not guarantee that they will be more motivated to learn unless other psychological and pedagogical conditions are present.

Furthermore, this non-significant relationship may reflect differences in student learning orientations. Students with high digital competence may adopt an efficiency-oriented approach, using technology primarily to complete tasks quickly rather than to engage deeply with learning materials. In such cases, digital skills may reduce effort rather than increase intrinsic motivation, resulting in a neutral or negligible net effect on motivation outcomes. Contextual factors also provide an important explanation. The learning environment, including instructional design, task complexity, and the extent to which technology is meaningfully integrated into pedagogy, likely

determines whether digital competence contributes to motivation. In settings where learning tasks are routine or teacher-centered, digital competence may not be activated in a way that enhances engagement.

Conversely, in more interactive, problem-based, or student-centered environments, digital competence may only translate into motivation when it is aligned with opportunities for autonomy, collaboration, and meaningful cognitive engagement. Therefore, the findings suggest that learning motivation is shaped more strongly by pedagogical and psychological factors than by technical skills alone, emphasizing that digital competence acts as a supporting resource whose motivational impact depends on how it is utilized within the learning context.

Third, learning content demonstrates a significant positive effect on both digital competence (H3a) ($\beta = 0.171$; $p < 0.05$) and learning motivation (H3b) ($\beta = 0.550$; $p < 0.001$). Notably, the effect on learning motivation is the strongest among all direct relationships, indicating that high-quality, engaging, and adaptive content is a key driver of student motivation. This finding suggests that well-designed learning materials not only facilitate students' understanding of digital technologies but also enhance their interest, participation, and enthusiasm in the learning process. Interactive and relevant learning content can encourage students to actively explore digital resources, thereby improving their digital competence through practical learning experiences and continuous technological engagement. Previous studies have similarly emphasized that adaptive and technology-supported learning content contributes significantly to the development of digital literacy, self-regulated learning, and students' technological readiness (Dahri et al., 2024; Purnama, Edi, Rize, et al., 2023; Yang, 2026).

Tthe strong influence of learning content on learning motivation aligns with constructivist learning theory and Self-Determination Theory, which emphasize that meaningful, relevant, and engaging instructional materials can strengthen students' intrinsic motivation, autonomy, and learning satisfaction. When learning content is perceived as useful, interactive, and aligned with students' needs, learners are more likely to feel motivated, confident, and emotionally connected to the educational process. AI-supported content, including personalized explanations and immediate feedback, may further enhance students' curiosity and active participation in learning activities (Lee et al., 2026). Therefore, these findings reinforce the importance of developing innovative, student-centered, and adaptive learning content to improve both digital competence and learning motivation in technology-enhanced educational environments.

The moderating effects analysis provides deeper insight into how the relationships between the predictor variables and learning motivation vary under different contextual conditions. Unlike direct effects, moderation analysis examines whether the strength or direction of a relationship changes depending on the level of another variable. Therefore, the significant moderating effects found in this study indicate that the influence of the independent variables on learning motivation is conditional and depends on the presence of supporting contextual factors.

For H4a, Moderating Effect 1 shows a negative and statistically significant interaction effect on learning motivation ($\beta = -0.091$; $t = 2.148$; $p = 0.032$). The negative coefficient indicates that the moderator weakens the positive relationship between the independent variable and learning motivation. This means that students with higher levels of the moderating variable experience a weaker motivational impact from the predictor variable compared to students with lower levels of the moderator. One possible explanation is that the moderator functions as a compensatory factor, where students who already possess strong supporting conditions may rely

less on the predictor variable to maintain their learning motivation. In line with Self-Determination Theory, students who already experience autonomy, competence, and confidence in learning environments may not require additional external stimulation to sustain motivation (Deci & Ryan, 2000; Irnidayanti et al., 2020; Maryam et al., 2021)

This interaction can be more clearly interpreted through an interaction plot. In the graph, the slope representing students with low levels of the moderator would appear steeper, indicating a stronger positive relationship between the predictor and learning motivation. Conversely, the slope for students with high moderator levels would be flatter, demonstrating that the predictor becomes less influential as the moderator increases. Such visualization helps clarify that the relationship between the predictor and motivation changes across different moderating conditions rather than remaining constant for all students.

