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The Impact of Intrinsic Motivation as Predictors of Academic Achievement: The Mediating Role of Deep Learning and Surface Learning in Learning Mathematics

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Keywords

intrinsic, extrinsic, task value, academic achievement, surface learning, deep learning

Abstract

This study examines the relationship between academic inspiration in mathematics and internal motivation, the chis of extrinsic incentives, subjective task value with a specific focus on the moderate roles played by deep learning and shallow is tape. A cross-sectional research design and validated questionnaires were used to collect data from high school students at the various and total number of educational institutions in one metropolitan area included 571 high school students. Non-urban (32.0% male and 43.8% female, Urban, 8.9% male and 15.2% female, mean age = 17.20, SD = 0.294, Cronbach's α = 0.720) from Kampong Cham Province, Cambodia. What the findings of this study make clear is that intrinsic motivation quite significantly predicts academic achievement; compared with servant motivation, it even has a big edge. Surface learning tactics negatively affected academic success, while deep learning strategies promoted it. It also found out that subjective task value increased the predictive validity of intrinsic motivation for success. Such findings demonstrate just how complex the relationships are between a great many motivating factors and learning processes, all aspects of which teachers need to nurture in order for their students 'success in math to succeed.

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INTRODUCTION

Understanding the key elements that affect achievement in mathematics learning holds the key to raising students' grades and, ultimately, assisting Cambodia's educational system to gain acceptance in the international community (Berkvens, 2017; Duggan, 1996). UNDP and UNESCO declare that good education is a precondition for sustainable development, but successful teaching techniques have to be found which will result in higher individual students` achievements and increased general participation (Bora & Science, 2025; Duggan, 1996; Educational et al., 2016; UNDP & measures, 2021). This study examines the relationship between mathematical academic achievement and subjective task value, extrinsic reward, and intrinsic motivation, particularly in a context where educational obstacles remain (Adamma et al., 2018; Federici & Skaalvik, 2014; Michaelides et al., 2019; Phan, Harth, et al., 2025). Intrinsic motivation has been demonstrated to have a positive correlation with academic achievement, as it fosters meaningful engagement with the material (Phan & Harth, 2025; R. M. Ryan & E. L. J. C. e. p. Deci, 2000). The World Economic Forum said that there needs to be a balance between internal and external motivation in order to build a workforce that can keep up with a fast-changing economy (Carnevale, 1990; Ndudi et al., 2023; Phan, Harth, et al., 2025). The concept of subjective task value, which pertains to students' perceptions of the significance and utility of mathematics in their lives, significantly influences their motivation and engagement (Eccles & Wigfield, 2002; Phan, Harth, et al., 2025). Increasing students' understanding of the importance of mathematics can result in better academic performance in Cambodia, where it is typically perceived as a difficult subject (Bora & Science, 2025; Phan, Harth, et al., 2025; Phan & Harth, 2025).

The mediating functions of surface learning and deep learning strategies further clarify the correlation between these motivational factors and academic success (Bora & Science, 2025; Hu et al., 2020; Phan & Harth, 2025).

Deep learning is distinguished by an emphasis on comprehending and applying knowledge, whereas surface learning (Hu et al., 2020), usually entails rote memorization and superficial engagement (Biggs, 1987b; Phan & Harth, 2025). According to research, students who use deep learning techniques (Phan & Harth, 2025), which are frequently motivated by internal motivation and a high subjective task value generally perform better academically when learning mathematics (Hu et al., 2020; Marton & Säljö, 1976; Phan, Harth, et al., 2025).

The relationship between intrinsic motivation, extrinsic reward, and subjective task value as determinants of academic achievement has drawn attention in educational psychology, particularly in the area of mathematics learning (Phan, Harth, et al., 2025; Phan & Harth, 2025; R. M. Ryan & E. L. J. C. e. p. Deci, 2000). Extrinsic motivation is the impact of demands or rewards from outside sources on behavior, whereas intrinsic motivation is the innate desire to act for its own sake (Deci & Ryan, 1985; Locke & Schattke, 2019; R. M. Ryan & E. L. J. C. e. p. Deci, 2000). Because intrinsic motivation encourages greater engagement and persistence in learning tasks, research has repeatedly demonstrated a positive relationship between it and academic performance (Bhaduri et al., 2011; Meece et al., 2006; Phan, Harth, et al., 2025).

On the other hand, extrinsic incentives can also be very important, especially if they enhance intrinsic factors and increase students' performance and effort (Bhaduri et al., 2011; Deci et al., 1999a; Eisenberger et al., 1999). Additionally, the concept of subjective task value that is, the perceived importance and applicability of a task has been found to be a crucial factor influencing motivation and success (Rebitzer & Taylor, 2011; R. M. Ryan & E. L. Deci, 2000; Wigfield & Eccles, 2002). Students are more likely to take a keen interest in mathematics and perform better academically when they see how applicable the subject is to their daily lives (Arthur et al., 2018; Sharma & Technology, 2021; YEO, 2010). The connection between these motivating elements and academic achievement is further clarified by the mediating functions of surface learning and deep learning techniques (Hua et al., 2024; J. Zuo et al., 2024). The focus on comprehending and applying mathematical knowledge sets surface learning apart from other methods, which typically involve rote memorization and surface-level engagement (Biggs, 1987b; Phan, Harth, et al., 2025). According to studies, students who use deep learning strategies which are frequently motivated by intrinsic motivation and subjective task value generally perform better academically in mathematics learning (Marton & Säljö, 1976; J. Zuo et al., 2024).

