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Resultado de Investigación

THE ROLE OF EPISTEMOLOGICAL BELIEFS IN PREDICTING ENGINEERING MATHEMATICS COURSE PERFORMANCE: THE MEDIATING ROLE OF MOTIVATIONAL BELIEFS

EL PAPEL DE LAS CREENCIAS EPISTEMOLÓGICAS EN LA PREDICCIÓN DEL DESEMPEÑO EN EL CURSO DE MATEMÁTICAS DE INGENIERÍA: EL PAPEL MEDIADOR DE LAS CREENCIAS MOTIVACIONALES

O PAPEL DAS CRENÇAS EPISTEMOLÓGICAS NA PREVISÃO DO DESEMPENHO DO CURSO DE MATEMÁTICA DE ENGENHARIA: O PAPEL MEDIADOR DAS CRENÇAS MOTIVACIONAIS

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Abstract

Learning mathematics and developing mathematical thinking skills are two of the most important aims of engineering coursework. However, engineering students often find it difficult to grasp the complexities of mathematics despite its importance to the field. The widespread lack of math self-confidence among engineering students is a major obstacle to a successful engineering mathematics education. Current research seeks to understand the mediating role of motivational beliefs in the relationship between epistemological and predictive beliefs. The statistical population consisted of all engineering students at Islamic Azad University, Shahr-e Ray Branch. From this population, 107 undergraduate male and female students in engineering fields—who had previously completed Mathematics 1, Mathematics 2, and Differential Equations courses—were randomly selected. The research was conducted during the first semester of the 2022–2023 academic year. After explaining the purpose of the study and recruiting participants, students filled out online versions of Schumer's Epistemology and Pentridge's Motivational Questionnaire. After collecting data using PLS, he analyzed it using his PLS technique. The subsequent outcomes are as follows. The three variables (epistemological beliefs, motivational beliefs, and academic performance) are all interconnected in significant ways. Academic success can be predicted in part by students' epistemological beliefs, with motivational beliefs acting

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as a moderator. In other words, epistemological and motivational beliefs influence students' academic performance.

Keywords: Epistemological Beliefs; Motivational Beliefs; Academic Performance; Engineering Education; Engineering Mathematics; Mathematical performance.

Resumen

Aprender matemáticas y desarrollar habilidades de pensamiento matemático son dos de los objetivos más importantes de los cursos de ingeniería. Sin embargo, a los estudiantes de ingeniería a menudo les resulta difícil comprender las complejidades de las matemáticas a pesar de su importancia para el campo. La falta generalizada de confianza en sí mismos en las matemáticas entre los estudiantes de ingeniería es un obstáculo importante para una educación matemática de ingeniería exitosa. La investigación actual busca comprender el papel mediador de las creencias motivacionales en la relación entre las creencias epistemológicas y predictivas. La población estadística estuvo compuesta por todos los estudiantes de ingeniería de la Universidad Islámica Azad, Sede Shahr-e Ray. De esta población, se seleccionaron aleatoriamente 107 estudiantes universitarios (hombres y mujeres) de carreras de ingeniería que habían cursado previamente las asignaturas de Matemáticas 1, Matemáticas 2 y Ecuaciones Diferenciales. La investigación se llevó a cabo durante el primer semestre del año académico 2022-2023. Después de explicar el propósito del estudio y reclutar a los participantes, los estudiantes completaron versiones en línea de la Epistemología de Schumer y el Cuestionario motivacional de Pentridge. Después de recopilar datos utilizando PLS, los analizó utilizando su técnica PLS. Los resultados posteriores son los siguientes. Las tres variables (creencias epistemológicas, creencias motivacionales y desempeño académico) están interconectadas de manera significativa. El éxito académico puede predecirse en parte a partir de las creencias epistemológicas de los estudiantes, y las creencias motivacionales actúan como moderadoras. En otras palabras, las creencias epistemológicas y motivacionales influyen en el desempeño académico de los estudiantes.

Palabras Clave: Creencias epistemológicas; creencias motivacionales; rendimiento académico; educación en ingeniería; matemáticas para ingeniería; Rendimiento matemático.

