Humanities and Social Sciences Letters
2025 Vol. 13, No. 4, pp. 1652-1669
ISSN(e): 2312-4318
ISSN(p): 2312-5659
DOI: 10.18488/73.v13i4.4539

Exploring factors influencing mathematics lecturer's intention to use mathematical modelling in Vietnamese universities

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Article History
Received: 20 March 2025
Revised: 16 September 2025
Accepted: 24 October 2025
Published: 12 November 2025

Keywords
Higher education
Mathematical modelling
Mathematics lecturers
Teaching mathematical modelling
TPB.

ABSTRACT

Mathematical modelling in mathematics education has garnered significant attention from researchers due to its ability to connect mathematics with real-world contexts and promote the practical application of mathematical knowledge in students' professional activities. However, the use of this method at universities in Vietnam is not widespread. This study aims to describe the current state of adoption and explore the factors influencing university lecturers' intention to use mathematical modelling in their teaching based on the Theory of Planned Behavior (TPB). A survey was conducted with 306 mathematics lecturers from universities in the North, Central and South of Vietnam. Descriptive statistics and regression analysis were performed using SPSS version 25. The results indicate that lecturers with higher academic qualifications (doctorates, associate professors, and professors) and extended teaching experience tend to adopt mathematical modelling more frequently. Female lecturers also used this approach more often than their male counterparts. Additionally, data analysis revealed that all three factors in the TPB model (attitude, subjective norms, and perceived behavioral control) positively influence lecturers' intention to adopt this teaching method. This research provides a comprehensive overview of the current situation. It serves as a scientific foundation for proposing policies and measures to promote mathematical modelling in mathematics education at universities in Vietnam.

Contribution/Originality: This study is the first to apply the theory of planned behavior to examine Vietnamese university mathematics lecturers' intentions to use mathematical modeling, revealing key influencing factors and low adoption rates, thus providing evidence-based recommendations for improving MM integration in higher education.

1. INTRODUCTION

Mathematics has evolved in close relationship with practical applications and is closely tied to the developmental stages of human society (Zhu, 2020). Mathematical education fosters critical thinking, problem-solving skills and creativity among learners (Greefrath & Carreira, 2024). Mathematical modelling (MM) has emerged as a key trend in universities worldwide among the various teaching approaches. Although a universally accepted definition of MM is yet to be established, numerous researchers describe it as "the process of translating a real-world problem into a mathematical problem by constructing and solving mathematical models followed by evaluating and refining the solutions within the real-world context" (Edwards & Hamson, 2020). Similarly, Asempapa and Brooks (2022) emphasize that MM involves "learners identifying a real-world scenario, making assumptions and choices, employing a mathematical model to derive a useful solution, and addressing the practical situation with their findings." MM has been widely implemented across various educational domains, including engineering, economics, natural and social sciences. Research has explored diverse aspects of MM, such as teaching mathematics through modelling in specialized courses (Merck, Gallagher, Habib, & Tarboton, 2021), developing pre-service teachers' modelling competencies (Sen Zeytun, Cetinkaya, & Erbas, 2023) and evaluating the effectiveness of modelling tasks in higher education (Galligan et al., 2019). At the university level, MM enables students to develop solution skills in practical and creative problem-solving and enhances overall teaching and learning in mathematics.

For example, Xianfang, Yachao, and Ru (2019) note that MM fosters abstract thinking and increases the creativity to solve real-life problems among students, especially engineering students as observed by Kang and Noh (2012). In Vietnam, MM has garnered growing interest among the implementation of the 2018 general education curriculum to develop modeling competencies among students. Several studies have focused on applying MM in teaching topics, such as probability and statistics, exponential functions, differential equations, and experimental modelling tasks in high schools (Giang & Trang, 2022; Nguyen, 2016; Tong, Loc, Uyen, & Giang, 2019). Other research in Vietnam has explored strategies to enhance practical problem-solving skills through MM in teaching probability and statistics to economics and business students alongside the factors influencing independent learning capabilities at Thai Nguyen University (Ngoc, 2022).

Numerous challenges have been noted in integrating MM into university-level mathematics instruction. Research highlights that students often struggle with constructing models, connecting real-world contexts to mathematics, and comprehending the significance of each stage in the modelling process (Caron & Bélair, 2007; George, 1988).

Common obstacles include limited understanding of mathematical concepts, difficulties bridging the real and mathematical worlds and a lack of organization or systematic approach to MM tasks. Students frequently focus solely on outcomes without paying attention to the modelling process, lack prior experience with MM or face time constraints (Sen Zeytun et al., 2023). For teachers, barriers include limited experience, resource constraints, and time pressures (Erbas et al., 2014). Many K–12 teachers in the United States have little or no experience with modelling activities or associated pedagogical methods (Asempapa & Sturgill, 2019).

Despite these challenges, MM offers substantial benefits. Reliable, validated assessment tools, including instruments that gauge attitudes toward MM among teachers and learners can bridge the gap between educational research and teaching practice. Such tools would enhance the quality of modelling activities developed by educators and improve their implementation (Nortvedt & Buchholtz, 2018). Pre-service mathematics teachers need to be equipped with MM knowledge and skills during their university programs while engineering students should learn mathematics through MM to apply mathematical competencies to their future professional fields (Jacobs & Durandt, 2017; Sen Zeytun et al., 2023).