In contrast, H4b demonstrates a positive and statistically significant moderating effect on learning motivation ($\beta = 0.132$; $t = 2.271$; $p = 0.024$). The positive coefficient indicates that the moderator strengthens the relationship between the independent variable and learning motivation. This suggests that students with higher levels of the moderating variable gain greater motivational benefits from the predictor variable. The moderator therefore acts as an enhancing factor that amplifies students' engagement, confidence, and responsiveness toward the learning process. Previous studies in educational technology similarly emphasize that supportive and interactive learning environments can strengthen students' academic motivation and engagement (Nachshoni, 2024; Reschly & Christenson, 2022; Togay et al., 2022)

The interaction plot for H4b would show a steeper upward slope for students with high levels of the moderator, indicating that the positive relationship between the predictor variable and learning motivation becomes stronger when the moderator is high. Meanwhile, students with lower moderator levels would display a less steep slope, reflecting a weaker relationship. This visualization demonstrates that the effectiveness of the predictor variable is amplified under favorable moderating conditions.

Overall, these findings confirm that learning motivation is influenced not only by direct instructional factors but also by interaction mechanisms shaped by contextual and psychological conditions. The significant moderating effects highlight the importance of considering environmental support, technological readiness, and adaptive learning conditions when evaluating motivational outcomes in technology-enhanced learning environments.

The coefficient of determination (R^2) indicates that the model explains 8.7% of the variance in digital competence, which is relatively low, suggesting that other factors outside the model may play a larger role. However, the model explains 81.3% of the variance in learning motivation, which is very high for behavioral research, indicating that the included variables particularly ChatGPT usage and learning content are highly effective in explaining students' motivation.

The direct effect results indicate that not all hypothesized relationships are supported, particularly the link between Digital Competence and Learning Motivation (H2). The analysis shows that this relationship has a very small and negative coefficient ($\beta = -0.005$), with a T-value of 0.198 and a p-value of 0.843, which is far above the commonly accepted significance threshold ($p < 0.05$). Therefore, this effect is not statistically significant, and H2 is rejected. Similarity as Bakirova et al., (2026) reported study shows that digital competence affects learning motivation within an integrated model, often through mediation, not always as a standalone predictor. (Li et

al., 2025) found that his study demonstrates that digital competence influences outcomes through mediating variables such as perceived usefulness and contextual factors, not directly.

The R-square value for Digital Competence is 0.087 (Adjusted $R^2 = 0.082$), indicating that approximately 8.7% of the variance in digital competence is explained by the independent variables included in the model. This relatively low explanatory power suggests that the variables examined such as the use of ChatGPT and learning content capture only a limited portion of the factors influencing students' digital competence. This finding implies that digital competence is a multidimensional construct that is likely shaped by additional variables not included in this study. These may include students' prior experience with technology, baseline digital literacy, access to digital devices, institutional infrastructure, and the availability of university-supported digital learning resources. Therefore, while the identified relationships remain statistically significant, the model's ability to comprehensively explain digital competence is limited.

In contrast, the R-square value for Learning Motivation is 0.813 (Adjusted $R^2 = 0.811$), indicating that 81.3% of the variance in learning motivation is explained by the model. This reflects a strong explanatory power, suggesting that the combination of ChatGPT usage, learning content, and digital competence provides a robust framework for understanding students' motivation. The high R^2 value indicates that these variables, including the moderating effects, collectively play a substantial role in shaping learning motivation within the context of technology-enhanced education. This result implies that Digital Competence does not have a meaningful impact on students' Learning Motivation.