Resumo

Aprender matemática e desenvolver habilidades de pensamento matemático são dois dos objetivos mais importantes dos cursos de engenharia. No entanto, os alunos de engenharia geralmente acham difícil entender as complexidades da matemática, apesar de sua importância para o campo. A falta generalizada de autoconfiança matemática entre os alunos de engenharia é um grande obstáculo para uma educação matemática de engenharia bem-sucedida. A pesquisa atual busca entender o papel mediador das crenças motivacionais na relação entre crenças epistemológicas e preditivas A população estatística foi composta por todos os estudantes de engenharia da Universidade Azad Islâmica, campus Shahr-e Ray. Desse grupo, foram selecionados aleatoriamente 107 alunos de graduação (homens e mulheres) dos

cursos de engenharia que já haviam cursado as disciplinas de Matemática 1, Matemática 2 e Equações Diferenciais em semestres anteriores. A pesquisa foi realizada no primeiro semestre do ano letivo de 2022-2023.Depois de explicar o propósito do estudo e recrutar participantes, os alunos preencheram versões online da Epistemologia de Schumer e do Questionário Motivacional de Pentridge. Depois de coletar dados usando PLS, ele os analisou usando sua técnica PLS. Os resultados subsequentes são os seguintes. As três variáveis (crenças epistemológicas, crenças motivacionais e desempenho acadêmico) estão todas interconectadas de maneiras significativas. O sucesso acadêmico pode ser previsto em parte pelas crenças epistemológicas dos alunos, com as crenças motivacionais atuando como moderadoras. Em outras palavras, as crenças epistemológicas e motivacionais influenciam o desempenho acadêmico dos alunos.

Palavras-Chave: Crenças epistemológicas; crenças motivacionais; desempenho acadêmico; educação em engenharia; matemática de engenharia; Desempenho matemático.

1. Introducción

In the current era, the increasing development of technology has brought tremendous changes in human life, and simple life has given way to complex life. Mathematics has more than ever found its place in all social and industrial fields, and humans are increasingly turning to mathematics to help solve the complex problems of their lives. Based on this, today, higher education systems worldwide are striving to.

OECD's Programme for International Student Assessment (PISA) in 2002 Supported pupils' intellectual and logical growth by including mathematics in the curriculum so they can keep up with scientific and technological breakthroughs and their future lifestyles (Rastgar et al, 2014). The primary goal of education, according to researchers, practitioners, and policymakers, should be to provide students with the mathematical skills necessary to succeed in the workplace and in society at large (PISA, OECD, 2002).

Hence, developing one's analytical and self-control skills is one of the main goals of taking mathematics courses for students. The goal of teaching it is to strengthen one's capacity for perception, comprehension, and reasoning, as well as to cultivate rational thought and build a system for logical reasoning, argumentation, and creativity. Mathematical education is beset with problems that not only make teaching this subject difficult but also endanger the lives of many people by causing a mathematical decline. Thus, the concept of mathematical failure encompasses any student whose academic performance falls short of expected levels and goes beyond the context of an exam failure and retake (Chen, 2013).

So, it can be said that one of the goals of teaching mathematics is to develop learners' mental abilities and intellectual order. The aim of teaching it is to develop the power of perception, understanding, and reasoning, nurture rational thinking, create a method of argumentation, logical thinking, and fostering creativity.

Mathematics holds a critical place in engineering education. According to the American Society for Engineering Education (Meyer & Marx, 2014), over 40% of engineering students either drop out or change their majors. Institutions and individuals both have an impact. In 2014, the American Society for Engineering Education (ASEE) held the opinion that courses in mathematics, physics, and chemistry taught by instructors outside of the engineering department should be included in the engineering curriculum. Students know these classes are important, but they frequently don't connect the mathematics they learn

in these classes and the fields they want to pursue. References (Cardella, 2007 Gruenwald et al, 2010). Others consider mathematics as a gateway for talented individuals to enter engineering (Winkelman, 2009). Professional engineers also use mathematics extensively in their work (Goold & Devitt, 2012). Despite the importance of mathematics for engineers, learning mathematics is a major issue for engineering students. The lack of confidence among engineering students in learning mathematics has been reported as one of the fundamental challenges of engineering education in Australia (Cuthbert & MacGillivray, 2003).

Academic performance refers to the learned or acquired abilities of an individual in educational subjects, which are measured through standardized learning assessments or teacher-made exams (Mousavinejad, 1997).

Mathematics grades are included in final averages. In addition to the classroom setting, students' academic success may also be influenced by their immediate social and emotional environments,

However, it should be noted that mathematical performance is part of overall academic performance. Various factors (environmental, educational, familial, and individual) can influence academic performance.

As well as their families and personal circumstances. Factors in family relationships (parental neglect, failure to establish appropriate and friendly relationships with students, parental interference with studies, distance from family, family economic poverty, student employment), and a lack of knowledge about the proper way to study mathematics among students (Mousavinejad, 1997). According to Yarmohammadi &Maggi (2018) there have been several studies looking at different facets of mathematics achievement in the classroom. Epistemological ideas based on students' misunderstandings about the nature of mathematics, its difficulties, and the dullness of mathematics instruction have been singled out as a major cause of student disengagement (Yarmohammadi & Maggi, 2018)