The goal of this study is to examine how subjective task value, extrinsic incentive, and intrinsic motivation affect mathematical performance as predictors, with a focus on the mediating roles of surface and deep learning (Kamberi, 2025; Song et al., 2022; J. Zuo et al., 2024). Examining these connections may help develop a classroom environment that fosters mathematical competency and boosts motivation (Chan et al., 2023; Kamberi, 2025; Phan, Harth, et al., 2025; Phan & Harth, 2025). The purpose of this study is to examine how academic performance in mathematics is predicted by intrinsic motivation, extrinsic incentive, and subjective task value in the Cambodian environment, with an emphasis on the mediating functions of deep and surface learning (Bora & Science, 2025; Chan et al., 2023; Kamberi, 2025; Yang et al., 2025). We can provide recommendations on how to develop a classroom setting that supports Cambodian students' mathematical proficiency and boosts their enthusiasm by examining these relationships, which aligns with the broader goals set by international organizations (Diseth & differences, 2011; Vanthournout et al., 2014; Yang et al., 2025; Zhang et al., 2022).

1.1. Academic achievement

Academic achievement in mathematics is a crucial area of study for educational researchers in developing nations like Cambodia, where social and economic development depend on educational reforms (Marshall et al., 2012; Ngo & Practice, 2013; Pov et al., 2021). According to the research, a number of factors, such as motivation, instructional strategies, and sociocultural contexts, affect how well children do in mathematics (Edens & Potter, 2013; Wang et al., 2020).

Higher academic achievement has been connected to intrinsic motivation, or a sincere desire to study (R. M. Ryan & E. L. J. C. e. p. Deci, 2000). In Cambodia, where students typically encounter obstacles such as scarce resources and high-stakes exams, developing intrinsic desire is essential for improving involvement and tenacity in mathematics studies (Lavasani et al., 2011; Reed et al., 2008; Schunk & DiBenedetto, 2021). However, extrinsic motivation which is influenced by outside variables like grades and parental expectations can also have an effect on students' performance (Al-Dhamit & Kreishan, 2016; Ginsburg & Bronstein, 1993). But it might not maintain interest over time (Deci et al., 1999a; Deci et al., 1999b). The quality of mathematics instruction has a big impact on children's academic performance. According to this study, active learning strategies that encourage student participation and critical thinking yield better results than traditional lecture-based mathematics instruction (Fan & Williams, 2010; Freeman et al., 2014; Gottfried et al., 1994; Iqbal et al., 2023).

Since many classrooms in Cambodia still use rote memorization and passive learning, implementing student-centered teaching strategies is necessary to improve mathematics instruction (Educational et al., 2016; Gottfried et al., 1994; Sayed & Ahmed, 2015). To understand how students engage with mathematical content, it is also necessary to understand the distinctions between surface learning and deep learning methodologies (Chin & Brown, 2000; Dolmans et al., 2016; Fauskanger & Bjuland, 2018). While surface learning, which is defined as memorization without comprehension, usually yields worse results, deep learning, which involves a thorough understanding and application of topics, is linked to academic success (Biggs, 1987a, 1987b) (Marton & Säljö, 1976; Saljo & Marton, 1976). Students in Cambodian schools can gain a deeper understanding of mathematics instruction by utilizing deep learning techniques (Nhem & Kobakhidze, 2025; Sokkhey et al., 2020). Cambodian students' academic performance in mathematics is significantly influenced by their sociocultural background (Kim, 2002; Phan & Harth, 2025; Pov et al., 2021; Sothan, 2019). There are numerous factors that could affect students' motivation and performance, including their financial status, parental involvement, and cultural perspectives on education (Chhin et al., 2018; Eng et al., 2016; Phan & Harth, 2025).

Although many Cambodian households place a high value on education, financial constraints may limit access to resources and learning support (Chen et al., 2007; Tan & practice, 2007). These sociocultural barriers must be addressed in order to improve academic performance in mathematics (Bora & Science, 2025; Phan, Harth, et al., 2025; Ravet & Mtika, 2024), education, but some national and international organizations, like the Peace Family and Development Organization (PFDO), work to support students (Getachew & Birhane, 2016; Phan, Harth, et al., 2025; Springer et al., 2007).

1.2 Intrinsic Motivation

Students' academic performance is greatly impacted by intrinsic learning motivation, or the desire to participate in an activity because it is interesting and fulfilling, especially when learning mathematics (Phan, Harth, et al., 2025; Phan & Harth, 2025; Trevino & DeFreitas, 2014). In Cambodia, where educational issues persist, improving math performance and student engagement necessitates an awareness of the elements that promote intrinsic motivation (Bora & Science, 2025; Phan, Harth, et al., 2025; Trevino & DeFreitas, 2014).

Students' engagement and performance in mathematical learning are greatly impacted by intrinsic motivation, particularly when taking into account Cambodia's educational system (Augustyniak et al., 2016; Phan, Harth, et al., 2025; Phan & Harth, 2025). The literature review's statement highlights the unique opportunities and difficulties faced by Cambodian math students while summarizing recent studies that look at the variables influencing their intrinsic motivation (Gottfried et al., 1994; Hanus et al., 2015; Pestana et al., 2023).

Cultural Context: Students' intrinsic motivation for mathematics learning is greatly influenced by Cambodian cultural norms. According to Phan et al. (2025), depending on how well these ideas mesh with contemporary teaching methods, conventional views about education and achievement can either increase or decrease students' enthusiasm to participate in mathematics learning (Mwilongo et al., 2025; Phan, Harth, et al., 2025). The intrinsic motivation of students in mathematics learning is greatly influenced by the cultural values of Cambodia (Mwilongo et al., 2025; Phan, Harth, et al., 2025). Depending on how well they mesh with contemporary teaching methods, conventional views about education and achievement can either increase or decrease students' enthusiasm to study mathematics, according to Phan et al. (2025).

Task Value: An important factor in determining intrinsic motivation is the perceived worth of mathematics learning. A quasi-experimental study by Phan et al. (2025) showed how highlighting the practical uses of mathematics learning might boost students' intrinsic motivation and encourage deeper learning strategies (Phan, Harth, et al., 2025; Phan & Harth, 2025).

Parental Support: Improving intrinsic motivation in mathematics requires parental participation. According to (Ismail et al., 2018; Rowan-Kenyon et al., 2012), students who are grow up in supportive home circumstances are more likely to follow their mathematical interests because they feel more invested in their education and are more motivated to mathematics learning (Rowan-Kenyon et al., 2012; Wang, 2012).