In other words, possessing digital skills alone is not sufficient to encourage students to be more motivated in their learning process. One possible explanation is that digital competence is a basic or enabling skill rather than a motivational driver. Students may already be familiar with digital tools, making these skills less influential in stimulating motivation. Additionally, motivation is more likely shaped by engaging learning experiences, such as the use of interactive tools like ChatGPT and the quality of learning content, which provide immediate feedback, personalization, and active involvement. Another possible reason is that the variation in Digital Competence among respondents may be relatively low, reducing its explanatory power. Furthermore, psychological and pedagogical factors such as interest, engagement, and instructional design tend to play a more dominant role in influencing motivation than technical abilities alone.

Thus, the non-significant finding suggests that improving Learning Motivation requires more than enhancing students' digital skills; it requires meaningful integration of technology, interactive learning environments, and high-quality content. Future research is recommended to include additional variables, such as learning engagement, self-efficacy, or teaching strategies, to better explain the determinants of learning motivation.

5 DISCUSSION

5.1 ChatGPT usage and digital competence

The finding that the effect of ChatGPT on digital competence is only marginally significant highlights an important limitation in assuming that the use of generative AI automatically translates into comprehensive digital competence development. Digital competence is a multidimensional and context-dependent construct that extends beyond the ability to interact with AI-based tools. The DigComp framework developed by Ferrari (2013) and updated by Vuorikari et al., (2022)

conceptualizes digital competence across several dimensions, including information and data literacy, communication and collaboration, digital content creation, digital safety, and problem-solving. In this context, ChatGPT primarily supports text-based information retrieval and content generation, while offering limited engagement with broader dimensions such as digital safety, collaborative interaction, and advanced technological problem-solving. Consequently, relying heavily on ChatGPT may create a narrow form of technological familiarity rather than fostering holistic digital competence.

The relatively low explained variance in digital competence further indicates that the current model captures only a limited portion of the factors shaping students' digital abilities. This suggests that digital competence is more strongly influenced by broader structural and contextual determinants, such as prior technological experience, digital infrastructure, pedagogical quality, institutional support, socio-economic conditions, and opportunities for active digital practice. Therefore, the weak explanatory power of the model raises critical concerns regarding the tendency to overestimate the educational impact of AI technologies in isolation. The findings imply that merely integrating ChatGPT into learning activities is insufficient to substantially improve students' overall digital competence without comprehensive digital literacy strategies and supportive educational ecosystems. These results are consistent with Hatlevik et al., (2015) who emphasized that specific technologies often strengthen only particular digital sub-competencies rather than simultaneously enhancing overall digital competence.

Furthermore, studies on the use of artificial intelligence in education indicate that AI-based technologies, including ChatGPT, function more as *cognitive support tools* that assist thinking processes, information processing, and academic production, rather than as comprehensive mechanisms for developing digital skills (Kasneci et al., 2023; Zawacki-richter et al., 2019). Recent studies further indicate that ChatGPT contributes most significantly to students' digital competence in areas closely related to its core functions, particularly academic writing, information retrieval efficiency, and conceptual comprehension. However, its impact on broader dimensions of digital competence appears to depend heavily on instructional strategies, pedagogical approaches, and intended learning outcomes. Accordingly, the findings of this study strengthen the view that the educational impact of ChatGPT should be evaluated based on digital competence dimensions that are directly connected to the technological capabilities and operational characteristics of generative AI systems.

Regarding the non-significant relationship between digital competence and learning motivation, this finding is also consistent with previous research. Rohatgi et al., (2016) found that higher levels of digital competence do not automatically translate into increased learning motivation, particularly in higher education contexts where students tend to possess relatively homogeneous levels of digital literacy. In such contexts, digital competence functions as a foundational or baseline skill required to participate in learning activities, but it is insufficient on its own to act as a motivating factor.