Wheeler) 2007) explains that the word epistemology comes from the Greek word for "the study and interpretation of knowledge," and it refers to theories about the nature, origins, and extent of human knowledge. It examines the relationship between the knower and the known, as well as the composition, standards, and degree of certainty of various types of knowledge (Klein,2005; Schommer, 1990). Schommer proposed a model of epistemological understanding that is more systematic than other systems regarding knowledge. Domains are classified as either simple or complex, knowledge stability as either deterministic or relative, learning ability as either innate or acquired, and learning velocity as either rapid or progressive (Schommer et al, 2005). Schommer believed that epistemological beliefs were largely independent of other beliefs. He reasoned that different epistemological assumptions can influence students in different ways. As per Dweck (2008a), our worldviews are shaped by our beliefs, which also serve to explain the importance of our experiences and establish the fundamental values that guide our day-to-day actions. According to theorists like (Perry 1999; Hofer & Pintrich, 1997) learning strategies, the process of gaining knowledge, problem-solving skills, information processing and evaluation abilities, comprehension, and academic achievement are all influenced by one's epistemological beliefs.

Cognitive ability and motivation are two other factors that influence students' learning and academic performance in this area. Cognitive functions include knowing, understanding, diagnosing, and thinking, whereas motivation encompasses emotional state, perspective, and assessment. In the past, learning and education have benefited from students' motivation Pintrich & Schunk, 1996; Covington, 2000). It has consistently been one of the most crucial elements influencing academic achievement (Areepattamannil, 2011). Because people are naturally proactive in accomplishing their goals, when people are motivated to participate in this domain by the possibility of success in the future, their levels of activity tend to increase

(Lee et al., 2010). As a result, motivating beliefs can be defined as a person's set of social and personal standards that they use to determine whether or not to act, per the research of (Lepper et al., 2005).

Overall, motivational beliefs are of particular importance as determinants of motivation in learning and academic performance among engineering students. Educational psychologists pay special attention to this factor, alongside cognitive factors, in explaining, predicting, and controlling students' academic performance. Understanding motivational beliefs and their components is important because it helps administrators, educators, and academic advisors in recognizing the factors that influence and direct students' learning. Furthermore, making necessary changes in the levels of various motivational components—such as self-efficacy, intrinsic valuation, and test anxiety—can serve as a fundamental strategy to help students improve their academic performance, particularly in mathematics.

The topic of motivation has a special meaning in psychology, and one cannot understand psychological phenomena in this sense without understanding the motivation for action. Students with many differences in their academic progress have often been shown to be very similar in terms of their learning abilities and talents. Motivational and cognitive factors are considered (Linnenbrink & Pintrich, 2000).

Components such as self-efficacy, intrinsic value, and exam anxiety were considered, respectively, as indicators of motivational components. Students' mathematical self-efficacy beliefs refer to their judgments about the confidence in their abilities to understand and solve mathematical problems, complete tasks, or succeed in mathematical activities (Pajares &Miller, 1994).

Intrinsic task value: Intrinsic task value refers to the importance that a student places on completing or learning a particular lesson or subject. In other words, intrinsic task value is the extent to which a task or subject is important to the student (Ames& Archer, 1988).

The third motivational component relates to students' emotional and affective reactions to the task. An important question for students is: 'How do I feel about this task?' Several emotional and affective responses may occur (e.g., anxiety, fear, anger, pride, etc.), but in learning situations, one of the most significant appears to be exam anxiety. Exam anxiety refers to the fears that individuals exhibit during an exam or while performing a task (Dusek, 1980). In order to create systematic directions for academic progress and enhance student performance, motivational and epistemological beliefs are crucial (Heikkilä et al. 2011).

Based on the aforementioned theoretical foundations, it can be argued that epistemological beliefs influence academic performance through two pathways:

Direct Pathway: Epistemological beliefs are directly related to academic performance. For instance, Shariqa et al. (2021), in a study titled "Epistemological Beliefs and Girl Students' Academic Achievements regarding Mathematics Curriculum," demonstrated that epistemological beliefs have a direct and significant relationship with the academic achievement of female high school students.

Indirect Pathway (Mediating): Epistemological beliefs affect academic performance through their influence on motivational beliefs. Thus, it can be stated that epistemological beliefs can affect students' motivation and their use of learning strategies. Students who adopt a more complex view of knowledge are more likely to set mastery-oriented learning goals and engage more deeply with the learning material. Epistemological beliefs also influence our motivational beliefs—such as our activeness in using learning strategies—and ultimately our academic performance (Shell & Husman, 2008). Pintrich and Schunk (1996) believe that epistemological beliefs are a predictive factor for academic performance, and they define motivation as a force that energizes, sustains, and directs behavior toward this goal. Epistemological beliefs encompass individuals' personal beliefs about science and how it is acquired. Some consider mathematics as the gateway to engineering and as a facilitator for good design.