Socioeconomic Factors: Levels of intrinsic motivation can be influenced by socioeconomic status. Particularly pertinent to the Cambodian students context, (Théry et al., 2018) discovered that students in Cambodia from lower socioeconomic backgrounds frequently encounter extra difficulties that can reduce their intrinsic motivation, such as restricted access to educational resources and assistance (Chen et al., 2018; Chiu et al., 2008; Mata et al., 2012).

1.3 Extrinsic Motivation

Students' performance and level of engagement in math classes are greatly influenced by extrinsic motivation, especially in the context of Cambodia (Chhor et al., 2024; Phan, Harth, et al., 2025; Sambonin & Liu, 2017). This literature review statement summarizes current research on the variables influencing extrinsic motivation in order to highlight the particular opportunities and difficulties faced by Cambodian students in math classes (Chhaing & Phon, 2023; Phan, Harth, et al., 2025).

Incentives and Rewards: Students' attitudes toward mathematics learning are greatly influenced by extrinsic motivators like grades and awards (Adamma et al., 2018; Phan, Harth, et al., 2025). According to Phan et al. (2025), Outside rewards are usually well received by students, which might boost their learning motivation to finish arithmetic projects, especially in a competitive environment (Adamma et al., 2018; Mzomwe, 2018).

Parental Expectations: One of the most important extrinsic motivators for students is parental participation and expectations (Mata et al., 2012; Mzomwe, 2018). High academic expectations from parents might boost their children’s drive to perform well in mathematics learning as they strive to achieve themselves (Middleton & Spanias, 1999; Phan, Harth, et al., 2025; Phan & Harth, 2025; Phan, Long, et al., 2025).

Teacher Influence: One important source of extrinsic motivation is teachers (Phan, Harth, et al., 2025). Teachers can boost their students' interest in learning mathematics by effectively utilizing praise, appreciation, teaching self-confidence, and teaching instructional attitude, claim Phan et al. (2025), (Noels et al., 1999; Phan, Harth, et al., 2025). This recognition could increase students' interest in the subject, which could create a positive feedback loop (Carless & Education, 2019; Noels et al., 1999; Phan, Harth, et al., 2025).

Socioeconomic Factors: The efficacy of extrinsic motivators may be impacted by socioeconomic level (Boekeloo et al., 2015; Li et al., 2025). Due to restricted access to resources and support, students from lower socioeconomic backgrounds may rely more heavily on extrinsic rewards, which can have an impact on their overall motivation and mathematical learning performance (Carless & Education, 2019; Chen et al., 2018).

Cultural setting: The cultural context in Cambodia affects how extrinsic incentive is perceived and used. Cultural beliefs about learning and success can affect how students respond to extrinsic motivators, with some believing that external rewards are essential to their academic success (Phan, Harth, et al., 2025; Phan & Harth, 2025).

1.4 Subjective Task Value

Subjective task value, which encompasses the perceived importance, utility, and enjoyment of their task, has a significant impact on students' motivation and engagement in mathematics studies (Federici & Skaalvik, 2014; Vanslambrouck et al., 2018). To improve educational attainment in Cambodia, educators, parents, and students must comprehend how subjective task value affects students' attitudes toward learning mathematics (Li et al., 2016; Phan, Harth, et al., 2025; Phan & Harth, 2025; Vanslambrouck et al., 2018).

Research indicates that students' perceptions of the significance of learning mathematics have a significant impact on their motivation to do so (Gilbert et al., 2014; Hossein-Mohand & Hossein-Mohand, 2023). Claims that many students in Cambodia struggle with mathematics because they are not interested in it, which can lead to disengagement and poor academic performance (Phan, Harth, et al., 2025; Phan & Harth, 2025). Improving students' subjective task value is crucial to fostering a positive learning atmosphere and improving their overall perceptions of learning mathematics (Arthur et al., 2017; Hagan et al., 2020).

Student's perceptions of mathematics learning are also influenced by Cambodia's social and cultural context (Mutodi & Ngirande, 2014; Pantziara et al., 2015). Many students find mathematics study to be a challenging and abstract subject, which might demotivate them. According to (Cai & Evaluation, 2022; Li et al., 2016), The inclusion of culturally relevant examples and mathematical applications in the curriculum may raise students' subjective task value by demonstrating the significance of mathematics learning in daily life (Lazarides et al., 2020; Ng et al., 2016).

Teachers also have a big influence on how pupils view learning mathematics. claims that the expectations and comments that students receive from their teachers can have a significant impact on how they view the importance of learning mathematics (Arthur & Statistics, 2019; Ng & Education, 2018). By assisting teachers in communicating the significance of learning mathematics, professional development programs that enhance their pedagogical abilities can raise students' subjective task values in Cambodia (Hattie & psychology, 2015; Phan, Harth, et al., 2025; Phan & Harth, 2025).

1.5 Surface learning

Surface learning, which is characterized by a focus on memorization and minimal engagement with the material, presents a number of challenges for math learners (Corte, 2004; Dolmans et al., 2016). Understanding the prevalence and effects of surface learning is essential to improving students' mathematical learning proficiency and overall educational outcomes in Cambodia (Dolmans et al., 2016; Phan, Harth, et al., 2025; Phan & Harth, 2025).

According to research, a large number of Cambodian students have surface learning habits, which are frequently brought on by conventional teaching strategies that prioritize memorization over conceptual understanding (Dinsmore & Alexander, 2012; Phan, Harth, et al., 2025). Claims that this method prevents students from applying mathematical concepts they have learned in real-world contexts, which leads to a lack of critical thinking abilities and a deep comprehension of the material (Phan, Harth, et al., 2025; Richland et al., 2012). According to Bora, students in Cambodian classrooms typically place more emphasis on memorization than active engagement with the material because of the emphasis on passing tests, which results in surface learning (Phan, Harth, et al., 2025; Phan & Harth, 2025).

