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University lecturers' perceptions of core themes of mathematics education in economics

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ABSTRACT

This study aims to propose a set of core themes for mathematics education in economics to enhance the effectiveness of mathematics instruction for economics students and to explore university lecturers' perceptions of these themes. To address these aims, a two-phase mixed-methods design was employed: first, a systematic review of 23 peer-reviewed studies examining student performance, pedagogical strategies, and curriculum development in mathematics education for economics was conducted; second, a survey of 22 mathematics lecturers from Vietnamese universities and colleges gathered practitioner insights. Survey responses provided empirical perspectives on current teaching practices, identified common constraints such as time pressures and resource limitations and confirmed the practical relevance of the proposed themes. The findings underscore an urgent need for comprehensive reforms in both curriculum and pedagogy to better align mathematics instruction with real-world economic applications and contemporary challenges; in particular, they highlight the importance of addressing students' foundational learning difficulties, fostering higher-order thinking skills, leveraging diverse instructional methods and digital tools, and integrating interdisciplinary approaches that reflect economic contexts. These insights have practical implications for curriculum designers and educators, suggesting targeted strategies for program development, enhanced teacher training, and purposeful technology integration to strengthen students' mathematical competence and research capabilities in response to the evolving demands of modern economies.

Contribution/Originality: This study contributes valuable findings that validate core themes for economics-focused mathematics education, offering the first empirically grounded framework that bridges theoretical insights with practitioner perspectives to guide curriculum reform.

1. INTRODUCTION

Teaching mathematics to economics students is fundamental for understanding and analyzing complex economic phenomena (Yu, 2023). Indeed, mathematics acts as the foundational language of economics, offering a structured framework for modeling economic dynamics, forecasting outcomes, and crafting policies (Sun, 2023). Fundamentally, quantitative economics relies extensively on mathematical methodologies to formalize theories, interpret data, and draw informed conclusions. Ranging from fundamental arithmetic to advanced calculus and linear algebra, proficiency in mathematics equips economics students with the analytical skills needed to dissect economic challenges, formulate hypotheses, and rigorously test theories (Simon & Blume, 2010). Furthermore, mathematics fosters precise communication and logical reasoning, empowering economists to effectively articulate their findings and construct

persuasive arguments supported by empirical data (Watson & Beswick, 2007). In today's era, marked by data abundance and computational capabilities, the adept use of mathematical techniques for data analysis and econometric modeling has become indispensable for conducting research and shaping evidence-driven policy decisions (Bryda & Costa, 2023). Additionally, a robust mathematical foundation empowers economics students to navigate interdisciplinary domains such as finance, statistics, and operations research, thereby broadening their career prospects and enriching their societal contributions (Maass, Geiger, Ariza, & Goos, 2019).

While economics and mathematics share a symbiotic relationship, many economics students struggle with mathematical subjects. Many students do not understand the connection between the derivative as a mathematical concept and its economic interpretation via local linear approximation on a conceptual level (Ariza, Llinares, & Valls, 2015; Feudel & Biehler, 2021). One significant difficulty lies in the transition from concrete numerical reasoning to abstract mathematical concepts. Unlike arithmetic, which deals with tangible numbers and operations, mathematics introduces students to the realm of abstraction, where variables represent unknown quantities and equations symbolize complex relationships (Filloy, Rojano, & Solares, 2004). This shift can be particularly daunting for economics students, who may have a stronger inclination towards real-world applications and struggle to grasp the theoretical underpinnings of mathematical concepts. Additionally, the interdisciplinary nature of economics demands proficiency in a wide range of mathematical techniques, from calculus and linear algebra to probability theory and statistics (Vali, 2014; Wang, 2013). For students without a strong mathematical background, mastering these diverse mathematical tools can be challenging, leading to feelings of overwhelm and frustration. Economics students often face difficulties in applying mathematical concepts to economic problems, as the translation from mathematical models to real-world scenarios requires a deep understanding of economic theory and context (Lesh, 1981; Ojose, 2023). This disconnection between theory and application can impede students' ability to fully grasp the relevance and utility of mathematical concepts in the field of economics. The fast-paced nature of many economics courses leaves little room for remedial instruction or personalized support, exacerbating the challenges faced by students struggling with mathematical concepts. Consequently, economics students may experience anxiety and self-doubt, further hindering their ability to engage effectively with mathematical subjects. Despite these challenges, with perseverance, targeted support, and effective pedagogical strategies, economics students can overcome their difficulties and develop the mathematical proficiency necessary for success in their academic and professional pursuits (Dweck, Walton, & Cohen, 2014; Sithole et al., 2017). In the group of students who did not perform well in mathematics, motivation was very important. Among the motivational factors, intrinsic motivation was most strongly related to the academic success of first-year students (Arnold & Straten, 2012). Implementing an effective math teaching method for economics students requires a pedagogical approach that fosters understanding, engagement, and practical application of mathematical concepts within an economic context (Vimbelo & Bayaga, 2024). One such method is the use of real-world examples and applications to demonstrate the relevance and utility of mathematical concepts in economics (Szabo, Körtesi, Guncaga, Szabo, & Neag, 2020). By grounding mathematical principles in familiar economic scenarios, instructors can help students connect abstract mathematical concepts to tangible economic phenomena, thereby enhancing comprehension and retention. Additionally, incorporating active learning techniques such as problem-based learning, group discussions, and case studies can promote student engagement and facilitate a deeper understanding of mathematical concepts. By encouraging students to actively participate in the learning process and apply mathematical tools to solve real-world economic problems, instructors can foster critical thinking skills and cultivate a deeper appreciation for the role of mathematics in economics (Grabinger & Dunlap, 2002; Mumtaz & Latif, 2017; Ng, Ting, Lam, & Liu, 2020). Furthermore, providing personalized support and feedback tailored to students' individual learning needs can help address gaps in understanding and build confidence in mathematical proficiency (Narciss et al., 2014). Whether through one-on-one tutoring sessions, office hours, or online resources, offering additional support outside of the classroom can empower students to overcome challenges and succeed in mastering mathematical concepts. Moreover, integrating technology such as interactive simulations, data visualization tools,

