

ChatGPT, Achievement Motivation, and Problem-Solving: Evidence from Thai and Cambodian Undergraduates

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ABSTRACT

Background. The rapid global adoption of ChatGPT has raised growing interest in its role in supporting student learning, yet the effectiveness of generative AI tools in enhancing higher-order cognitive skills such as problem-solving may depend on individual learner characteristics that remain underexplored.

Purpose. This quantitative study aimed to examine the relationship between ChatGPT usage and problem-solving ability among students enrolled in a Media Design course, and to test whether this relationship is moderated by achievement motivation.

Method. The study involved 115 university students from four intact classes across two higher education institutions in Thailand and Cambodia. Data were collected through a survey questionnaire and analysed using Partial Least Squares Structural Equation Modeling (PLS-SEM), preceded by a measurement invariance test (MICOM) to assess the appropriateness of pooling data across the two national samples.

Results. The findings indicate that ChatGPT usage was positively and significantly associated with problem-solving ability ($\beta = 0.386$, $p < 0.001$), as was achievement motivation ($\beta = 0.291$, $p < 0.01$). The interaction between ChatGPT usage and achievement motivation also showed a significant positive effect ($\beta = 0.157$, $p < 0.05$), indicating that achievement motivation strengthens the relationship between ChatGPT usage and problem-solving ability. The model explained 44.6% of the variance in problem-solving ability ($R^2 = 0.446$).

Conclusion. This study has significant implications for instructional practices in higher education settings, particularly for lecturers designing AI-integrated learning activities. By understanding how achievement motivation shapes students' benefit from ChatGPT, educators can tailor instructional strategies that support both technology adoption and the development of independent problem solving skills.

KEYWORDS

Achievement Motivation; ChatGPT; Higher Education; Problem-Solving Ability

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INTRODUCTION

The emergence of ChatGPT in late 2022 sparked unprecedented adoption of generative artificial intelligence technology in the history of digital applications, with over 100 million users within a short time of its launch (Aydin et al., 2026).

This phenomenon has not only transformed the overall technological landscape but also triggered a fundamental transformation in higher education across countries ranging from the United States and the United Kingdom to Australia and New Zealand (Sok & Bunry, 2021). However, this rapid adoption has not been matched by adequate institutional readiness; a UNESCO (2023) global survey of over 450 schools and universities found that fewer than 10% of these institutions have formal policies or guidelines addressing the use of generative AI in academic settings (Be et al., 2026). This gap between technology adoption and governance readiness makes the study of ChatGPT's use in learning contexts particularly its relationship to students' problem-solving skills a pressing issue requiring further research.

In Asia, research related to ChatGPT in education is growing rapidly, with an annual growth rate of over 500% between 2022 and 2025, making it one of the fastest-growing fields of study in the region (Gursoy & Cai, 2025). This phenomenon is also evident in Indonesia, which has one of the highest rates of ChatGPT access globally. Several large-scale studies in Indonesian universities confirm the high level of acceptance and use of ChatGPT by students (Qadhi et al., 2025).

However, this high adoption rate does not necessarily translate into students' readiness to use it independently and critically. Research in Southeast Asia has found that students tend to have lower levels of confidence in using AI independently, preferring approaches that remain mediated by instructor guidance (Sok et al., 2025). This gap between the high adoption rate and the less than optimal readiness for use is an important basis for research that focuses on the context of higher education in Asia, particularly in examining how the use of ChatGPT is related to students' problem-solving abilities in the learning process (Erwin et al., 2026; Panmei, 2025).

The studies referenced in this preliminary research are sourced from reputable journals indexed by Scopus and/or Web of Science. They have undergone rigorous peer review, ensuring their validity and methodological quality can be scientifically validated. A recent meta-analysis of 35 experimental studies showed that ChatGPT has a significant positive impact on students' problem-solving abilities, with a high effect size ($g = 0.933$) (Wu et al., 2026). Similar findings were confirmed by another systematic review and meta-analysis published in the Scopus Q1 journal, *Computers & Education* (Deng et al., 2025).