A pertinent question is as follows: Are teachers genuinely interested in and ready to adopt MM? Beyond the commonly cited obstacles, such as time constraints, lack of instructional materials or organizational challenges, other barriers might exist. For instance, teachers may understand the significance and benefits of MM but feel constrained by rigid curricula, lack of institutional support or insufficient confidence to implement MM effectively. These factors may result in situations where teachers recognize the value of mathematical modeling but choose not to incorporate it into their teaching. This also means detailed studies are needed to identify the challenges and barriers to adopting MM in teaching and propose effective support and strategies to encourage educators to adopt MM into their instructional practices. Understanding the lecturers' intention to use MM is crucial in developing policies to increase its adoption in education. This research used the TPB framework on lecturers' behavioral intention to use MM. These results give insights into a properly detailed current situation in Vietnam and add value for improving mathematics education by offering mathematical modeling in an internationally comparative environment. Two general questions will be addressed in the present study which are as follows: 1) What is the present state of the utilization of mathematical modeling by university lecturers in Vietnam? (2) What factors determine the intention of university lecturers to use mathematical modeling in teaching?

2. LITERATURE REVIEW

2.1. The Use of Mathematical Modelling in Higher Education

MM is widely recognized to be an essential approach in mathematics education, from elementary to higher education (Erbas et al., 2014). MM works as a tool to connect mathematics with real contexts by constructing and solving practical problems through mathematical models theoretically founded on various perspectives. Several researchers define it as developing mathematical models within a specific context to solve real-world problems although a universally agreed definition of MM does not exist (Xianfang et al., 2019). Similarly, other researchers have defined MM as identifying a real-life situation, making assumptions and decisions, and developing solutions using a mathematical model translated into the practical context (Asempapa & Brooks, 2022). It works as a pedagogical approach to enhance engagement with students in STEM areas and has improved the mathematical competencies of students (Greefrath & Carreira, 2024). Vorhölter, Greefrath, Borromeo Ferri, Leiß, and Schukajlow (2019) further describe MM as integrating technological tools to translate real-world scenarios into mathematical contexts and computational models. The type of MM is the mathematics education objective and the MM is a teaching tool. Firstly, based on educational goals, it is proper to divide MM into two broad categories: the first one is the kind of MM since this focuses on the deepening of the learners' understanding of how math interrelates with practical aspects, and the second is MM as teaching tools in which math will be used as an instrument for showing the way to solve problems within real-life contexts (Erbas et al., 2014). Various theoretical perspectives, such as realistic modelling, socio-critical modelling, and epistemological modelling converge on the goal of developing learners' mathematical thinking and problem-solving skills. There is also no unified standard for the process of mathematical modelling given the lack of consensus on the concept of MM (Ferri, 2018; Greefrath & Carreira, 2024). Researchers have proposed several modelling processes. Swetz and Hartzler (1991) introduced a four-step process starting from a practical problem, translating it into a mathematical problem, solving it using appropriate mathematical tools, and converting the mathematical solution into a practical resolution. Kaiser, Blum, Borromeo Ferri, and Stillman (2011) expanded this into a seven-phase process namely, (1) identifying a practical problem and developing an initial model. (2) Restructuring the model to focus on the core issues. (3) Constructing a mathematical model. (4) Solving the mathematical model to find results. (5) Analyzing the model and its results in practical terms. (6) Evaluating the model. (7) Providing solutions to the initial practical problem. In the digital era, Gei (2024) proposed another seven-phase process (see Figure 1) emphasizing technology integration. Despite differences in these processes, they share the commonality of engaging learners in practical situations, applying mathematical concepts to solve problems, and drawing conclusions within real-world contexts.

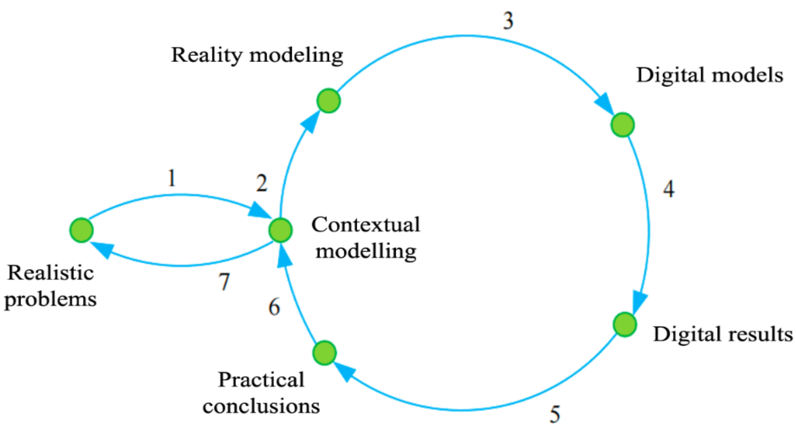

Figure 1. The process of mathematical modelling

Source: Gei (2024).

MM plays a significant role in enhancing the quality of higher education, particularly in training students in fields such as education, economics, engineering, and technology (Ngu, Nam, Cuong, & Thao, 2025). For example, German universities provide practical education that enables engineering students to apply mathematics to address real-world challenges (Alpers, 2011). University students develop a deeper understanding of related concepts and theorems, bridging the gap between theory and practice while focusing on problem-solving and mathematical comprehension by incorporating mathematical modelling. Consequently, teaching activities yield remarkable results (Xianfang et al., 2019).

Courses on mathematical modelling can also help students foster innovation, teamwork, computational proficiency, and academic writing skills (Zhu, 2020). Xu (2021) highlighted the importance of cultivating students' modelling skills in mathematics teaching, arguing that this approach transforms initially dry mathematical knowledge into dynamic, engaging content. This consolidates theoretical knowledge and fosters innovative thinking. Many engineering students view MM as a positive and practical learning approach (Merck et al., 2021).