and online learning platforms can enhance student learning experiences and provide opportunities for hands-on exploration of mathematical concepts in economics. By leveraging technology to create dynamic and interactive learning environments, instructors can cater to diverse learning styles and promote active engagement with mathematical concepts (Khanum, 2023). Therefore, implementing a pedagogical approach that combines real-world relevance, active learning, personalized support, and technology integration can help educators effectively teach mathematics to economics students and empower them to apply mathematical tools with confidence and proficiency in their academic and professional pursuits.

In a large-scale research project on teaching methods, we sought information on the application of methods to support students in understanding the importance of mathematics for economics students. With this objective in mind, we plan to conduct a systematic evaluation of literature related to effective mathematics teaching methods for economics students.

The main research questions are:

RQ1: What are the core themes of mathematics education in economics as the basis for effective mathematics teaching for economics students?

RQ2: What are university lecturers' perceptions of these core themes?

2. MATERIALS AND METHOD

2.1. Data Collection

There are four main database directories used to establish a comprehensive document repository: Scopus, Google Scholar, ScienceDirect, and ERIC. These databases encompass a wide range of resources, including titles, abstracts, and keywords, providing researchers with a comprehensive scope of documents. In the field of educational sciences, these four databases are widely recognized as indispensable and reliable sources for conducting research and accessing academic information. Their inclusion ensures a robust and comprehensive exploration of relevant literature in this field.