However, both studies explicitly emphasize that research on moderating variables influencing the strength of the relationship between ChatGPT use and student learning outcomes is still very limited, urging further research that considers moderating factors more comprehensively (Al Issa & Maheshwari, 2026). One factor that has the potential to act as a moderator but has not been widely studied empirically is achievement motivation, an individual characteristic (Banat et al., 2024; Erwin & Dakhalan, 2024) that is theoretically thought to determine the extent to which students utilize ChatGPT productively in the problem-solving process, rather than using it as a shortcut that hinders cognitive development. A search of the literature indexed in Scopus and Web of Science has not found any research that specifically examines the moderating role of achievement motivation in the relationship between ChatGPT use and students' problem-solving abilities, particularly in the context of instructional media courses in universities in Southeast Asia. This research gap underlies the urgency and novelty of this research.

To answer this research, this study uses a quantitative approach with a cross-country survey method involving students from universities in Thailand and Cambodia, implemented using Partial Least Squares Structural Equation Modeling (PLS-SEM). This approach was chosen because of its ability to test relationships between variables simultaneously, including moderating effects, while also accommodating the characteristics of cross-cultural survey data which are generally not normally distributed (Hair et al., 2020). Before data from both countries are combined in a single

model analysis, this study will conduct a measurement invariance test through the Measurement Invariance of Composite Models (MICOM) procedure to ensure the equivalence of instrument meanings across populations (Henseler, 2017), so that the results obtained can be methodologically accounted for.

Based on the above description, this study aims to analyze the relationship between ChatGPT use and students' problem-solving abilities in an instructional media course, and to examine the role of achievement motivation as a moderating variable in this relationship, among university students in Thailand and Cambodia. Theoretically, this study contributes to the literature on moderating variables in ChatGPT utilization in higher education, which has been explicitly identified as under-researched. Practically, the findings of this study are expected to provide a basis for lecturers and policymakers in designing ChatGPT integration strategies that consider the characteristics of student achievement motivation.

RESEARCH METHODOLOGY

Research Design

This study employed a quantitative approach with a correlational survey design (cross-sectional survey design), which aims to examine relationships between variables at a single point in time without manipulation of the research variables (Creswell & Creswell, 2017). This design was chosen because it aligned with the research objective, which was to analyze the relationship between ChatGPT use and students' problem-solving abilities, with achievement motivation as a moderating variable, without requiring experimental control of ChatGPT exposure itself. Data were analyzed using the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach, chosen for its ability to simultaneously test structural models with latent constructs and moderating effects, as well as its suitability for relatively small to medium-sized survey data that do not require the assumption of a multivariate normal distribution (J. Hair & Alamer, 2022).

Research Subjects

The subjects in this study were students taking the Instructional Media Design course in the odd semester of the 2025 academic year at two universities, located in Thailand and Cambodia, respectively. Subjects were selected using a cluster sampling technique on pre-formed classes (intact groups), involving four classes from both countries. In Thailand, the subjects consisted of Class A (n=28) and Class B (n=26), while in Cambodia, they consisted of Class C (n=31) and Class D (n=30), resulting in a total of 115 students. The cluster sampling technique was chosen due to limited access to a fully randomized student population, while also aligning with the class management structure established by each institution. The adequacy of the sample size was evaluated by considering the complexity of the research model involving moderating effects, referring to the inverse square root method approach to estimating the minimum sample size in PLS-SEM (Kock & Hadaya, 2018) which is visualized in Table 1.

Table 1. Respondent Profile

Characteristic	Category	n	%
Country	Thailand	54	47.0%
	Cambodia	61	53.0%
Gender	Male	48	41.7%
	Female	67	58.3%
Age	18-19 years	35	30.4%
	20-21 years	62	53.9%
	≥22 years	18	15.7%
ChatGPT Usage Frequency	Frequent	51	44.3%
	Occasional	44	38.3%
	Rare	20	17.4%
Total		115	100%

Research Instruments

This study used a survey questionnaire consisting of three instruments adapted from previously validated scales. ChatGPT use was measured using items adapted from the Unified Theory of Acceptance and Use of Technology (UTAUT) framework, based on an instrument validated in the context of Southeast Asian university students (Thongsri et al., 2018). Problem-solving ability was measured using the Problem-Solving Questionnaire, developed and validated specifically for the higher education context, which encompasses four dimensions: solution planning, critical evaluation of solutions, generation and evaluation of alternatives, and prioritization and review of alternatives (Ventura-León et al., 2025).