2.2. Challenges Faced by Lecturers in Using Mathematical Modelling in Teaching

Mathematics lecturers with strong subject knowledge and a positive attitude towards using MM are better positioned to support students effectively (Jacobs & Durandt, 2017). According to Pollak (2007), MM helps students understand and apply mathematics daily. However, one of the significant challenges lecturers face is their limited in-depth understanding of real-world phenomena beyond the scope of mathematics.

In higher education, lecturers must grasp students' needs, identify core topics in the curriculum, integrate mathematical knowledge with real-world scenarios, foster interdisciplinary connections, and manage time effectively (Gei, 2024). Ikeda (2013) pointed out that many lecturers are not adequately prepared and lack practical experience to teach using MM effectively. Some may even fail to recognize the importance and benefits of developing students' mathematical modelling competencies due to their limited exposure to related tasks and activities (Jacobs & Durandt, 2017).

Jacobs and Durandt (2017) conducted a study on the attitudes of 50 third-year pre-service teachers in South Africa toward teaching MM. The findings revealed that most of these students exhibited positive attitudes and were motivated by the modelling tasks they experienced, encouraging them to explore the method further. Similarly, Schmidt (2011) questioned 105 primary and secondary school teachers in Germany about the usage barriers of MM. The findings highlighted issues, such as a lack of time and resources and problematic assessment of students' learning outcomes. In Australia, skills in media production are seldom focused on in teacher education (Galligan et al., 2019). For instance, in the United States, a study by Asempapa and Sturgill (2019) with 62 teachers and 18 student teachers called for training and professional development programs for teachers focusing on mathematical modeling and its pedagogy. Asempapa and Brooks (2022) presented the first tool, the Mathematical Modelling Attitude Scale (MMAS) designed to assess the attitude of K–12 teachers toward MM. They also suggested developing similar tools for mathematics teachers at all levels of education to ensure that evaluation and improvement are consistently conducted.

There is a need for studies on effective instructional strategies for MM. According to Jacobs and Durandt (2017), there is also limited study on the intention to use MM in teaching mathematics which has been conducted globally and in Vietnam's higher education institutions. Few studies have highlighted specific challenges university lecturers face in integrating MM into their practices.

2.3. Theoretical Framework: The Theory of Planned Behavior

There are a considerable number of researchers in the world who study the factors that influence individual behavior. Moreover, numerous theoretical models have been employed so far; the most significant include the Technology Acceptance Model (TAM), the Theory of Reasoned Action (TRA) and the Theory of Planned Behavior (TPB). TPB was developed by Ajzen (1991) as an extension of TRA and predicts how individuals behave based on three main factors: attitude, subjective norms, and perceived behavioral control (Ajzen, 1985). Attitude describes an individual overall evaluation or perception of a particular behavior. The positive attitude enhances the possibility of intention to act while negative attitudes may deter such behavior. Subjective norms refer to the perceived social pressure or influence to perform or not to perform a specific behavior. When deciding which course of action should be taken regarding a behavior, people reflect on whether important family and friends favor or disfavor engaging in their behaviors. Perceived behavioral control is an individual's perception of their ability to execute a given behavior. Greater perceived control strengthens intention and facilitates the execution of the actual behavior (Ajzen, 1991). In this case, these three factors together are regarded as predictors of intention, which eventually influences behavior. TPB has been applied broadly to understand individual decisions and the adoption of tools or methods at various levels and in education (Nyasulu & Dominic Chawinga, 2019).

Internationally, TPB has also been widely used in educational research. Sadaf, Newby, and Ertmer (2012) used TPB to identify predictors of student teachers' intention to use Web 2.0 technologies. Pierce and Ball (2009) explored factors influencing technology adoption in secondary mathematics teaching. Similarly, Armah and Robson (2019) used TPB to study the intention to adopt problem-solving methods in mathematics instruction. Teo (2012) incorporated both TAM and TPB to study the intention to use technology by student teachers in 2012. TPB has also been applied in various educational studies in Vietnam. For example, Minh and Anh (2020) conducted research on lecturers' intention factors in e-learning. Do et al. (2021) researched the diffusion of RME in teaching mathematics. The following research investigated some factors affecting intentions to use digital games for teaching in schools in northern Vietnam. Additionally, Thao, Danh Nguyen, Ngo Van, Nguyen Thi Thu, and Nguyen Chi (2023) explored factors affecting the intention to use digital games in teaching at schools in Northern Vietnam.

TPB is an appropriate framework to study factors affecting teachers' intentions in professional development activities. In a study, Dunn, Hattie, and Bowles (2018) found that beliefs about the effectiveness of learning influence the intention of teachers to engage themselves in professional development activities. The theory was applied by Patterson (2001) in evaluating attitudes toward microbiology teachers attending professional development workshops and how attitudes influenced the application of the results of the same workshop. Similarly, Gold, Thomm, and Bauer (2024) pointed out attitude, subjective norms, and perceived behavioral control which are positive factors in pre-service teachers' intentions about using research in their teaching.

The current study is based on the TPB framework to answer the research questions and in light of this model, three hypotheses are presented:

H_1: Attitude (AT) positively impacts the intention to use MM in teaching mathematics to university lecturers in Vietnam.

H_2: Subjective norm (SN) positively impacts the intention to use MM in teaching mathematics to university lecturers in Vietnam.

H_3: Perceived behavioral control (PBC) positively impacts the intention to use MM in teaching mathematics to university lecturers in Vietnam.