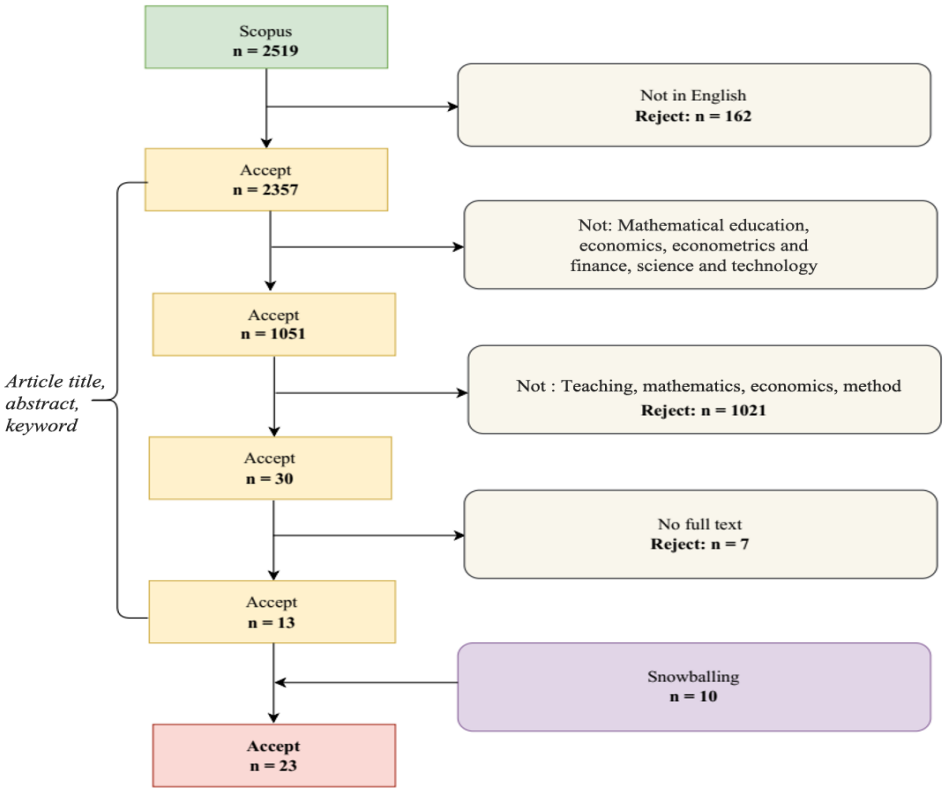

Figure 1. Flow chart illustrating the systematic search process, resulting in 23 articles.

2.2. Search Criteria

To select articles for review, we conducted a comprehensive search of peer-reviewed research journals in the fields of mathematics education, science education, pedagogy, economics, and technology. The search was performed in Scopus for articles in English. Search queries included terms such as econom*, student*, method*, teach*, education*, advanced math*, university math*, higher math*, and their combinations. There are no limits regarding the date of publication (see Figure 1).

We first excluded 162 articles because they were not in English. Next, we screened the titles and abstracts to determine their relevance. Articles that did not pertain to Mathematics or did not mention Economics, Finance, Science, or Technology were excluded, narrowing the results to 1,051. From these, we selected 22 articles specifically focused on teaching mathematics to economics students. Additionally, we eliminated 8 articles that were not available in full text. Finally, to ensure comprehensiveness, we used the snowballing method to identify other potentially relevant sources, resulting in an additional 9 articles. The snowballing method was applied by searching Google Scholar, ScienceDirect, and ERIC. In total, our final collection includes 23 articles from journals, book chapters, and conference papers. These articles provide a robust basis for our systematic review of mathematics teaching methods for economics students.

2.3. Data Extraction

For each of the 23 articles, we extracted information regarding the following core themes of mathematics education in economics:

- The role and contribution of mathematics in economics.
- Barriers and opportunities for economics students in learning mathematics - Perspectives of students, lecturers, and educators.
- Developing thinking in teaching mathematics for economics students.
- Pedagogical methods and teaching strategies for mathematics applied to economics students.
- Using information technology in teaching mathematics for economics students.
- Lecturers' ability to apply their subject-specific knowledge in instructional settings.
- Integrating interdisciplinary knowledge in teaching and learning mathematics.
- Effective mathematics teaching models to develop economic research capacity.

2.4. Survey Design, Data Collection and Analysis Survey Data

Design survey questions (Appendix table), questions designed on Google form sent to teachers with the link: https://forms.gle/Pqpfn74xxZcbZGpn7. Data collected through a Google Form application. A total of 22 lecturers teaching mathematics to economics students at various universities and colleges in Vietnam responded to the survey. An overview of the participants' general information is provided in Table 1.

Table 1. General information about the lecturers.

University/College Name	The number of lecturers who participated in the survey	Teaching experience (in years)		
		< 5 years	5 - 10 years	> 10 years
National Economics University, Vietnam.	3	0	0	3
University of Economics - University of Danang, Vietnam.	3	0	0	3
University of Economics - Vietnam National University, Hanoi.	3	0	1	2
Banking Academy	3	0	0	3
Quang Ninh University of Industry, Vietnam.	3	0	1	2
Dong Nai University	3	0	0	3
Danang College of Economics and Planning	4	0	0	4

We used statistical analysis to compare and analyze the feedback from the instructors. The Ethical Committee of Vinh University, Vietnam, approved the implementation of this study by the university's doctoral candidate and the research team under Decision No. 2844/QĐ-ĐHV dated November 27, 2024.

3. RESULTS

3.1. The Core Themes of Mathematics Education in Economics

The theoretical basis for researching how to teach mathematics to economics students is provided in 23 articles. Eight core themes of mathematics education in economics related to the effectiveness of mathematics teaching and learning for economics students are identified:

- The role and contribution of mathematics in economics.
- Barriers and opportunities for economics students in learning mathematics: Perspectives of students, lecturers, and educators.
- Developing thinking in teaching mathematics for economics students.
- Pedagogical methods and teaching strategies for mathematics applied to economics students.
- Using information technology in teaching mathematics for economics students.
- Lecturers' ability to apply their subject-specific knowledge in instructional settings.
- Integrating interdisciplinary knowledge in teaching and learning mathematics.
- Effective mathematics teaching models to develop economic research capacity.