Therefore, it can be said that epistemological beliefs can influence students' motivation and use of learning strategies. Students who adopt a more complex view of knowledge are more likely to have mastery-oriented goals for learning and engage more deeply with the learning materials.

Pintrich & Schunk (1996) believe that epistemological beliefs are a predictor of academic performance and define motivation as a driving, sustaining, and directing force of behavior toward this goal.

Individuals' personal views about science and how to become experts in it are included in their epistemological views. Some believe that mathematics serves as the starting point for engineering and excellent design (Winkelman, 2009).

Research has been conducted in this direction:

Rosjanuardi & Jupri (2022). The focus of a study named "Epistemological Obstacle in Learning Trigonometry" is on epistemological roadblocks in the teaching of mathematics. They discovered that pupils frequently lack a basic understanding of trigonometry. Understanding these epistemological roadblocks can help teachers better comprehend the misconceptions held by their students.

In a study titled "Teachers' Epistemology on the Origin of Mathematical Knowledge," Obreque & Andalon (2020) examined the socio-epistemological theory of mathematics education, which recognizes mathematics as a human endeavor that is reconstructed and conceptualized in certain fields. Most of the time, the findings showed that educators view mathematics as prior knowledge and credit human behavior for its discovery, interpretation, and formalization.

An investigation into the relationship between associate degree students' epistemological beliefs and lifelong learning was conducted at a state university in Turkey under the title "Investigation of The Relationship between Lifelong Learning and Epistemological Beliefs of Associate Degree Students" (Gürbüz & Karakuyu ,2021). The results of the study indicated that lifelong learning and epistemological beliefs have a positive, significant, and moderately strong relationship.

An analysis of the correlation between eighth-grade Taiwanese students' scientific achievement and their motivational beliefs was conducted in a study titled "Patterns of Motivational Beliefs in the Science Learning of Total, High and Low-Achieving Students: Evidence of Taiwanese TIMSS 2011 Data" (Wang & Liou, 2018). In contrast to certain other international programs, Taiwanese students demonstrated low motivational beliefs in learning the sciences, despite their high academic achievement in this subject. Obreque & Andalon (2020) came to the conclusion that learning science is aided by motivational beliefs.

A review of the literature on science, math, engineering, and math (STEM) education in Indonesia was done by (Khotimah et al., 2021). In Khotimah (2021), a study titled "Science, Technology, Engineering, and Mathematics (STEM) Education in Indonesia: A Literature Review" was carried out. The study looked at how STEM education affected student learning in Indonesia and came to the conclusion that STEM education improved students' achievement, character, attitude, scientific literacy, critical thinking, creative thinking, and 21st-century skills. A meta-analysis by Li et al (2022) examined how students' motivation to study math is affected by math anxiety.

The relationship between mathematics motivation and anxiety among K–12 students was examined in a meta-analysis by Li et al. (2022), titled "Relationship between mathematics anxiety and students' motivation to learn mathematics," which examined the effects of potential moderating factors, including various motivational measures, dimensions of mathematics anxiety, student developmental stage, and cultural background. When the results were evaluated for overall applicability, they showed a somewhat negative correlation between students' math anxiety and motivation.

In a study titled "Evaluating students' motivational beliefs regarding science learning across grade level and gender," there is also a reference to (Liou et al., 2021). "If motivational beliefs of students regarding science learning (e.g., G., gender) were looked at, there are significant differences in self-concept in science and the intrinsic value of science across grades levels. The results of the hierarchical regression analyses showed that there is a significant correlation between science achievement and motivational beliefs in science. However, there were differences in motivational beliefs in science related to gender and grade level, as well as science achievement.

In a study titled "Teaching mathematics to engineering students," Sazhin (1998) and Gruenwald et al., (2008) investigated how some novel concepts might help with teaching mathematics to University of Brighton mechanical engineering students. They came to the conclusion that general equations should be illustrated with real-world numerical examples, and that mathematics is a language for expressing the laws of physics, chemistry, and engineering. They also discovered that the concepts of physics are far more straightforward than those of mathematics.

It is essential to provide practical numerical examples when explaining general equations, as physical concepts hold more significance than mathematical concepts. Mathematics serves as the language for articulating laws in the fields of physics, chemistry, and engineering. Surprisingly, the complexity of the subject was much lower than expected. The successful completion of the Engineering Mathematics course signifies the fulfillment of a crucial component within the specialized Engineering curriculum. The concerning trend of college students either avoiding enrollment or attending only initial sessions of engineering mathematics courses has become more evident in recent times, indicating a lack of interest in learning the subject and its associated tasks.

The lack of effort exerted by students in engineering mathematics exams leads to their failure in these assessments. It is important to note that Mathematics 1 and 2, as well as differential equations, are required prior to taking this course. Hence, the objective of this research is to address the following inquiry: 1. Do epistemological beliefs directly predict academic performance in engineering mathematics?