Achievement motivation was measured using the Propensity to Achieve Scale developed (Johnson, 1990), which is widely used in educational psychology research to assess an individual's tendency to choose achievement-oriented tasks. All items were measured on a five-point Likert scale, ranging from (1) strongly disagree to (5) strongly agree. Given that this study involved respondents from two countries with different languages of instruction, all instruments were translated into Thai and Khmer through a back-translation procedure to ensure equivalence of meaning between the languages, before being piloted on a small group outside the main research sample.

Analysis Data

Data were analyzed using the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach with the aid of SmartPLS software. The analysis was conducted in two main stages: measurement model evaluation (outer model) and structural model evaluation (inner model). The outer model evaluation included a convergent validity test, which was declared met if the factor loading value for each indicator was ≥ 0.70 and the Average Variance Extracted (AVE) value was ≥ 0.50 . Reliability testing was conducted using Composite Reliability and Cronbach's Alpha values ≥ 0.70 (J. F. Hair et al., 2019).

Discriminant validity was tested using the Heterotrait-Monotrait Ratio (HTMT) criterion, with a threshold below 0.90, as a more reliable alternative to the conventional Fornell-Larcker criterion (Henseler et al., 2015). Before combining data from Thailand and Cambodia into a single analytical model, measurement invariance testing was conducted using the Measurement Invariance of Composite Models (MICOM) procedure to ensure the constructs' meaningfulness across the population.

Internal model evaluation included the coefficient of determination (R^2), effect size (f^2), and predictive relevance testing using the PLSpredict procedure to assess the model's out-of-sample

predictive ability. Hypothesis testing, including the direct and moderating effects of achievement motivation, was conducted using a bootstrapping procedure with 5,000 subsamples at a 5% significance level, with hypotheses accepted if the T-statistic value was >1.96 and the P-value was <0.05 (Hair et al., 2019).

Research Procedures

This study employed a quasi-experimental mixed-method research design integrating a pre-test and post-test intervention framework with explanatory structural modeling. The intervention was implemented during a 14-week media design course in which students engaged in ChatGPT-assisted learning activities. The pre-test and post-test procedures were used to evaluate changes in students' learning outcomes, while PLS-SEM was applied to examine the structural relationships among the investigated constructs after the intervention (J. Hair & Alamer, 2022b).

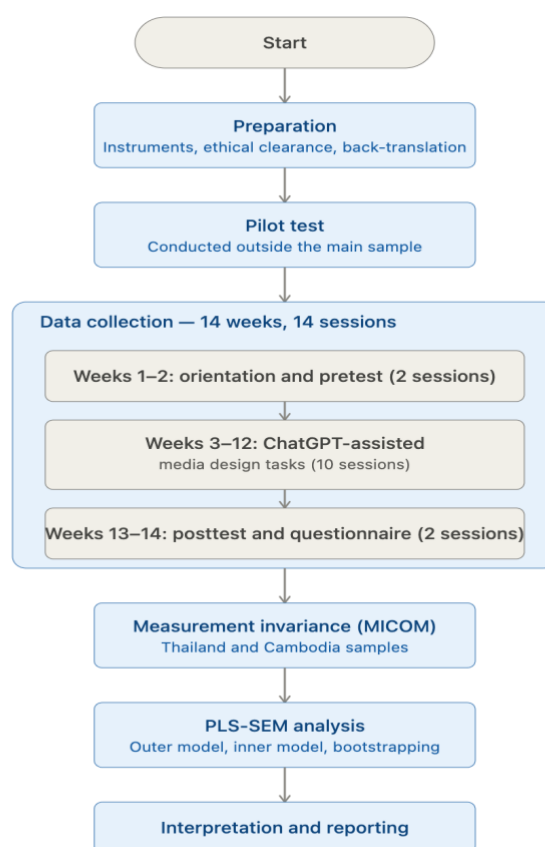


Figure 1. Research procedure flowchart

RESULT AND DISCUSSION

Before pooling the data from Thailand and Cambodia, a three-step Measurement Invariance of Composite Models (MICOM) procedure was conducted.