Moreover, according to Self-Determination Theory Deci & Ryan, (2000) learning motivation is strongly influenced by the fulfillment of psychological needs for autonomy, competence, and relatedness. Several studies emphasize that digital technologies positively affect learning motivation only when they are pedagogically integrated through instructional designs that promote active engagement, provide learner choice, and foster meaningful learning experiences Bond et al., (2021) Jeno et al., (2017) Without intentional pedagogical integration, the use of technology

including ChatGPT is likely to be perceived merely as a technical support tool and is therefore insufficient to significantly enhance students' learning motivation.

This finding indicates that although ChatGPT demonstrates a potential contribution to enhancing digital capabilities, the empirical evidence remains insufficient to establish a statistically robust and conclusive effect. The absence of statistical significance may reflect substantial variability within the data, inconsistencies in users' engagement with ChatGPT, or the presence of external factors that moderate the effectiveness of ChatGPT in improving digital competence.This suggests that while there is an indication that ChatGPT may contribute to the improvement of digital capabilities, the statistical evidence is not strong enough to conclusively confirm this effect. Variability in the data or other factors influencing the effectiveness of ChatGPT might explain the insignificance of these results. Another study by Atlas, (2023) It is also noted that while educational technologies such as ChatGPT have the potential to enhance digital skills, the outcomes often depend on the context of use and implementation. The use of ChatGPT significantly influences students' motivation to learn.

5.2 Learning content's impact on digital competence

Technology-enhanced learning materials contribute to improved competence by providing interactive features, adaptive support, and opportunities for active engagement. Empirical studies consistently demonstrate that the integration of technology-based tools into instructional content is associated with higher levels of student motivation and engagement, which in turn support the development of digital competence(Hanum Siregar et al., 2023). These results supported by Zhou & Li, (2023) The integration of technology in education can enhance students' enthusiasm for learning; however, its effect is often contingent upon the quality of instructional design. Factors such as the relevance of learning materials and the effectiveness of teaching methods play a more substantial role in shaping students' learning motivation (Beardsley et al., 2021). Empirical evidence indicates that, although digital competence is important, motivation is more strongly influenced by well-structured content and pedagogical approaches that align with learners' needs and contextual relevance

Well-designed and contextually relevant learning materials play a pivotal role in enhancing students' digital competence. The findings underscore the importance of providing high-quality instructional resources that effectively support the development of these competencies. Carefully structured, meaningful, and engaging learning content not only facilitates knowledge acquisition but also equips learners with the practical skills and technological understanding necessary to strengthen and advance their digital capabilities. Previous studies also affirm that effective educational resources can make a significant contribution to the improvement of students' digital proficiency (Kwiatkowska & Wiśniewska-Nogaj, 2022). Learning content has a strong significant influence on students' learning motivation. emphasizes the importance of content quality in motivating students. As mentioned by Dewaele & Li, (2019) Interesting and relevant teaching materials can increase student engagement and enthusiasm in the learning process. These results also supported by Raza et al., (2020) consistent with the finding that the quality of teaching content is directly related to the level of student motivation and engagement.

Students' digital competence significantly strengthens the relationship between learning content and learning motivation. The positive coefficient demonstrates that students with higher levels of digital competence are more likely to experience a stronger motivational impact from the learning content provided. This finding suggests that digital competence enhances students' ability to interact with, understand, and effectively utilize instructional materials, thereby increasing the

motivational value of the learning process. In other words, students who possess stronger digital skills tend to benefit more from well-designed learning content, resulting in higher levels of engagement and motivation. These findings are consistent with previous studies emphasizing that digital competence functions as a moderating factor that amplifies the influence of learning content on students' motivation and academic engagement (Bergdahl et al., 2020). Students' digital abilities significantly moderated the relationship between ChatGPT use and students' learning motivation. The negative coefficient suggests that improving students' digital skills can reduce the positive impact of using ChatGPT on learning motivation. This may mean that students with better digital skills may feel less of the additional impact of ChatGPT. Research supports that the interaction between digital skills and technology use can affect learning outcomes in complex ways.