2. Do motivational beliefs directly predict academic performance in engineering mathematics?

3. Do epistemological beliefs and motivational beliefs influence students' performance in engineering mathematics?

Methodology:

In the first semester of 2021-2022, a statistical population was formed by 107 male and female engineering students who had successfully completed mathematics 1, 2, and differential equations, and were currently enrolled in engineering mathematics courses. Upon learning about the study's objectives and being encouraged to participate, the participants were requested to complete Schumer's epistemology and Pentridge's motivational questionnaires online. Following a detailed explanation of the research goals and obtaining consent from the participants, the Schommer Epistemological Beliefs and Pintrich motivational beliefs questionnaires were administered online using a Likert scale with 5 options: strongly agree, agree, no opinion, disagree, and strongly disagree.

The Pentrich et al. (1991) Motivational Beliefs Questionnaire consists of 25 five-choice questions based on the Likert spectrum, which includes components of self-efficacy, orientation, lack of test anxiety, and intrinsic valuation.

The Willer (2007) epistemological beliefs questionnaire in mathematics education consists of 6 components:

1. Source of knowledge (referring to the extent of learner agency and role in acquiring knowledge);

2. Knowledge structure (involving coherence, viewing knowledge as a collection of isolated or independent data, or as a set of related concepts);
3. Certainty of knowledge (beliefs regarding the certainty or temporality of knowledge);
4. Intrinsic personal ability or intrinsic general ability (whether the individual believes in the intrinsic nature of learning ability or sees it as subject to progress and improvement, in other words, whether learning ability is inherent or acquirable and changeable);
5. Speed of learning (believing in rapid learning and avoiding engagement and continuous activity for learning);
6. Application in the real world (referring to the usability of mathematical knowledge in real life).

Self-efficacy, intrinsic valuation, and test anxiety are components of motivational beliefs.

a) Self-efficacy: It creates a sense of ability in individuals to achieve academic success. In other words, self-efficacy can be defined as a personal judgment that a person has about their own abilities to design and pursue an educational goal (Panoura, 2003).

b) Intrinsic valuation of task: Intrinsic valuation refers to the degree of importance that students attach to performing a task, learning a subject, or a specific topic (Ames & Archer, 1998).

c) Test anxiety: Test anxiety refers to the fears that individuals show when performing a task. According to Dusek's (1980) perspective, test anxiety is an unpleasant state of behavioral and psychological consequences that manifests during exams or when performing a task.

Based on the questions (e.g., "I know that I can learn the course materials," "Learning the subject is important to me," "I get so nervous during exams that I cannot remember what I have learned," "I learn mathematics better when the instructor solves practical examples," "Mathematics is just knowing the right formula to solve problems," etc.), the researcher decided to use the questionnaires. The overall reliability of the questionnaires was examined using Cronbach's alpha, which was estimated to be 0.86 and 0.84, respectively.

In this section, the results of the data analysis are presented. First, descriptive statistics, including means and standard deviations, were calculated for the multiple variables. Then, to provide a simple overview of the relationships among the variables, a zero-order correlation matrix was computed for the main research variables. Subsequently, to test the proposed model, structural relationships among the research variables were examined using structural equation modeling (SEM).

Findings:

The descriptive statistics for the study variables are presented in Table 1.

Mean and standard deviation are presented in Table 1 as descriptive measures of the study variables.

Table 1

Descriptive measures of mean and standard deviation of study variables

SD	M	Subscales	Factor
3.63145	22.1028	Source of knowledge (SOK)	Cognitive beliefs (CB)
6.38483	21.6822	Certainty of knowledge (COK)	
4.48220	23.6729	Structure of knowledge (ST.OK)	

5.31778	16.3271	The speed of acquiring knowledge (SAK)	
5.23522	15.3178	innate ability (individual) (IAI)	
5.95797	23.4860	Inherent ability (general) (IAG)	
6.14771	25.6542	Application in the real world (ARW)	
21.38587	148.2430	Cognitive beliefs (CB)	
6.29366	33.7383	Efficacy(E)	Motivational beliefs
4.08072	19.2710	Goal orientation (GO)	
3.45345	14.7477	Internal valuation (IV)	
7.40962	23.0561	No exam anxiety (NOA)	
16.00361	90.8131	Motivational beliefs (MB)	
2.77052	15.2645	math 1	Academic Performance
3.01892	15.0678	Math 2	
3.42016	14.5023	Equations	
2.38474	14.9449	Academic Performance (AP)	

All of the data are currently normally distributed. Cognitive beliefs as mediators of academic performance in structural models for predicting academic success:

See Table 2 for a matrix depicting the relationships between the variables in the study)

Table 2

Correlation matrix between study variables

3	**2**	**1**	Matrix of variables
		1	Cognitive beliefs (CB)
	1	.488**	Motivational beliefs
1	.510**	.623**	Academic Performance

Repeatedly reiterating the letters "PLS" The PLS research theoretical model was put to the test, and the influence coefficients were calculated, using the structural equation modeling technique built into the PLS software. Examination of the Presuppositions:

Predictive: Mediator of motivational beliefs; epistemological beliefs.