Surface learning persists in Cambodia due to a combination of structural and cultural factors (Corte, 2004). Standardized testing is typically given priority in the educational system, which promotes surface learning techniques, (Tu & Hwang, 2024). Instead of grasping the fundamental ideas of mathematics, students might feel under pressure to memorize formulas and procedures (Nesher, 1986). The development of deeper or more sophisticated thinking abilities necessary for successful mathematical learning may be hampered by this emphasis on testing (Bora & Science, 2025; Chan et al., 2025; Hwang et al., 2024).

Students' approaches to learning are also greatly influenced by their teachers (Dolmans et al., 2016). According to Hattie (2009), good teaching methods can provide more in-depth learning opportunities (Hattie & Donoghue, 2018; Hattie & psychology, 2015). The emphasis can be shifted from surface learning to deeper engagement with mathematical topics in Cambodia with the support of professional development programs that give educators the tools they need to foster conceptual understanding and critical thinking (Bora & Science, 2025; Hattie et al., 2020; Phan, Harth, et al., 2025).

1.6 Deep Learning

Effective mathematics teaching requires deep learning, which is defined by a comprehensive grasp of concepts and the capacity to apply knowledge in a variety of contexts (Fauskanger & Bjuland, 2018; Mishra et al., 2021). Promoting deep learning in mathematics is essential in Cambodia to improve students' overall academic achievement and problem-solving abilities (Berner et al., 2021; Bora & Science, 2025; Chan et al., 2025; Phan, Harth, et al., 2025; Phan & Harth, 2025).

According to research, deep learning is frequently underrepresented in Cambodian math classes, where conventional teaching approaches might place more emphasis on rote memorization than conceptual understanding (Schoenfeld, 2022; Tian et al., 2022). According to (Phan & Harth, 2025), a lack of instructional strategies that encourage critical thinking and application makes it difficult for many students to engage with mathematical learning concepts on a deeper level (Phan & Harth, 2025; Shield & Dole, 2013). According to Bora, fostering an atmosphere that values inquiry and discovery is essential to helping students become more adept at deep learning (Bora & Science, 2025; Chan et al., 2025; Phan & Harth, 2025).

Cultural and institutional factors also affect how common deep learning is in Cambodia (Chiv et al., 2025; Heng et al., 2022). According to Chhin & Hwang (2019), the emphasis on standardized testing often leads to a focus on surface learning techniques, which may hinder students' ability to engage deeply with mathematical content (Lin et al., 2019). The pressure to score well on tests may limit students' opportunities for in-depth learning and discourage them from actively exploring mathematical concepts (Hwang et al., 2019; Phan, Harth, et al., 2025).

In order to encourage in-depth mathematical learning, teachers are crucial. Students' learning experiences can be greatly improved by employing effective teaching strategies like giving feedback, promoting student participation, and cultivating a development mindset (Hattie et al., 2009; Phan, Harth, et al., 2025). In the Cambodian setting, professional development programs that equip teachers with innovative teaching methods might help shift the focus from memorization to a better comprehension of mathematical learning concepts (Bora & Science, 2025; Hattie & psychology, 2015; Phan, Harth, et al., 2025).

1.7 The study's purpose and hypothesis

The goal of the study

Investigating the effects of intrinsic motivation, extrinsic incentive, and task value on mathematical academic accomplishment among Cambodian students is the aim of this study (Phan & Harth, 2025; Phan & Huu, 2024). The project intends to investigate the ways in which these motivating elements predict academic success as well as the mediating functions of surface learning and deep learning in this relationship (Phan, Harth, et al., 2025; Phan & Harth, 2025). Understanding these relationships will help the study provide light on how various motivational styles affect mathematical learning results, which will help shape educational practices and policies in Cambodia (Phan, Harth, et al., 2025).

Hypotheses

Hypothesis 1 (H_1): Academic success in mathematics is favorably predicted by intrinsic drive. According to this theory, pupils who are more intrinsically motivated would perform better academically in mathematics since they will be more involved and interested in the topic.

Hypothesis 2 (H_2): Mathematical academic success is favorably predicted by extrinsic motivation. According to this theory, kids who are driven by outside factors like grades or parental approval will likewise perform better academically in mathematics, however the outcome may be different from that of those who are motivated by internal factors.

Hypothesis 3 (H_3): Academic success in mathematics is positively predicted by task value. According to this theory, children will perform better academically in mathematics if they believe the topic is worthwhile and applicable to their daily life.

Hypothesis 4 (H_4): The relationship between task value, extrinsic motivation, intrinsic motivation, and academic accomplishment in mathematics is mediated by deep learning. According to this theory, greater levels of task value, extrinsic incentive, and intrinsic motivation will encourage more people to use deep learning techniques, which will improve academic achievement (Phan, Harth, et al., 2025).

Hypothesis 5 (H_5): The link between task value, intrinsic motivation, extrinsic incentive, and academic accomplishment in mathematics is adversely mediated by surface learning. According to this theory, reliance on surface learning techniques, such rote memorization, might impede academic success even while intrinsic and extrinsic motivations may encourage some learning engagement (Phan, Harth, et al., 2025).

Hypothesis 6 (H_6): There is a substantial correlation between intrinsic motivation, extrinsic incentive, task value, and academic accomplishment when deep learning and surface learning are combined. According to this hypothesis, both forms of learning are important in determining how motivating variables affect academic success, with surface learning possibly diminishing achievement and deep learning maybe enhancing it (Phan, Harth, et al., 2025).