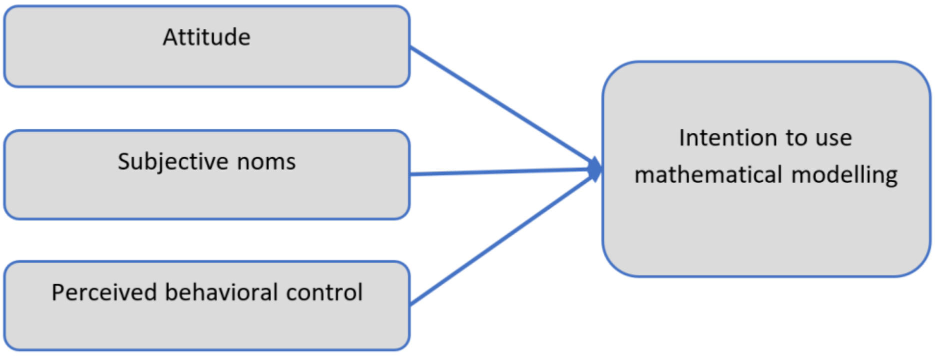

Figure 2. The conceptual model.

3. METHODOLOGY

Based on the TPB framework, this study designed a questionnaire to assess the current state and examine the impact of various factors on university lecturers' intention to use MM in teaching mathematics. It also addresses the research questions posed in the Introduction section. The questionnaire consisted of two main parts:

Part 1: This section included 11 questions gathering demographic and professional information about respondents, such as gender, teaching experience, highest educational qualification, training program, teaching discipline, employment type, frequency of MM usage, involvement in research using MM, source of knowledge about MM, and the type of university where they work.

Part 2: This section included 14 questions on a 5-point Likert scale (1: strongly disagree, 2: disagree, 3: neutral, 4: agree and 5: strongly agree).

Table 1 presents the contents of 14 questions. These questions were developed and adapted based on previous research by Do et al. (2021) and Teo and Beng Lee (2010).

Table 1. Coding factors of the study model

Construct	Items	Questionnaires	Reference source
Attitude (AT)	ATT1	MM is meaningful in teaching.	Odai, Wiley, and Shaker (2024) and Teo and Beng Lee (2010)
	ATT2	Anticipate mandatory requirements for using MM in teaching mathematics.	Teo and Beng Lee (2010)
	ATT3	Enjoy using MM.	Teo and Beng Lee (2010)
	ATT4	Teaching with MM is engaging.	Teo and Beng Lee (2010)
Subjective norms (SN)	SN1	Colleagues believe MM should be used in teaching.	Do et al. (2021)
	SN2	The university's curriculum requires the use of MM.	Do et al. (2021)
	SN3	Students find that using MM benefits their future careers.	Do et al. (2021)
	SN4	Colleagues are currently using MM.	Do et al. (2021)
Perceived behavioral control (PBC)	PBC1	Confident in having the necessary knowledge to use MM activities.	Dunn et al. (2018)
	PBC2	Using MM in teaching mathematics is straightforward.	Do et al. (2021)
	PBC3	Confident in resolving issues during the use of MM.	Do et al. (2021)
Behavioral intention (BI)	BI1	Plan to use MM in the near future.	Do et al. (2021)
	BI2	Intend to use MM more frequently.	Do et al. (2021)
	BI3	Anticipate opportunities to use MM soon.	Do et al. (2021)

A pilot survey was conducted with 64 university lecturers at Quang Nam University and Đa Nang University to test the questionnaire's reliability, validity, and clarity. The pilot study yielded Cronbach's alpha coefficients ranging from 0.795 to 0.902 exceeding the threshold of 0.6. The item-total correlations were all greater than 0.3, indicating the reliability of the scales. Following the pilot study, minor revisions were made to the questionnaire based on feedback, such as refining wording. The final questionnaire was subsequently prepared for the primary survey.

The study employed stratified cluster sampling, targeting universities in three regions of Vietnam: North, Central, and South. Randomly selected universities included public and private institutions offering programs in teacher education and fields such as economics, engineering, or technology. Within each university, lecturers were randomly selected based on criteria such as

1. Employment status (full-time, visiting, or contract lecturer).D
2. Gender.

3. Teaching experience.
4. Training program (domestic, international, or joint programs).
5. Discipline (teacher education, economics, engineering, or technology).

The survey was distributed online using Google Forms between October 9, 2024, and October 20, 2024. All participants provided informed consent and their responses were anonymized to ensure confidentiality and compliance with ethical research standards.

The research team received 320 responses from pedagogical universities, such as Hanoi Pedagogical University, Ho Chi Minh City Pedagogical University, Da Nang Pedagogical University and universities in the fields of economics and engineering in the North, Central and South regions of Vietnam. The final dataset included 306 valid responses for analysis after data cleaning to remove incomplete, erroneous, or inconsistent responses. Inconsistent responses included incomplete answers and single-option answers for all items or conflicting responses about understanding and frequency of MM use. Data were encoded and analyzed using Microsoft Excel and SPSS 25.

4. RESULTS AND DISCUSSION

4.1. Characteristics of the Survey Sample

The statistical results presented in Table 2 summarize the demographic and professional characteristics of the 306 lecturers who participated in the survey. Gender: Male lecturers accounted for 48.7% while female lecturers represented 51.3%. Teaching Experience: Most lecturers had over 10 years of university teaching experience (80.1%) with 19.9% having less than 10 years of experience. Academic Qualification: Most held master's degrees (49.7%) followed by doctoral degrees (34%). Associate professors (AP) and professors (P) comprised 12.7% while teaching assistants and researchers constituted 3.6%. Employment Type: A significant proportion (86.6%) were full-time lecturers at public institutions with the remainder comprising contract lecturers, adjuncts, or others. Discipline: Lecturers comprised 52% of the sample, 19.3% taught in economics, engineering, or technology programs, and 27.8% taught across both types. A small fraction (1%) taught in other health sciences and agriculture disciplines.