The initial diagram displays the coefficients of the latent paths, denoting the importance of each path, determined through the utilization of Smart PLS software. The significance of path coefficients in structural equations depends on the obtained t-value exceeding the critical value ($t \geq 1.96$).

Matching chassis:

Measurement model fit, structural model fit, and global model fit can all be used to evaluate the adequacy of a model. Modify your model's dimensions.

Reliability: PLS

Validating the trustworthiness of research measurement models using Cronbach's alpha and other combined reliability checks. Cronbach's alpha and combined reliability are computed by analyzing the factor loadings of the questions using the PLS data analysis algorithm. Below is a table displaying the findings.

Here, we take a look at how to use PLS to test research hypotheses. Factor-loading diagram for the study structure shown in Figure 1.

Figure 1
Structural model of studies with factor loading

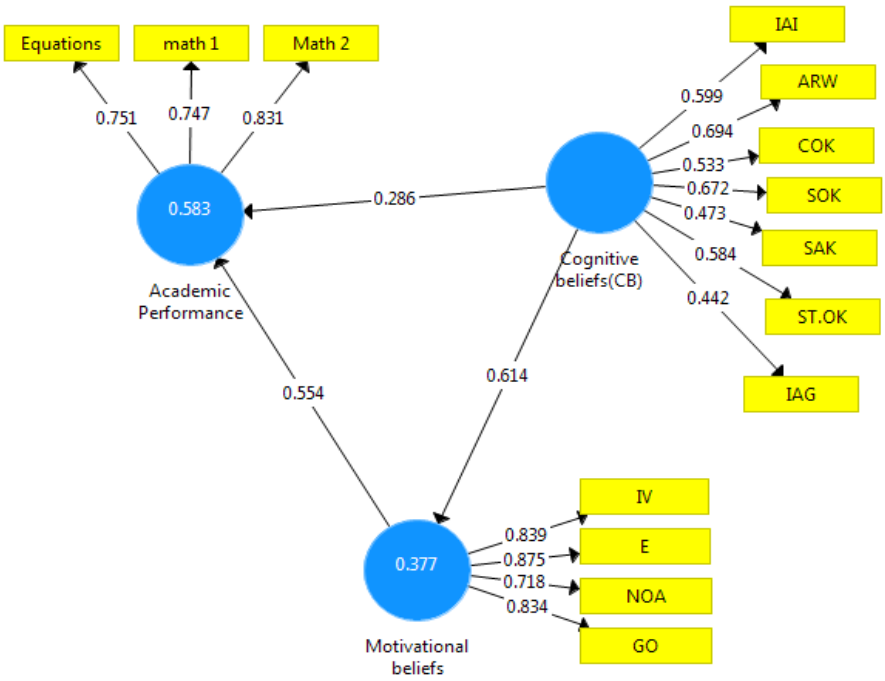
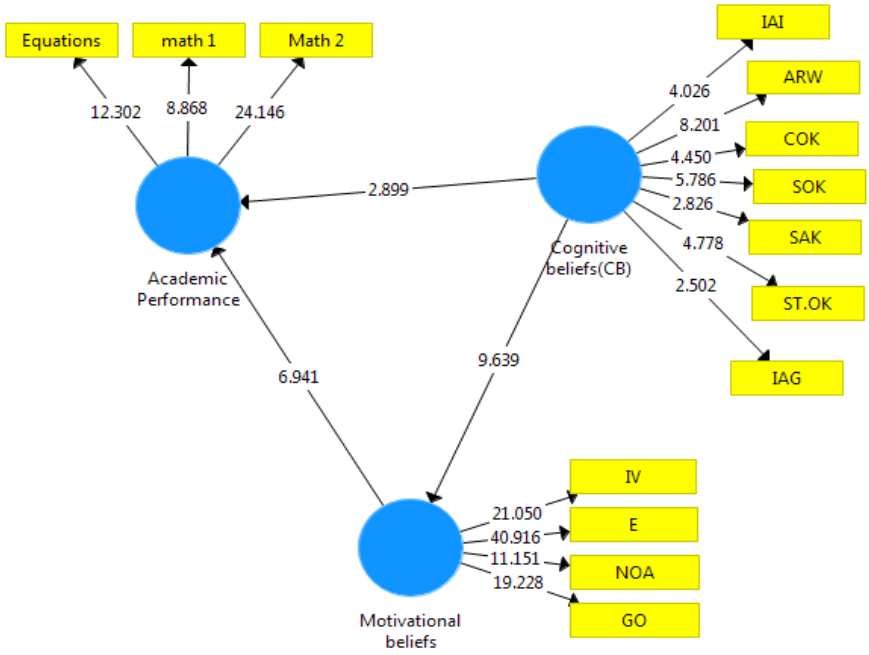


Figure 2

Structural model of studies with significant coefficients Compatible models



Cronbach's alpha and the study's concealed variables: reliability results (Table 3).