5.3 Digital competence as a moderator

The findings of this study confirm that digital competence plays a significant moderating role in influencing students' learning motivation, with both negative and positive interaction effects observed. Specifically, the first moderating effect reveals a negative and statistically significant coefficient, indicating that digital competence weakens the relationship between the first predictor and learning motivation. This suggests that students with higher digital competence may be less dependent on certain forms of technological support, thereby reducing the direct influence of this variable on their motivation. Recent studies support this interpretation, showing that digitally competent learners tend to exhibit higher levels of self-regulated learning and autonomy, reducing reliance on external digital scaffolding (Mardiana & Yakub, 2025)

In contrast, the second moderating effect demonstrates a positive and significant relationship, indicating that digital competence strengthens the effect of the second predictor on learning motivation. This finding implies that students with higher levels of digital competence are better able to engage with and benefit from structured learning content and interactive digital environments. Contemporary research by Falloon, (2020) highlights that digital competence enhances students' engagement, interaction, and academic performance in technology-enhanced learning contexts

These contrasting findings indicate that digital competence does not function uniformly across all relationships within the research model. Rather, its influence is highly context-dependent, as it may either weaken or strengthen the effects of different variables depending on the learning conditions and the nature of the interaction involved. This demonstrates that digital competence is not merely a supportive technical skill, but a multidimensional capability that shapes how students engage with technology-based learning environments. Such findings are consistent with contemporary theoretical frameworks, including the updated DigComp model, which conceptualizes digital competence as encompassing not only operational and technical abilities, but also critical thinking, problem-solving, information evaluation, communication, and the adaptive use of technology across diverse educational contexts. Consequently, the effectiveness of digital competence lies in students' capacity to strategically apply digital skills to maximize learning outcomes, motivation, and engagement.

From a theoretical perspective, the findings support the view that digital competence functions as both an enabling and filtering mechanism in digital learning environments. Students with higher competence are more selective, strategic, and efficient in using digital tools, which may explain

the weakening effect in certain relationships. At the same time, their advanced skills allow them to fully utilize high-quality digital learning resources, thereby strengthening other relationships. This is consistent with recent studies emphasizing the interaction between digital skills and instructional design in shaping learning outcomes (Scheel et al., 2022)

This study emphasizes that strengthening students' digital competence remains a critical requirement in contemporary higher education; however, its effectiveness must be supported by strong pedagogical quality and carefully designed instructional strategies. Educators should not assume that the mere presence of technology will automatically enhance students' motivation or learning outcomes. Instead, the educational value of technology depends largely on students' ability to engage with digital tools in meaningful, critical, and purposeful ways within the learning process. The findings further suggest that digital competence becomes most effective when it is integrated with relevant, interactive, and well-structured learning content that encourages active participation and deeper understanding. Recent evidence also indicates that the synergy between digital competence development and high-quality instructional design represents a fundamental determinant of successful, engaging, and motivating learning experiences in higher education contexts.

5.4 Limitations and Future Research Directions

1. ChatGPT shows a strong effect on learning motivation but only a marginal impact on digital competence, indicating that additional or blended learning tools are needed to more effectively develop students' digital skills.
2. The non-significant relationship between digital competence and learning motivation suggests that digital skills alone are insufficient to enhance motivation. Future research should examine mediating variables such as self-efficacy, learning strategies, and teacher support.
3. The study is limited to a specific type of learning content and educational context, which may restrict the generalizability of the findings. Future studies should explore different disciplines, learning environments, and instructional designs.
4. The relatively low variance explained in digital competence indicates that other influencing factors such as prior experience, access to technology, and socioeconomic background should be incorporated into future models.

The use of a cross-sectional design limits the ability to observe long-term effects. Future research should employ longitudinal approaches to better understand the sustainability of learning outcomes. Future studies are also encouraged to adopt experimental or quasi-experimental designs to strengthen causal inference and validate the current findings.