Table 2. Characteristics of the survey sample

Variables	Characteristics	Frequency (N)	Percent (%)
Gender	Male	149	48.7
	Female	157	51.3
Experience	Under 5 years	37	12.1
	5–10 years	24	7.8
	10-15 years	57	18.6
	15–20 years	96	31.4
	Over 20 years	92	30.1
Degree	Master	152	49.7
	Doctorate	104	34.0
	Associate professor/ professor	39	12.7
	Others (e.g., researchers and assistants)	11	3.6
Job	Full-time	265	86.6
	Adjunct	20	6.5
	Contract	19	6.2
	Others	2	0.7
Type of university	Public higher education institution	278	90.8
	Private educational institution	27	8.9
	Private educational institutions with foreign elements	1	0.3
Curriculum mathematics	Teacher education	159	52.0
	Economics/ engineering/ technology	59	19.3
	Both teacher education and other disciplines	85	27.8
	Others	3	1.0
	Total	**306**	**100.0**

4.2. Current Use and Frequency of Mathematical Modelling in Teaching

4.2.1. Awareness and Adoption of Mathematical Modelling

According to Table 3, 231 out of 306 lecturers (75%) reported awareness and usage of MM. Female lecturers demonstrated a slightly higher awareness and usage rate (55.4%) than their male counterparts (44.6%). Lecturers with 15–20 years of experience had the highest adoption rate (35.1%) while those with less than 5 years of experience had the lowest (6.1%). Among disciplines, lecturers in teacher education programs were the most active users of MM (54.5%) significantly surpassing those teaching in economics, engineering, or technology programs (16.4%).

4.2.2. Frequency of Mathematical Modelling Use

Only 58 out of 306 lecturers (19%) reported using MM frequently in their teaching. Among these frequent users, female lecturers had a higher usage rate (56.9%) than male lecturers (43.1%). Lecturers with 15–20 years of experience had the highest frequent usage rate (43.1%) whereas those with less than 10 years of experience had the lowest (1.7%). By discipline, teacher education lecturers represented the majority of frequent users (67.2%) while lecturers in other disciplines, such as economics, engineering, or technology reported significantly lower usage rates (10.3%).

Table 3. Awareness and frequency of MM use

Participant characteristics		Aware of using MM		Frequent use (aware users)	
		Frequency (N)	Percent (Column %)	Frequency (N)	Percent (Column %)
Gender	Male	103	44.6	25	43.1
	Female	128	55.4	33	56.9
Experience	Under 5 years	14	6.1	1	1.7
	5–10 years	19	8.2	1	1.7
	10–15 years	41	17.7	13	22.4
	15–20 years	81	35.1	25	43.1
	Over 20 years	76	32.9	18	31.0
Degree	Master's	98	42.4	19	32.8
	Doctorate	91	39.4	20	34.4
	AP/ professor	33	14.3	19	32.8
	Others	9	3.9	0	0
Curriculum	Teacher education	126	54.5	39	67.2
	Economics/ engineering/ technology	38	16.4	6	10.3
	Both disciplines	65	28.1	12	20.6
	Others	2	0.8	1	1.7
	Total	**231**	**75.0**	**58**	**19.0**

4.3. Approaches to Accessing and Developing Knowledge about Mathematical Modelling Among Vietnamese Lecturers

Table 4 outlines how Vietnamese lecturers acquire MM knowledge. The data indicates three primary approaches: self-directed learning, participation in workshops and training sessions, and integration into academic curricula.

Self-Directed Learning: The most common approach for lecturers to learn about MM is through self-study using internet resources and reference materials. This method is not significantly influenced by gender, years of experience, or teaching programs. However, female lecturers reported a slightly higher engagement in self-study (54.2%) than male lecturers (45.8%). Lecturers with 15–20 years of experience represented the highest proportion of self-directed learners (35.6%), while those with less than 5 years of experience had the lowest (7.2%). Regarding academic qualifications, master's degree holders led in self-study (47.6%), surpassing those with doctoral degrees and higher titles. Discipline-wise, lecturers in teacher education had the highest self-study rate (52.3%) compared to those teaching in engineering/technology-related fields (16.6%).

Participation in Workshops and Training Sessions: Workshops and training sessions were the second most common method for gaining knowledge about MM. Female lecturers again had a higher participation rate (55.3%) than male lecturers (44.7%). Lecturers with over 20 years of experience participated most frequently (33%) while those with less than 10 years had the lowest rate (11.7%). Doctoral-level lecturers were the most active participants in these sessions (38.3%). Notably, lecturers at public institutions had significantly higher participation rates in MM-related workshops (89.3%) than their private institution counterparts (10.7%).

Curriculum Requirements: The least impactful method was through program requirements that included MM-related content. Among those who learnt MM this way, lecturers with more than 20 years of experience represented the largest group (38.2%). Teacher education lecturers were more influenced by curriculum requirements (54%) than those in other disciplines (10.5%).

Table 4. Approaches to accessing and developing knowledge about MM in Vietnam.