Table 2. Results of the MICOM Procedure

Step	Assessment Criterion	Result	Interpretation
Step 1	Configural invariance	Established	The measurement model specifications were identical across the two groups.
Step 2	Compositional invariance (correlation, $c = 1$)	$p > 0.05$ for all constructs	Compositional invariance was established.
Step 3a	Equality of composite means	$p < 0.05$ for two of the three constructs	The composite means were not fully invariant across the groups.
Step 3b	Equality of composite variances	$p > 0.05$ for all constructs	The composite variances were invariant across the groups.

The results of the measurement invariance test using the three-stage MICOM procedure (Almailabi & Buunk, 2026) showed that the research model met configural invariance in Step 1, indicating that the structural model was identical between the Thai and Cambodian samples. In Step 2, all constructs demonstrated compositional invariance ($p > 0.05$), meaning the composite scores of both concrete sets were perfect. However, the test of equality of composite means in Step 3a showed that two of the three constructs did not meet the full equality criterion ($p < 0.05$), while equality of variances in Step 3b was met for all constructs. Based on these criteria, these results indicate partial invariance (partial measurement invariance). Referring to the guidelines of Henseler et al. (2016), partial invariance conditions still allow the data to be combined in a single combined analysis model, but differences in the mean values of the constructs between groups need to be interpreted cautiously and are reported as limitations in the discussion of the research results, as shown in Table 3.

Table 3. Convergent Validity and Construct Reliability

Construct	Items	Factor Loadings	Average Variance Extracted (AVE)	Composite Reliability	Cronbach's Alpha
ChatGPT Usage	PC1-PC5	0.712-0.864	0.612	0.887	0.842
Problem-Solving Ability	PS1-PS6	0.734-0.891	0.658	0.921	0.899
Achievement Motivation	MB1-MB7	0.701-0.823	0.571	0.901	0.876

The results of the measurement model evaluation showed that all indicators in the three research constructs ChatGPT usage, problem-solving ability, and achievement motivation had loading factor values above the threshold of 0.70, with a value range of 0.701 to 0.891. The Average Variance Extracted (AVE) values for all constructs were also above 0.50 (range 0.571-0.658), indicating that each construct was able to explain more than 50% of the variance in its indicators. Thus, the convergent validity of this research model was met according to the recommended criteria (Hair et al., 2019). In addition, the Composite Reliability (0.887-0.921) and Cronbach's Alpha (0.842-0.899) values for all constructs were above 0.70, indicating that the research instrument had a good level of internal consistency (Edelsbrunner et al., 2025; Pentapati et al., 2025).

Table 4. Discriminant Validity Assessment Using the HTMT Criterion

Construct	ChatGPT Usage	Problem-Solving Ability	Achievement Motivation
ChatGPT Usage			
Problem-Solving Ability	0.584		
Achievement Motivation	0.512	0.637	

Discriminant validity testing using the Heterotrait-Monotrait Ratio (HTMT) criterion shows that all HTMT values between constructs are below the threshold of 0.90 (range 0.512-0.637), so it can be concluded that the third research construct ChatGPT use, problem-solving ability, and

incentive motivation has adequate discriminant validity. These results indicate that each construct is empirically separate from one another and does not experience excessive context overlap, in accordance with the criteria developed as a more reliable alternative to the conventional Fornell-Larcker criterion (Bin Amatan et al., 2025).

Table 5. Coefficient of Determination and Predictive Relevance

Endogenous Variable	R ²	Category	Q ² _predict
Problem-Solving Ability	0.446	Moderate	0.318

The R² value of 0.446 indicates that ChatGPT usage, achievement motivation, and the interaction between these two variables collectively explain 44.6% of the variance in problem-solving ability. Moreover, the Q²_predict value greater than zero demonstrates that the model has adequate predictive relevance (Hair et al., 2019).