The project intends to further understanding of how task value, intrinsic motivation, and extrinsic incentive impact mathematical academic achievement, particularly in the context of Cambodian education, by testing these theories (Phan, Harth, et al., 2025; Phan & Harth, 2025). The findings are expected to give educators and legislators practical strategies to increase student motivation and promote more engaging learning opportunities, which will eventually lead to improved academic achievement in mathematics (Bora & Science, 2025; Phan, Harth, et al., 2025; Phan & Harth, 2025)

METHODS

2.1 Participants

This study was conducted with high school students in Kampong Cham Province, Cambodia, to gather their perceptions through questionnaires. It focuses on mathematics learning subject matter, behaviors' learning engagement and learning approach. The mathematics improvement course is designed to improve math proficiency of other majoring. This course dealt with the application of learning motivation and learning approach. A total of 571 high school students. Non-urban (32.0% male and 43.8% female, Urban, 8.9% male and 15.2% female, mean age = 17.20, SD = 0.294, Cronbach's α = 0.720) from Kampong Cham Province, Cambodia, participated in the study. The sociodemographic characteristics are presented in Table 1. Students were selected through (describe sampling method, e.g., random, convenience, stratified sampling). Participation was voluntary, and consent was obtained from students and school authorities.

Table 1. lists the sociodemographic characteristics of the sample.

location	Gender	Counts	% of Total	Cumulative %
non-urban	male	183	32.0%	32.0%
	female	250	43.8%	75.8%
urban	male	51	8.9%	84.8%
	female	87	15.2%	100.0%

Note. N 571.

2.2 Instrumentation Statement

This study will use a structured questionnaire as the main tool for data collection in order to examine the effects of intrinsic motivation, extrinsic incentive, and task value on academic progress in mathematics (Phan, Harth, et al., 2025). The primary constructs of the study, such as academic accomplishment, deep learning, surface learning, task value, intrinsic motivation, and extrinsic motivation, will all be measured via the questionnaire (Phan, Harth, et al., 2025).

2.3 Measurement Constructs

Students' intrinsic motivation to study and complete academic assignments will be assessed using the Academic Drive Scale (AMS), developed by Vallerand et al. (1992). This construct will be assessed using items from this scale (Vallerand & Blssonnette, 1992). The measure's primary focus is on students' interest in and satisfaction with learning mathematics (Vallerand et al., 1992).

Extrinsic Motivation: Using items from the same AMS, extrinsic motivation will be assessed. It will concentrate on outside variables that influence students' interest in mathematics, such as grades, awards, and recognition (Nielsen, 2018; Pelletier et al., 1995).

Task Value: A modified version of the Wigfield and Eccles (2000) Task Value Scale will be used to evaluate the task value construct (Phan & Harth, 2025; Phan, Long, et al., 2025; Wigfield & Eccles, 2000). Students' opinions of the value, practicality, and appeal of mathematics in their life are assessed using this scale (Eccles & Wigfield, 2020; Phan, Harth, et al., 2025).

Deep Learning: The Deep Approach to Learning Scale, which evaluates students' use of meaningful learning strategies including critical thinking and mathematical problem-solving, will be used to measure deep learning (Mathis & Mathis, 2020; Phan, Harth, et al., 2025).

Surface Learning: Items from the Surface Approach to Learning Scale, which gauges pupils' dependence on rote memory and cursory comprehension of mathematical topics, will be used to assess surface learning (Dolmans et al., 2016; Phan, Harth, et al., 2025).

Academic Achievement: Students' self-reported grades and performance on mathematics examinations will be used to gauge their academic achievement in the subject, giving a numerical indication of their level of success (Allen & Ideas, 2005).

2.4. Data analysis

To evaluate the data, JAMOVI Version 2.7.3 was used. Descriptive statistics were used to all sociodemographic variables and academic achievement. Pearson Chi-Square was used to examine significant differences in the relationship between sociodemographic characteristics and academic achievement levels. The relationship between the study's main variables was investigated using correlation analysis.

RESULT AND DISCUSSION

Table 1 displays the participants' sociodemographic information as well as the differences in distribution between groups. A total of 571 high school students. Non-urban (32.0% male and 43.8% female, Urban, 8.9% male and 15.2% female, mean age = 17.20, SD = 0.294, Cronbach's α = 0.720) from Kampong Cham Province, Cambodia, participated in the study.

Table 2 displays the reliability of the measuring apparatus based on the Cronbach's alpha coefficient. We may observe that for every research variable, the Cronbach's alpha falls between outstanding Cronbach's α 0.672, Mean 3.92, SD 0.307, McDonald's ω 0.730. Additionally, they strongly mirror the Cronbach's alpha α .73 to.86; (Biggs et al., 2007; Briggs et al., 2003; Vallerand et al., 1992); that is produced from standardized items.

Table 2. Scale Reliability Statistics

	Mean	SD	Cronbach's α	McDonald's ω
scale	3.92	0.307	0.672	0.730

Table 3 displays the differences between sociodemographic learning characteristics and items. Pearson Chi-square was used to examine significant differences in the relationship between the variables. The results show that there is no significant difference between intrinsic motivation, extrinsic motivation, task value, surface learning, and deep learning between students' living arrangements and academic performance; students from urban and rural locations had comparable distributions of high and low academic success. Similarly, academic achievement and students' year of study do not significantly differ, with high and low academic achievement being equally distributed throughout the second and third years of study. However, it shows a substantial difference between study funding and academic achievement.

Table 3. Reliability of measuring the instrument (according to Cronbach's alpha coefficient).

				If item dropped	
	Mean	SD	Item-rest correlation	Cronbach's α	McDonald's ω
Learning Motivation	3.88	0.398	0.796	0.547	0.649
Intrinsic learning motivation	3.79	0.607	0.375	0.641	0.706
Extrinsic learning motivation	3.61	0.724	0.398	0.642	0.704
Subjective task value	4.26	0.477	0.164	0.691	0.741
Learning Approach	3.97	0.377	0.581	0.602	0.684
Surface learning approach	4.23	0.500	0.169	0.691	0.747
Deep learning approach	3.72	0.535	0.412	0.628	0.703

Table 4. Correlation between sociodemographic factors and academic achievement.