Table 3

Results of Cronbach's alpha criterion combined with the reliability of the study's hidden variables.

Composite reliability (CR > 0.7)	Cronbach's alpha coefficients (Alpha > 0.7)	variables
.890	.834	Cognitive beliefs (CB)
.774	.764	Motivational beliefs
.820	.773	Academic Performance

Considering that the suitable value for Cronbach's alpha and composite reliability is 0.7, and according to the findings of the above table, these criteria have adopted a suitable value for the variables of Makon, it can be confirmed that the reliability of the research is appropriate.

Convergent Validity:

The second criterion for examining the fit of measurement models is convergent validity, which examines the degree of correlation of each construct with its questions (indices).

Table 4

General model fitting results

Average Variance Extracted (AVE > 0.5)	variables
.670	Cognitive beliefs (CB)
.534	Motivational beliefs
.603	Academic Performance

Results of the overall model fit.

GOF

An acceptable overall model fit is indicated by the GOF value of 0.531.

Table 5

Results of direct relationship and significance coefficients of research model hypotheses

Causal Relationship	**Path Coefficient (β)**	**T-Value**	**Significance (p-value)**	**Test Result**
Epistemological beliefs -> Motivational beliefs	0.614	9.761	0.001	Confirmation
Epistemological beliefs -> Academic performance	0.286	3.288	0.001	Confirmation
Motivational beliefs -> Academic performance	0.554	7.535	0.001	Confirmation

Given Figures 1 and 2, it can be said that the standardized coefficient (path coefficient) between two variables (epistemological beliefs and motivational beliefs) is β = 0.614. In addition, the t-statistic (a measure of statistical significance) between these two factors was t = 9.761. (greater than absolute value of 1.96). The correlation between your epistemological beliefs and how well you do in school is β = 0.286. Relationship between epistemological and motivational beliefs is β =0.554, and the t-statistic between them is t = 3.288 (absolute value greater than 1.96). The direct relationship between these two variables is also significant, as indicated by the coefficient of significance, t=7.535 (t-statistic), which is greater than the absolute value of 1.96.

Therefore, based on the above content and Table 7, the following two questions can be answered: Do epistemological beliefs directly predict academic performance in the engineering mathematics course?

Do motivational beliefs directly predict academic performance in the engineering mathematics course?

The answer is that both epistemological beliefs and motivational beliefs directly predict academic performance in the engineering mathematics course.

Table 6

Levels of indirect effects in the main research models.

Test result	Significance of values p(	(T-Value)	Path coefficient (β)	Causal relationships between research variables

proving a theory	.001	5.662	.352	Epistemological beliefs -> motivational beliefs -> academic performance

Table 6 shows that the indirectly standardized coefficient equals β=0.352. (Epistemological beliefs due to motivational beliefs about academic performance). The alternative path has a significant relationship, as measured by a significance coefficient (t-statistic) of t=5.662 (greater than the absolute value of 1.96). Therefore, the question of whether epistemological beliefs and motivational beliefs influence students' academic performance in the engineering mathematics course can be answered as follows: cognitive beliefs do influence the prediction of academic performance, with motivational beliefs playing a mediating role among engineering and technical students.

Discussion

It is crucial to motivate your students in the STEM fields to engage in critical thinking and acquire skills that are applicable in the contemporary world. The development of these disciplines (Science, Technology, Engineering, and Mathematics) heavily relies on education in the STEM fields (Stohlmann et al, 2014).

The engineering programs offered in Iran's higher education institutions typically include four core courses that emphasize the importance of mathematical logic in the engineering field: mathematics 1, mathematics 2, differential equations, and engineering mathematics. Nevertheless, professionals and educators in the engineering sector acknowledge the prevalent discontent among students regarding these courses, as well as the elevated rates of students discontinuing their studies.

From the beginning, it was stated that the decrease in engineering majors can be attributed to a lack of interest in mathematics. Considering the seriousness of the issue regarding student failure in engineering programs and math classes, it is essential to identify the key factors that impact students' academic achievements. Academia should consider aspects such as motivation, cognition, interpersonal skills, and effectiveness to gain advantages. Motivation can be exemplified by activating, enabling, maintaining, and achieving certain behaviors.