Participant characteristics		Learn about MM yourself from the internet and other reference sources.		By attending MM- related seminars/ trainings		The training program content at the school includes a course related to MM.	
		Frequency (N)	Percent (Column %)	Frequency (N)	Percent (Column %)	Frequency (N)	Percent (Column %)
Gender	Male	108	45.8	46	44.7	44	57.9
	Female	128	54.2	57	55.3	32	42.1
Experience	Under 5 years	17	7.2	12	11.7	5	6.6
	5–10 years	20	8.5	12	11.7	5	6.6
	10–15 years	43	18.2	15	14.6	17	22.4
	15–20 years	84	35.6	30	29.1	20	26.3
	Over 20 years	72	30.5	34	33.0	29	38.2
Degree	Master's	107	47.6	35	37.2	35	46.7
	Doctorate	89	39.6	36	38.3	29	38.7
	AP/ professor	29	12.9	23	24.5	11	14.7
Type of University	Public higher education institution	223	94.9	92	89.3	71	93.4
	Private educational institution	12	5.1	11	10.7	5	6.6
Curriculum	Teacher education	123	52.3	62	61.4	41	54.0
	Economics/engineering/ technology	39	16.6	19	18.8	8	10.5
	Both disciplines	73	31.1	20	19.8	27	35.5

Table 5. Research activities related to MM conducted by Vietnamese lecturers

Participant characteristics		Self-study, write articles, and conduct scientific research		Participate in seminars		Guide students to scientific research/ natural science		Other	
		Frequency (N)	Percent (Row%)	Frequency (N)	Percent (Row%)	Frequency (N)	Percent (Row%)	Frequency (N)	Percent (Row%)
Gender	Male	66	40.0	51	30.9	46	27.9	2	1.2
	Female	74	44.6	52	31.3	32	19.3	8	4.8
Experience	Under 5 years	7	31.8	13	59.1	2	9.1	0	0
	5–10 years	14	42.4	13	39.4	5	15.2	1	3.0
	10–15 years	16	38.1	12	28.6	6	14.3	8	19.0
	15–20 years	53	42.1	38	30.2	35	27.8	0	0
	Over 20 years	50	46.3	27	25.0	30	27.8	1	0.9

Degree	Master	59	54.1	29	26.6	13	11.9	8	7.3
	Doctorate	57	39.3	47	32.4	39	26.9	2	1.4
	AP/ professor	23	33.8	19	27.9	26	38.2	0	0
Job	Full-time	127	43.1	86	29.2	72	24.4	10	3.4
	Adjunct	8	47.1	5	29.4	4	23.5	0	0
	Contract	4	22.2	12	66.7	2	11.1	0	0
U program	International study abroad programs	2	22.2	3	33.3	4	44.4	0	0
	International study programs in Vietnam	7	58.3	2	16.7	3	25.0	0	0
	Domestic programs	130	42.3	98	31.9	69	22.5	10	3.3
M program	International study abroad programs	4	25.0	5	31.3	7	43.8	0	0
	International study programs in Vietnam	6	66.7	1	11.1	2	22.2	0	0
	Domestic programs	5	33.3	4	26.7	6	40.0	0	0
	International study abroad programs	121	42.6	92	32.4	61	21.5	10	3.5
D program	International study abroad programs	14	35.0	10	25.0	15	37.5	1	2.5
	International study programs in Vietnam	6	75.0	1	12.5	1	12.5	0	0
	Domestic programs	2	33.3	1	16.7	3	50.0	0	0
	International study abroad programs	77	37.7	74	36.3	52	25.5	1	0.5
Type of university	Public higher education institution	128	42.1	91	29.9	75	24.7	10	3.3
	Private educational institution	12	44.4	12	44.4	3	11.1	0	0
Curriculum	Teacher education	77	39.7	58	29.9	50	25.8	9	4.6
	Economics/ engineering/ technology	23	46.0	17	34.0	9	18.0	1	2.0
	Both disciplines	40	47.6	26	31.0	18	21.4	0	0

4.4. Research Activities Related to MM Conducted by Vietnamese Lecturers

Table 5 illustrates the types of MM-related research activities undertaken by lecturers in Vietnam, highlighting significant variations based on gender, experience, qualifications, and institutional affiliations. Both male (40%) and female (44.6%) lecturers most frequently engaged in self-research, publishing papers, and conducting scientific projects on MM. This trend was consistent across experience levels with lecturers having more than 5 years in academia prioritizing this activity. Lecturers with less than 5 years of experience preferred attending workshops (59.1%) compared to those with more experience who were more inclined toward research and writing. Senior academics, particularly those with associate professor or professor titles were more involved in supervising student research projects (38.2%). Similarly, lecturers with international education backgrounds also prioritized this activity. These included training colleagues, writing textbooks, developing teaching materials, and applying MM in projects related to economics or management though such activities were relatively infrequent.

4.5. Reliability of the Measurement Scale

The research model incorporates three independent variables (attitude (AT), subjective norms (SN), perceived behavioral control (PBC)) and one dependent variable (behavioral intention (BI)). Each construct was indirectly measured through 3 to 4 observed variables corresponding to 3 to 4 items. The reliability of the measurement scale was evaluated using Cronbach's alpha with the cleaned dataset. The results are summarized in Table 6.

Table 6. Cronbach's alpha analysis results

No.	Factors	Observed variables	Cronbach's alpha	Min – Max corrected item -Total correlation
1	AT	AT1, AT2, AT3 and AT4	0.872	0.626 - 0.809
2	SN	SN1, SN2, SN3 and SN4	0.836	0.623 - 0.727
3	PBC	PBC1, PBC2 and PBC3	0.869	0.715 - 0.774
4	BI	BI1, BI2 and BI3	0.851	0.695 - 0.754

The results in Table 6 indicate that the Cronbach's alpha values for all factors—AT, SN, PBC, and BI range from 0.836 to 0.872 exceeding the minimum threshold of 0.6. Additionally, the corrected item-total correlations for all observed variables are greater than 0.3. These findings demonstrate high internal consistency among the observed variables and confirm the reliability of the measurement scale (Hair, Anderson, Babin, & Black, 2010).