			Academic achievement level %			
Predictor	**Estimate**	**SE**	**Lower**	**Upper**	**t**	**p**
Intercept[a]	0.9892	0.1588	0.6772	1.3011	6.228	9.18e-10
location:						
urban – non-urban	0.0900	0.0293	0.0324	0.1475	3.071	0.00224
Gender:						
female – male	-0.0154	0.0241	-0.0627	0.0319	-0.638	0.52367
Academic Achievement	0.7583	0.0405	0.6786	0.8379	18.700	3.85e-61

[a] Represents reference level

Depending on whether a student is self-financed, family-financed, or receives a scholarship, the distribution of high and low academic achievement varies.

Table 5 presents the study variables' means, standard deviations, and correlations. Intrinsic motivation to know was found to be positively associated with academic achievement (0.880, p < .05, ** p < .01, *** p < .001p<.01), deep learning (0.289, p < .05, ** p < .01, *** p < .001), intrinsic motivation to experience stimulation (0.679, p < .05, ** p < .01, *** p < .001), and intrinsic motivation toward accomplishment (0.679, p <.01). Academic achievement (0.587, p <.01), deep learning approach (0.289, p <.01), and intrinsic desire toward accomplishment (0.679, p <.01) were all positively correlated with intrinsic motivation to experience stimulation. Academic achievement (0.880, p <.01) and deep learning approach (0.679, p <.01) were strongly correlated with intrinsic motivation for achievement. Academic achievement was favorably correlated with deep learning approach (0.289, p <.01).

To test the mediation effects between intrinsic motivation to know, intrinsic motivation to experience stimulation, intrinsic motivation toward accomplishment, and academic achievement through deep strategy of learning, in this study using 571 bootstrap procedure resampling. We discovered a positive and direct correlation between academic achievement and intrinsic motivation to learn (b .12, p .04, 95% CI (.003,.236), proving the first hypothesis. However, academic achievement was not directly associated with intrinsic motivation to experience stimulation or intrinsic motivation toward accomplishment (b −.04, p .47, 95% CI (−.145,.067), b .08, p .09, 95% CI (−.012,.186), respectively), which contradicted Hypotheses 1b and 1c. In terms of the mediation effects, we discovered that the deep learning strategy mediated the relationship between academic achievement and intrinsic motivation to know (b .03, SE 02, 95% CI (.001,.075), academic achievement and intrinsic motivation to experience stimulation (b 03, SE .01, 95% CI (.001,.055), but not between academic achievement and intrinsic motivation toward accomplishment (b .02, SE ¼.01, 95% CI (−.001,.036). This finding partially confirms Hypothesis 2. These findings demonstrate that a higher deep learning technique acted as a mediating factor in the association between academic achievement and students' scores on intrinsic motivation to know. Only via the use of deep learning techniques was there a strong indirect association between academic achievement and intrinsic motivation to experience stimulation (see Figure 1 and Table 6).

Table 5. Means, standard deviations, and correlations between study variables.

	LM	ILM	ELM	STV	LA	SLA	DLA	AA
Learning Motivation	—							
Intrinsic learning motivation	0.679 ***	—						
Extrinsic learning motivation	0.766 ***	0.247 ***	—					
Subjective task value	0.479 ***	0.053	0.087*	—				
Learning Approach	0.223 ***	0.193 ***	0.178 ***	0.041	—			
Surface learning approach	0.027	-0.003	0.089*	-0.065	0.705 ***	—		
Deep learning approach	0.289 ***	0.275 ***	0.168 ***	0.118 **	0.749 ***	0.059	—	
Academic Achievement	0.880 ***	0.618 ***	0.678 ***	0.389 ***	0.658 ***	0.364 ***	0.587 ***	—

Notes. Higher scores correspond to higher values of the specified construct for all variables (e.g., higher intrinsic motivation to know). Intrinsic motivation (IM). p <.01. Note. * p < .05, ** p < .01, *** p < .001

The primary objective of this study was to examine the direct and mediating relationships between different types of intrinsic drive and academic success using a learning motivation and learning approach (Froiland et al., 2012). The results support Hypothesis 1a by showing a positive and significant correlation between intrinsic willingness to learn and demonstrated academic success (Augustyniak et al., 2016). Feelings of fulfillment and pleasure are the outcome of intrinsic motivation to learn, explore, or discover new things (Vallerand & Blssonnette, 1992).

The results of the study thus confirm for the students that the most representative type of intrinsic motivation that is directly related to the academic success of their approach to learning mathematics is intrinsic motivation for learning mathematics (Kamberi, 2025). Similar results have been found in previous research, but those studies have only examined intrinsic learning motivation as a single concept without differentiating between its various forms (Izuchi et al., 2017; Kamberi, 2025; R. M. Ryan & E. L. J. C. e. p. Deci, 2000; Vecchione et al., 2014).