The coefficient of determination (R²) value of 0.446 indicates that the variables of ChatGPT usage, achievement motivation, and the interaction effect of the two together are able to explain 44.6% of the variance in students' problem-solving abilities, which according to Cohen's (1992) criteria is classified as moderate. Meanwhile, the predicted Q² value of 0.318 (greater than zero) indicates that the research model has adequate predictive relevance to out-of-sample data, in accordance with the PLSpredict procedure recommended (Chicco et al., 2021). These findings indicate that the developed model not only explains the relationship between variables in-sample but also has good generalization capabilities.

Table 6. Results of Path Coefficient Testing

Hypothesis	Structural Path	Path Coefficient (β)	t-Statistic	p-Value	f ²	Decision
H1	ChatGPT Usage → Problem-Solving Ability	0.386	4.215	< 0.001	0.214	Supported
H2	Achievement Motivation → Problem-Solving Ability	0.291	3.102	0.002	0.126	Supported
H3	ChatGPT Usage × Achievement Motivation → Problem-Solving Ability	0.157	2.084	0.037	0.031	Supported (small moderating effect)

The results of hypothesis testing using the bootstrapping procedure with 5,000 subsamples demonstrated that ChatGPT usage had a positive and statistically significant effect on students' problem-solving ability ($\beta = 0.386$; $t = 4.215$; $p < 0.001$; $f^2 = 0.214$). Therefore, H1 was supported, indicating that ChatGPT utilization contributed substantially to improving students' problem-solving ability.

Achievement motivation also showed a positive and significant effect on problem-solving ability ($\beta = 0.291$; $t = 3.102$; $p = 0.002$; $f^2 = 0.126$). Thus, H2 was supported, suggesting that students with stronger achievement motivation tended to demonstrate better problem-solving performance.

The interaction analysis further revealed that the interaction between ChatGPT usage and achievement motivation had a positive and statistically significant effect on problem-solving ability ($\beta = 0.157$; $t = 2.084$; $p = 0.037$). However, the effect size of the interaction term was relatively small ($f^2 = 0.031$), indicating that although achievement motivation plays a statistically significant moderating role, its practical contribution to explaining additional variance in problem-solving ability is limited. Therefore, H3 was supported with a small moderating effect. These findings suggest that students with higher achievement motivation may benefit slightly more from ChatGPT-assisted learning activities, but the effectiveness of ChatGPT appears to be primarily explained by its direct contribution rather than by the interaction effect.

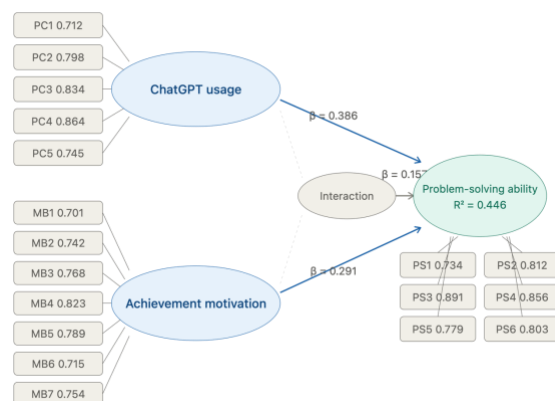


Figure 2. Full PLS-SEM model of the relationship between ChatGPT usage and problem-solving ability, moderated by achievement motivation.

The findings of this study indicate a positive effect of ChatGPT on students' problem-solving abilities ($\beta=0.386$), reported an effect size of $g=0.933$ specifically for the problem-solving dimension one of the largest effects among all cognitive dimensions studied (Wang et al., 2025; Zhu et al., 2025). This finding is also consistent, finding that ChatGPT improved the quality of students' creative solutions while simultaneously reducing cognitive load (Urban et al., 2024). This consistency across contexts strengthens the argument that ChatGPT functions as cognitive scaffolding, rather than simply a passive information-seeking tool.

However, not all studies report positive results. Found no significant difference in programming students' practical task performance after 15 weeks of ChatGPT intervention (Kosar et al., 2024). Even reported a 25.1% decrease in learning efficiency in students who relied solely on ChatGPT for writing assignments (Kessler, 2025). These differences likely stem from varying intervention durations and the risk of over-reliance displacing independent thinking. Thus, the effects of ChatGPT appear to be contextual, depending on how it is integrated into the learning design.