4.6. Validation of Factors Influencing the Use of Mathematical Modelling

Exploratory Factor Analysis (EFA) was conducted to examine the relationships among observed variables and assess the convergent and discriminant validity of the measurement scale. Key criteria used in the EFA include the Kaiser-Meyer-Olkin (KMO) value which evaluates the suitability of the dataset for factor analysis. Bartlett's Test of Sphericity: Tests whether correlations among variables are significant determining the appropriateness of factor analysis. The results of the EFA are presented in Table 7.

Table 7. Table of exploratory factor analysis EFA

Parameters	EFA for independent variables	EFA for dependent variables
KMO value	0.850	0.728
Sig. of Bartlett's test	0.000	0.000
Number of extracted factors	3	1
Number of variables to be excluded	0	0
Total variance explained	73.503	77.783

The KMO values for independent and dependent variables (0.850 and 0.728, respectively) satisfy the 0.5 < KMO < 1 condition indicating that the dataset is appropriate for factor analysis. The significance values for Bartlett's test (Sig = 0.000) confirm statistically significant correlations among variables. Furthermore, the EFA results extracted three factors for the independent variables and one for the dependent variable with no variables excluded. The total variance explained exceeds 50% for both models (73.503% for independent variables and 77.783% for the dependent variable) validating the suitability of the factor model.

The study applied Varimax rotation with a loading threshold of 0.5. Table 8 presents the results showing that observed variables with similar characteristics converged onto the same factor while maintaining clear distinctions from other factors. The rotated matrix confirms that the observed variables appropriately cluster under the four factors (AT, SN, PBC, and BI) aligning with the theoretical framework. The study created representative factors and conducted Pearson correlation and linear regression analyses to transform the observed variables into factor measurements for hypothesis testing.

Table 8. Table of rotated component matrix

Observed variables	Components			
	ATT	SN	PBC	BI
AT4	0.865			
AT3	0.863			
AT1	0.834			
AT2	0.686			
SN2		0.841		
SN1		0.750		
SN4		0.743		
SN3		0.725		
PBC2			0.908	
PBC3			0.893	
PBC1			0.855	
BI1				0.898
BI2				0.887
BI3				0.861

4.7. Results of Multivariate Linear Regression Analysis

A multivariate linear regression analysis was conducted to analyze the effects of the factors in the hypothesized model with statistical significance set at 5%. Pearson correlation coefficients were calculated to determine the relationships between variables. According to Table 9, the independent variables AT, SN, and PBC exhibit strong correlations with the dependent variable BI with Pearson correlation coefficients greater than 0.5 and sig. values of 0.000 (< 0.05). These results confirm statistically significant linear relationships among the variables with all positive correlation coefficients.

Table 9. Correlation analysis results

Variables		AT	SN	PBC	BI
Pearson correlation	AT	1			
	SN	0.591**	1		
	PBC	0.166**	0.161**	1	
	BI	0.611**	0.495**	0.219**	1

Note: ** sig. < 0.05.

A regression analysis was conducted to test the validity of the three hypotheses in the theoretical model. The results in Table 10 indicate the following: The sig. of the f-test is less than 0.05 confirming that the regression coefficients are statistically significant and that the regression model fits the dataset. The Durbin-Watson statistic is 1.776 falling within the acceptable range of 1.5–2.5 indicating no autocorrelation in the residuals. The Variance Inflation Factor (VIF) values for the independent variables are all below 2 (AT: 1.550, SN: 1.547 and PBC: 1.035), confirming no multicollinearity issues (Hair et al., 2010).

All standardized beta coefficients are positive indicating that the independent variables have a positive influence on the dependent variable. Thus, all hypotheses (H1, H2 and H3) are accepted. The adjusted R^2 value is 0.406, suggesting that the independent variables AT, SN, and PBC explain 40.6% of the variance in the dependent variable BI while the remaining 59.4% is attributed to other factors outside the model and random errors.

The standardized regression equation is as follows:

$$BI = 0.478 * AT + 0.195 * SN + 0.109 * PBC + \varepsilon \quad (1)$$

where ε represents the residual error.

Table 10. Regression results

Variables	BI			
	Std. error	**Standardized beta coefficients**	**Sig.**	**VIF**
Constant	0.239	-	0.061	-
AT	0.061	0.478	0.000	1.550
SN	0.061	0.195	0.000	1.547
PBC	0.048	0.109	0.016	1.035
Number of observations	306			
Adjusted R^2	0.406			
Sig. of the f-test	0.000			
Durbin - Watson value	1.776			

The positive beta coefficients indicate that all independent variables directly and positively influence the dependent variable (behavioral intention (BI)). Attitude (AT) has the most decisive influence on BI, with the most significant beta coefficient of 0.478. Subjective norms (SN) have a moderate influence, with a beta coefficient of 0.195. Perceived Behavioral Control (PBC) has the weakest impact with a beta coefficient of 0.109. These findings suggest that while all factors contribute to lecturers' intention to use mathematical modelling in teaching, their attitudes toward the method are the most critical determinant followed by the influence of social norms and, finally, their perceived control over using the technique.

5. DISCUSSION

MM in mathematics education at universities is pivotal in bridging abstract mathematical concepts with real-world applications and professional knowledge for students. The research model and analysis results provide a comprehensive view of the current state of MM usage among university mathematics lecturers in Vietnam and the factors influencing their intention to adopt this method.