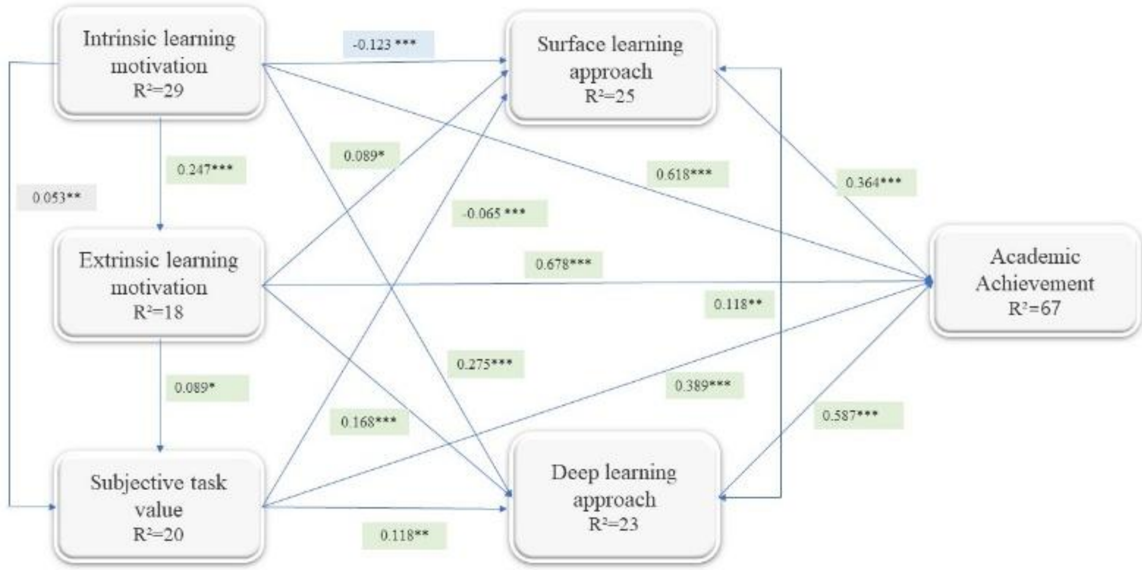

Figure 1 shows how different forms of intrinsic motivation, extrinsic motivation, task value affect surface learning, deep learning and academic performance when used in conjunction with a deep learning technique. Coefficients that are standardized are given. TE = total effects. IM = Intrinsic motivation. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 5. Types of intrinsic motivation have both direct and indirect effects on academic accomplishment when using deep learning strategies.

	CI intervals of confidence		
	B	SE	95%CI
Intrinsic motivation to know	.15	.09	[.002, .276]
Direct effect			
The indirect effect through a deep learning	.05	.04	[.001, .078]
Intrinsic motivation to experience stimulation	−.03	.07	[−.145, .069]
Direct effect			
The indirect effect through a deep learning	.06	.04	[.001, .056]
Intrinsic motivation toward accomplishment	.09	.05	[−.015, .176]
Direct effect			
The indirect effect through a deep learning	.04	.03	[−.001, .046]

Notes. CI intervals of confidence. B coefficient of standardized regression. Bold effects are significant.

The lack of a direct correlation between academic success and intrinsic motivation for effort and achievement disproved hypotheses 1b and 1c. This conclusion may be explained by the fact that kids who are naturally excited and driven to succeed might not value grades as much. Rather, they study material that goes beyond the required curriculum, which promotes a feeling of personal satisfaction. Therefore, pursuing objectives that improve their competence and skill sets is highly valued by people who are naturally driven to succeed (Carbonneau et al., 2012).

Students who are driven by an innate need for stimulation are also more likely to participate in academic pursuits that satisfy their need for excitement and stimulation while completing assignments (Kamberi, 2025). The idea that the three forms of intrinsic drive might have different effects, which could account for the noteworthy outcomes, is supported by this observation (Trevino & DeFreitas, 2014). Hence, intrinsic drive should not be seen as a single concept for learning mathematics, but rather as a complex idea (Trevino & DeFreitas, 2014).

Regarding the mediation effects, we found that the deep learning strategy for mathematics partially validated Hypothesis 2 by mediating the relationship between academic achievement and intrinsic motivation to know, academic achievement, and intrinsic motivation to experience stimulation, but not between academic achievement and intrinsic motivation to accomplish (Adamma et al., 2018; Al Shuaili & Reviews, 2025; Trevino & DeFreitas, 2014).

The results of the study showed that students who performed better academically also had higher scores on the intrinsic learning motivation to know scale. Furthermore, this connection was lessened by a more sophisticated deep learning method (Juriševič et al., 2008). This suggests that students who are genuinely motivated to study are driven primarily by intrinsic incentive to learn since they are interested in the task at hand and eager to explore novel concepts to increase their general knowledge (Schapiro & Livingston, 2000). A deep learning approach is employed throughout the learning process because the content is interesting and relevant (Ahmad et al., 2018).

This dual nature promotes greater learning tenacity and deeper information absorption (Saritha et al., 2019). As a result, these factors support improved academic performance. Researchers like (Vansteenkiste et al., 2006) have reported similar findings, indicating that students who use deep learning strategies typically exhibit higher mathematics academic achievement (Saritha et al., 2019). However, these findings are limited to studies in which intrinsic motivation was evaluated as a single construct rather than stratified by type (Aguiar-Castillo et al., 2021).

Given that intrinsic motivation to learn is one of the forms of intrinsic learning motivation that are fully incorporated into the internal representation of mathematics learning (Aguiar-Castillo et al., 2021; Vallerand, 2007), students who are more likely to exhibit this motivational orientation will naturally adopt the deep learning strategy (Briggs et al., 2003) and learn because they enjoy learning new things, which also improves their mathematics academic achievement (Vansteenkiste et al., 2009).

Academic achievement and intrinsic motivation to experience stimulation were only significantly correlated indirectly through the use of deep learning, according to the results of other studies (Aguiar-Castillo et al., 2021; Dargan et al., 2020). In this instance, their academic success in mathematics is not shown to be mediated by the deep learning approach (Lau et al., 2008; Lavelle-Hill et al., 2024). This relationship can be explained by the fact that trying new things and finding inner fulfillment are the main goals of intrinsic motivation to experience stimulation (Dai et al., 2025; S. Zuo et al., 2024). High academic achievement in mathematics results from this, and students may occasionally incorporate various learning strategies (Dai et al., 2025; Dinsmore & Alexander, 2016).

Finally, intrinsic motivation for mathematics achievement demonstrates that a student is committed to the learning process primarily because of the satisfaction and joy that comes from reaching new objectives (An et al., 2024; Hayat et al., 2020). In this case, achieving greater academic success in mathematics becomes the objective, though not always for the enjoyment of the knowledge gained during the learning process (Ardura & Galán, 2019; Valadas et al., 2017). This suggests that in order to achieve greater academic success in mathematics, the student may employ a number of strategies in addition to deep learning (Alotaibi & Alanazi, 2021; Cai et al., 2025).