The primary contribution of this study lies in the role of achievement motivation as a moderator ($\beta=0.157$), addressing the issue identified (Bratu et al., 2025) regarding the scarcity of research on moderator variables in the context of ChatGPT. These findings also align, who found that individual characteristics moderate students' intentions and usage of ChatGPT (Jo, 2024). A question remaining for future research is whether this moderation pattern is linear or follows an inverted U-shape, where very high achievement motivation might risk diminishing students' critical attitude toward ChatGPT outputs. This direction opens opportunities for further research employing nonlinear analysis or the segmentation of motivation groups.

CONCLUSION

This study found that ChatGPT usage was positively and significantly associated with students' problem-solving abilities in the Instructional Media Design course. Achievement motivation demonstrated a statistically significant but relatively modest moderating role in this relationship. These findings suggest that the effectiveness of ChatGPT-assisted learning is not entirely uniform across students, as motivational characteristics may influence the extent to which learners utilize AI-based tools to support their cognitive processes. However, the small magnitude of the interaction effect indicates that achievement motivation functions as a contextual facilitator rather than the primary determinant of ChatGPT effectiveness.

Theoretically, this study contributes to the growing literature on generative artificial intelligence adoption in higher education by highlighting the role of individual motivational factors in shaping learning outcomes. The findings extend current discussions regarding AI-supported learning by demonstrating that technological affordances and learner characteristics should be considered simultaneously when examining AI effectiveness. Furthermore, this study expands empirical evidence from the under-researched mainland Southeast Asian higher education context, where investigations of ChatGPT-supported instructional practices remain limited.

Practically, the findings indicate that successful integration of ChatGPT into instructional settings should not focus solely on technological availability and accessibility. Educational institutions should also consider strategies that promote students' achievement motivation, self-regulated learning, and purposeful engagement with AI-based learning tools. Such approaches may help students use ChatGPT more effectively as a cognitive support resource rather than merely as an information retrieval tool.

This study has several limitations that should be considered when interpreting the findings. First, although the study employed a 14-week intervention with pre-test and post-test measurements, the quasi-experimental design was conducted without random assignment of participants, which limits the extent to which causal relationships can be established. Second, the use of cluster sampling may restrict the generalizability of the findings beyond the participating institutions. Third, the study involved students from only two Southeast Asian countries, and therefore the findings should not be generalized to the broader Southeast Asian higher education context without further validation. Fourth, because the investigated constructs were measured using self-reported instruments, potential common method bias should be considered despite the procedural and statistical controls applied.

Future research should employ randomized controlled designs, longitudinal approaches, and larger multi-country samples to further examine the long-term effects of ChatGPT-assisted learning. Future studies may also investigate other learner characteristics, such as AI literacy, self-regulated learning, cognitive engagement, and digital competence, to provide a more comprehensive understanding of the mechanisms underlying AI-supported learning effectiveness.

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DECLARATION OF GENERATIVE AI

During the preparation of this manuscript, the authors used OpenAI ChatGPT to assist with language refinement, grammatical correction, academic wording, and improving the clarity and readability of the manuscript. The AI tool was not used to generate, manipulate, or fabricate research data, statistical results, or research findings. Following the use of this tool, the authors carefully reviewed, verified, and edited the generated content and took full responsibility for the accuracy, integrity, and final content of the publication.

ETHICAL STATEMENT

This study was conducted in accordance with ethical principles applicable to research involving human participants. Ethical approval was obtained from Chiang Mai University (Faculty of Education) and the Royal University of Phnom Penh - RUPP (Faculty of Education / Institute of Foreign Languages), under approval numbers [RUPP-REC-2026-031 and No. ED-042/2026]. Participation was voluntary, and all participants were informed about the study's objectives, procedures, confidentiality, and data usage prior to providing informed consent. Participants were assured that their identities and personal information would remain confidential and that they could withdraw from the study without penalty. The collected data were used solely for academic and research purposes, and no personally identifiable information is disclosed in this manuscript.

AUTHORS' CONTRIBUTION

Author 1: Writing - review and editing.

Author 2: Research implementation; Data analysis; Validation.

Author 3: Data curation; Investigation; Reference management; Literature review; Research support and manuscript improvement.

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