According to Ames & Archer (1988), students' motivation levels are closely tied to their beliefs about themselves and their tasks. It is believed that when approaching a problem, certain factors are always considered. The cornerstone of motivation, in any form, is having a personal standard (Ames& Archer, 1988). Additionally, Schommer (1993) emphasizes that achieving success is greatly influenced by a crucial factor. The epistemological beliefs of students also play a significant role in their academic behavior, directly and indirectly impacting their outcomes (Schommer ,1993).

Conclusion

A recent investigation has been conducted to explore the correlation between epistemological and motivational beliefs and their potential to forecast academic achievement. The study focused on engineering students, specifically 107 individuals, both male and female, who were enrolled in engineering majors and had completed mathematics 1 and 2 as well as differential equations in previous semesters. The survey will be conducted during the first half of the 2021-2022 academic year. Once the purpose of the study was explained and participants were recruited, students completed online versions of Schumer's Epistemology and Pentridge's motivational questionnaire. The collected data was then analyzed using the PLS technique. The following presents a summary of the findings.

Epistemological beliefs and motivational beliefs exhibit a significant correlation with each other, as well as with academic performance. Students' epistemological beliefs can partially forecast their academic success, with motivational beliefs acting as a moderator.

In other words, a student's academic achievement is influenced by their epistemological and motivational beliefs. Specifically, the foundational mathematical courses (mathematics 1, 2, differential equations) are linked to epistemological and motivational beliefs for engineering mathematics majors. This implies that students' performance in mathematics 1, 2, and differential equations improves when their epistemological beliefs and motivations for mathematics are strong. Consequently, this has an impact on engineering mathematics classes. To clarify further, students with robust epistemological beliefs and motivations for mathematics tend to excel in introductory and intermediate algebra and calculus, as well as engineering mathematics. The relationship between motivational components and mathematical achievement can be explained as follows: motivation, as the cause and main driver of behavior, strengthens students' academic behaviors and, moreover, directs their academic behaviors toward engaging in activities and programs that lead to academic achievement (in mathematics). Mathematical self-efficacy, which is one of the components of motivational beliefs, is an important issue in relation to mathematical achievement. Since mathematical self-efficacy refers to students' beliefs about their own abilities in mathematics, high self-efficacy in this domain leads to greater effort, persistence, and resilience, and these frim self-efficacy beliefs have a relatively significant impact on students' level of success. The relationship between epistemological beliefs and academic achievement can be explained as follows: epistemological beliefs are considered personal theories about the nature of knowledge and how it is acquired. Personal beliefs about the nature of knowledge can influence an individual's beliefs regarding the process of knowing. For example, the belief that knowledge is absolute entails the view that the transfer of knowledge is a one-way process from teacher to learner (Hofer & Pintrich, 2002). In the context of the relationship between the dimension of certainty of knowledge—a variable within epistemological beliefs—it should be said that beliefs about knowledge and learning affect learners' personal conceptions and the activities necessary for success in learning. If students believe that scientific subjects and findings are discrete, absolute, objective, and unambiguous facts with no possibility of error or mistake, their academic achievement will be reduced.

Mooney's research has demonstrated that the academic performance of students in mathematics plays a crucial role in determining their persistence in engineering studies. In accordance with the Iranian curriculum, which mathematics courses from the undergraduate programs of different engineering disciplines can serve as indicators of engineering students' academic success? Nevertheless, recent studies have highlighted that courses such as mathematics 1, 2 and differential equations are significant predictors of academic performance and are particularly influential in engineering mathematics courses.

The achievement of students in this particular course demonstrates their solid grounding in mathematics, which in turn enhances their likelihood of excelling in engineering courses. Based on this discovery and the significance of the engineering mathematics course, it is advisable for department managers and professors who guide undergraduate students to enhance the chances of student success in the engineering mathematics course by overseeing the delivery of high-quality mathematics courses 1 and 2 during the initial two semesters. The selection of professors who possess a genuine interest in teaching these engineering courses will enable the realization of this crucial objective.

The results of this study are in line with those of (Cuthbert& MacGillivray, 2003) , (Goold, & Devitt 2012), (Wang& Liou, 2018), (Rosjanuardi & Jupri, 2022), (Obreque& Andalon ,2020), and (Gürbüz & Karakuyu, 2021). In other words, the results of the research are consistent with the mentioned studies.

It is recommended that mathematics professors teaching foundational courses work to increase students' motivation. Additionally, all university officials should adopt strategies for newly admitted engineering students to help those who have just graduated from high school engage more effectively with the university environment.

It is recommended that mathematics professors teaching foundational courses work to increase students' motivation. Additionally, all university officials should adopt strategies for newly admitted engineering students to help those who have just graduated from high school engage more effectively with the university environment.

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