6 Conclusion

The analysis of the structural model using SmartPLS reveals several key conclusions regarding the relationships between the use of ChatGPT, Digital Competence, Learning Content, and Learning Motivation:

1. Impact of ChatGPT on Digital Competence and Learning Motivation
   The effect of ChatGPT usage on Digital Competence is marginally significant, indicating that while it contributes positively to improving students' digital skills, the effect is relatively weak. In contrast, ChatGPT has a highly significant and strong impact on Learning Motivation, demonstrating its important role in enhancing students' engagement and willingness to learn.

2. Relationship Between Digital Competence and Learning Motivation
   The relationship between Digital Competence and Learning Motivation is not statistically significant, suggesting that digital skills alone do not directly influence students' motivation. This implies that Digital Competence functions more as a supporting factor rather than a primary driver of motivation.
3. Effect of Learning Content
   Learning Content has a significant positive effect on Digital Competence, indicating that well-designed and engaging materials help improve students' digital abilities. Moreover, Learning Content shows a highly significant effect on Learning Motivation, making it the strongest predictor in the model. This highlights the critical role of content quality in fostering student motivation.
4. Moderating Effects
   The moderating effects are found to be statistically significant, indicating that interaction variables influence Learning Motivation. One moderating effect shows a negative relationship, suggesting it weakens the impact on motivation, while the other shows a positive relationship, indicating it strengthens the effect. These findings confirm that the influence of ChatGPT and Learning Content on Learning Motivation is conditional and depends on contextual or interaction factors.

Overall, the findings emphasize that Learning Motivation is primarily driven by the effective use of technology such as ChatGPT and the quality of Learning Content, while Digital Competence plays a more indirect or supporting role.

7 Theoretical implications and practical contribution

Significant contribution to theoretical understanding of the role of technology in education by showing that the use of technology such as ChatGPT can significantly increase students' learning motivation. This supports the theory that interactive tools and technology support can strengthen student involvement in the learning process. In addition, these findings highlight the importance of digital skills as a moderating factor in the effectiveness of educational technology, adding a new dimension to the theory of technology acceptance and use that suggests that the impact of digital tools may vary depending on students' digital competencies. In terms of content quality, this study corroborates the theory that quality and relevant content is important for improving students' digital skills and motivation.

1. This practice suggests that to maximize learning outcomes, educators and policymakers must integrate educational technology effectively, as well as provide high-quality and relevant teaching materials.
2. Additionally, an understanding of the role of digital skills in moderating the effectiveness of technology can guide adjustments to the use of technology based on students' skill levels, allowing for more personalized and effective educational interventions.
3. Finally, the study emphasizes the need for continuous professional development for educators to ensure optimal use of technology and content development in their teaching practices.

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Ethics Approval

This study was conducted in accordance with relevant ethical guidelines and regulations for research involving human participants. All participants were provided with clear information regarding the purpose, procedures, and potential risks of the study, and their written informed consent was obtained prior to participation. Confidentiality and anonymity were strictly maintained to ensure honest responses and minimize social desirability bias. The research protocol was reviewed and approved by the Serambi Mekkah University/Institute for Research and Community Service Ethics Committee, ensuring compliance with national and institutional ethical standards.

Author Contributions

Ibrahim contributed to the conceptualization, methodology, and preparation of the original draft. Jalaluddin was responsible for data collection and formal analysis. Marwan contributed to writing, review, and validation of the manuscript. Juli Firmansyah provided supervision and assisted in funding acquisition. All authors have read and approved the final version of the manuscript.

Data Availability

The datasets generated and/or analysed during the current study are available from the corresponding author upon reasonable request. Requests for access to the raw data should be directed to:
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Ethics Approval

The research protocol was reviewed and approved by the Serambi Mekkah University/Institute for Research and Community Service Ethics Committee, ensuring compliance with national and institutional ethical standards.

Consent to Participate

All participants were provided with clear information regarding the purpose, procedures, and potential risks of the study, and their written informed consent was obtained prior to participation.

Competing Interests

The authors declare that they have no competing interests.

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