5.1. Current State of Mathematical Modelling Usage

Descriptive statistics reveal that 75% of university lecturers are familiar with MM but only 19% use it regularly (see Table 3). Lecturers primarily focus on conducting research and publishing papers rather than participating in workshops or supervising student research projects (see Table 4). Self-directed learning is the most significant means of acquiring MM knowledge while other forms of support, such as workshops, training sessions, and curriculum requirements play only supplementary roles. Lecturers with higher academic qualifications (e.g., PhDs, associate professors and professors) and extensive teaching experience are more likely to utilize MM than those with less experience. Similarly, lecturers in teacher education programs are more inclined to use MM than those in economics, engineering, or technology disciplines. Additionally, female lecturers report higher rates of frequent MM usage than male lecturers (56.9% vs. 43.1%), a finding consistent with the study by Asempapa and Brooks (2022) on K12 teachers in the United States.

5.2. Factors Influencing Mathematical Modelling Adoption

Regression analysis confirmed the positive influence of the three hypothesized factors (AT, SN, and PBC) on lecturers' intention to use MM. However, the degree of influence varies across these factors.

Attitude emerged as the most significant factor influencing lecturers' intention to use MM in mathematics teaching. This finding aligns with Asempapa and Brooks (2022) who demonstrated that positive attitudes among K12 teachers in the U.S. significantly promoted MM adoption. In the context of Vietnam, enhancing lecturers' positive attitudes can be achieved through training programs emphasizing MM's benefits, such as fostering students' creative thinking and problem-solving abilities. Given the challenges lecturers face in connecting mathematical theory to practical applications, these initiatives are critical for boosting confidence and enthusiasm for MM.

The second leading factor is the subjective norm which evidences colleagues, students, and institutional programs influencing a lecturer's actions. However, the relatively minor beta value depicts that social influence is not strong enough to lead to the ubiquitous adoption of MMs. Indeed, this scenario may be observed due to mismatched teaching policies across institutions. This can be achieved by building some communities of practice among mathematics lecturers through sharing experiences and resources. Previous literature has indicated that peer support is potentially a powerful facilitator of behavioral change, especially among higher education students (Jacobs & Durandt, 2017).

The weakest impact on MM adoption was found to be from perceived behavioral control. This result indicates that the lecturers still experience difficulties in organizing and conducting MM activities in their teaching. Similarly, Erbas et al. (2014) also reported that lecturers often felt inadequately prepared to integrate MM into their curricula. The unsupportive teaching environment in Vietnam may partly support this, such as a lack of instructional resources and practical examples. Improvement in this respect calls for more investment by the educational authorities to develop teaching resources, including MM-based examples, software tools, and special training programs.

5.3. Implications for Practice and Policy

The findings highlight that targeted interventions are required to enhance the adoption of MM in Vietnamese universities. This should focus on i) Improvement in Positive Attitudes: Workshops and training programs should be conducted to show the concrete benefits of MM in enhancing students' creativity and practical problem-solving skills. ii) Developing Professional Communities: Developing networking and forums in which lecturers share their best practices, experiences, and resources relating to the teaching of MM. iii) Resources and Tools: A set of specific teaching materials related to the discipline of MM with practical examples and technological tools will be produced for and distributed among European universities for effective implementation. iv) Removing Institutional Obstacles: The development of harmonization teaching policies for different institutions would, in turn, make it easier for faculties to take up and use mixed methods effectively. Thus, it could be inferred that the proposed methods help bridge the discrepancy that usually occurs at the university level of mathematics education between awareness of theory and practice concerning MM, thus offering students better opportunities to create links between mathematics and real-life aspects.

6. CONCLUSION

This study was based on the theoretical framework of TPB and, therefore, designed a survey tool to identify factors influencing university lecturers' intentions to use MM in mathematics teaching in Vietnam. The findings have shown that all three main factors of TPB, namely attitude, subjective norms, and perceived behavioral control, influence the intention of lecturers to adopt MM. Attitude was the most effective factor that lecturers are mainly motivated by acknowledging the value of and interest in MM.

This is the very first study conducted in Vietnam focusing on university lecturers' intentions to use MM for teaching mathematics. The findings unveil the surprising fact that only 19% of the lecturers use MM frequently when teaching. The low proportion indicates that urgent targeted measures should be taken to increase the embedding MM into practice. The following recommendations are drawn from the findings: Specific plans include specialist MM workshops, including international experts; the development of detailed instructional materials and teaching tools that guide the implementation of MM and the development of policies that encourage and incentivize the lecturers on more effective use of the method.

Despite its value, the study had some limitations. First, most responses came from public universities with only a few from private ones. This is limiting because it restricts the variation in different educational contexts. Secondly, although TPB is an efficient and popular framework, it might not fully capture the cultural specificities of Vietnam that could play a role in the intentions of lecturers. Lastly, the research was highly weighted in specific disciplines, making generalization across all academic disciplines difficult.

For future research, it is suggested that these limitations be overcome by expanding the scope of the survey to private universities and a wider range of academic disciplines. Qualitative methods would provide an even more profound insight into the barriers and motivators that affect MM adoption. This would also allow the investigation of cultural and contextual factors influencing how MM can best be integrated into Vietnamese higher education. These future studies would provide a more solid foundation and basis for making more effective teaching strategies, increasing the quality of higher education to contribute to ongoing education reforms in Vietnam.

Funding This study received no specific financial support.
Institutional Review Board Statement: The Ethical Committee of Quang Nam University, Vietnam has granted approval for this study on 8 October 2024 (Ref. No. 01/XN-HĐKHĐT).
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study adhered to all writing ethics.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: Conceptualization, writing–original draft, editing, visualization, Ngu Pham Nguyen Hong (NPNH); writing–review and editing, formal analysis, methodology, Nam Nguyen Danh (NND); validation, supervision, Cuong Le Minh (CLM); conceptualization, writing–original draft, writing–review and editing, Thao Trinh Thi Phuong (TTP). All authors have read and agreed to the published version of the manuscript.

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