CONCLUSION

In summary, a number of mediating factors significantly influence the relationship between academic achievement and learning motivation in mathematics learning, including intrinsic motivation, extrinsic motivation, task value, deep learning, and surface learning (Everaert et al., 2017; Kamberi, 2025; Phan & Harth, 2025). Research has shown that when intrinsic motivation is used to cultivate a genuine interest in learning mathematics, higher levels of engagement and persistence are observed (R. M. Ryan & E. L. J. C. e. p. Deci, 2000). According to Biggs (1987), students who get personal fulfillment from their education are more likely to use deep learning techniques, which improve their comprehension and memory of mathematical learning concept (Biggs, 1987b).

On the other hand, extrinsic motivation might not support long-term mathematics academic performance, even though it might be useful in the short term (Wild & Neef, 2023; Yarin et al., 2022). It frequently results in surface learning strategies, where pupils prioritize rote repetition over comprehension (Entwistle & McCune, 2004). Students' task value in mathematics learning has a big influence on their motivation and learning performance as well (Lavasani et al., 2010; Tossavainen, Rensaa, Haukkanen, et al., 2021). Students are more inclined to interact deep learning approach with mathematics major when they believe it to be meaningful and relevant, which improves mathematics academic performance (Eccles & Wigfield, 2002). According to the study's findings, only intrinsic motivation to learn is favorably and directly associated with mathematics academic success out of the three forms of intrinsic motivation (Phan, Harth, et al., 2025).

The results of the study also imply that deep learning strategies acted as a mediator in the association between academic achievement and intrinsic motivation to learn and intrinsic motivation to experience stimulation (Bong, 2004; Tossavainen, Rensaa, Johansson, et al., 2021). Interestingly, there was only a substantial indirect correlation between academic achievement and intrinsic willingness to experience stimulation through deep learning (Rach et al., 2024; Rach, 2023). Students who are engage in class activities purely for enjoyment and excitement may not prioritize learning or success as much as (Phan, Harth, et al., 2025; Ratelle et al., 2004).

The results of this investigation constitute a noteworthy contribution to the corpus of academic literature (Chambers, 2007; Conrad & education, 1996). The results emphasize the need to eliminate a few intrinsic motivation-related subscales, such as intrinsic motivation for achievement and intrinsic motivation for experience (Harackiewicz et al., 1993). This is because when a deep learning technique was used to examine the direct relationship between academic achievement and intrinsic motivation, only the intrinsic motivation to know subscale was relevant (Phan, Harth, et al., 2025). According to these results, the "intrinsic motivation to know" subscale is the most significant example or prototype of the intrinsic motivation construct in an academic context (Rheinberg & Engeser, 2018).

The findings suggest that educators should try to create classroom environments that emphasize the value of learning mathematics and boost students' intrinsic motivation for learning (Heyman et al., 1992; Rheinberg & Engeser, 2018). By fostering a culture of deep learning and providing opportunities for students to connect mathematical concepts to real-world applications, teachers can promote higher academic achievement (Dede, 2014; Mierluş-Mazilu & Yilmaz, 2023). Future studies should continue to explore these relationships, particularly across a range of educational contexts, in order to develop useful strategies for improving student motivation and mathematical learning achievement (Cleary & Kitsantas, 2017; Gilbert et al., 2014).

LIMITATIONS AND SUGGESTIONS FOR FUTURE STUDIES

The main focus of this study was on task value, intrinsic and extrinsic motivation, and how they relate to mathematics academic success, surface learning, and deep learning (Malek et al., 2020; Phan, Harth, et al., 2025; Phan & Harth, 2025). This restricted focus could ignore other important elements that affect learning results, like social dynamics in the classroom or emotional intelligence (Phan, Harth, et al., 2025; R. M. Ryan & E. L. J. C. e. p. Deci, 2000). Data was collected at a particular point in time using a cross-sectional methodology. This restricts the capacity to make causal deductions about the long-term effects of internal and extrinsic motives on learning outcomes (Biggs, 1987b; Malek et al., 2020; Phan, Harth, et al., 2025).

To gain a deeper understanding of these interactions, longitudinal research is required (Thomson & Holland, 2003). Using self-reported surveys to measure learning motivation and learning approach may introduce bias since participants may not accurately reflect their true motivations or learning styles (Pintrich, 2003; Thomson & Holland, 2003). Future studies should use observational methods or performance-based assessments to verify self-reported data (Kiechle et al., 2015; Schmitter-Edgecombe et al., 2011).

The study was conducted in a specific cultural environment, which would have reduced the generalizability of the findings in other mathematics educational settings (Guo et al., 2018). Studying in a range of educational environments is essential since cultural influences can significantly affect motivation and learning skills (Guo et al., 2018; Hattie & Timperley, 2007). The sample was unable to fairly represent the entire student body, particularly in terms of socioeconomic status, ethnicity, and educational background. This limitation might make it more difficult to extrapolate the results to different student demographics (Parker et al., 2012; Wigfield & Eccles, 2002). Future research should look at additional factors that influence learning strategies and academic achievement, such as emotional intelligence, peer pressure, and teacher support. This would provide a deeper understanding of the learning process (Guo et al., 2018; Schunk et al., 2008). By using longitudinal designs, researchers may monitor how motivation and learning techniques evolve over time, giving them a better understanding of how these characteristics affect academic accomplishment at various educational stages (Zimmerman, 2002). Utilizing a correlational techniques approach may improve the data's richness (Wolters et al., 2006). Deeper understanding of students' motives and educational experiences could be obtained by combining quantitative surveys with qualitative interviews or focus groups (Creswell et al., 2014). To evaluate how cultural characteristics affect intrinsic and extrinsic motivation, task value, and learning techniques, future research should incorporate a variety of cultural contexts (Hidi, 2000; Zhang et al., 2025). This would aid in comprehending if the results are universal or specific (Hattie & Timperley, 2007; Hidi, 2000).

The findings would be more broadly applicable if the sample was expanded to include a wider variety of students with respect to socioeconomic level, ethnicity, and educational background (Marks, 2011; Williams et al., 2010). Multi-site research conducted at various educational institutions may be necessary for this (Eccles & Wigfield, 2002).

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