3.1.1. The Role and Contribution of Mathematics in Economics

Mathematics plays a crucial role in economics, serving as a foundational tool for analysis, decision-making, and problem-solving. In all of the extracted articles, there are eight articles that specifically affirm the role and contribution of mathematics in economics. For instance, Franzoni and Quartieri emphasize the integration of mathematical methods to enhance financial knowledge and economic understanding, illustrating how quantitative skills are essential for this purpose (Franzoni & Quartieri, 2020). "Statistical Methods for Evaluating Experimental Data on the Use of Mathematical Competencies in Study for a Resilient Economy" (Petruk et al., 2023), additionally, highlights the importance of statistical analysis in assessing the effectiveness of mathematical competencies.

Moreover, Mathematics can significantly enhance economic, environmental, and ecological sustainability by employing techniques and methods that optimize company resources and make better use of existing assets. Additionally, connecting mathematics to students' daily lives helps them recognize its practical value by addressing common questions like: "Why do I have to study this subject?" and "How will this concept be useful in real life?" It is crucial to provide diverse examples of mathematics in various fields, interconnecting it with other subjects and current issues, thereby shaping students into more well-rounded citizens (Lucas & Paulo, 2023). Maxwell explores the extent to which mathematics is currently used in the teaching of economic principles and examines the influences on its application at the basic level (Maxwell, 1993). Similarly, the study of Yu (2023) underscores the critical role of numerical data in economics and examines their specific applications to deepen our understanding of mathematical knowledge (Yu, 2023). In economics, the study and description of fundamental economic laws and phenomena need to be closely integrated with contemporary mathematical concepts and methods to ensure standardization and the scientific aspect of economic activities. Mathematics, as an important theoretical subject, is both abstract and logical, serving as a powerful tool in this field and clarifying the relationship between mathematical knowledge and economics (Edgeworth, 1889; Shibata, Okuhara, Mohri, & Shiode, 2016). The essential purpose of studying mathematics is to cultivate a critical and methodical approach to problem-solving and to foster rationality and dexterity in resolving issues. Even if students seldom use the specific calculus learned directly in their lives, it plays an indispensable role in their scientific development, training, and skill acquisition. Although specific calculus concepts may not be directly

applied in everyday life, they are crucial for scientific progress and skill development, preparing individuals to analyze and address problems systematically (Rosado & Ribeiro, 2022).

In conclusion, mathematics is a fundamental tool for understanding and navigating the complexities of the economic "space" we live in, enhancing both professional and personal decision-making processes.

3.1.2. Barriers And Opportunities for Economics Students in Learning Mathematics - Perspectives of Students, Lecturers, And Educators

An analysis of the challenges and opportunities in teaching and learning mathematics among economics students reveals several key themes in the literature. Veloo and Julinamary (2015) highlight students' difficulties in interpreting symbols and graphs essential components of economic analysis attributable to the abstract nature of mathematical concepts that often lack a direct connection to real-world economic scenarios (Veloo & Julinamary, 2015). Similarly, Agah (2020) emphasizes the disconnect between theoretical mathematics and its practical application, advocating for curriculum reforms that better integrate both domains (Agah, 2020). Educators also face pedagogical challenges, particularly in adopting effective teaching strategies that promote student engagement and conceptual understanding (Mardanov & Khasanova, 2014; Shibata et al., 2016).

Conversely, Lucas and Paulo (2023) identify opportunities in integrating mathematical modeling into the economics curriculum, which can strengthen students' analytical capabilities and facilitate the application of mathematics to environmental and economic issues (Lucas & Paulo, 2023). Maxwell underscores the foundational role of mathematics in articulating and comprehending fundamental economic principles, thus enabling students to approach more advanced theoretical and applied problems with greater competence (Maxwell, 1993). Collectively, these articles underscore the critical need for innovative teaching strategies that make mathematics accessible and relevant to economics students, highlighting both the challenges in achieving this and the significant opportunities for improving economic education through better integration of mathematical concepts.

3.1.3. Developing Thinking in Teaching Mathematics for Economics Students

Developing higher-order thinking in mathematics is crucial for finance and economics students. Tularam emphasizes that advanced mathematical thinking in the context of finance and economics enables students to better understand and analyze complex financial systems (Tularam, 2013). By focusing on higher-order thinking, students can enhance their ability to solve intricate financial problems, make data-driven decisions, and adapt to dynamic market conditions. The teaching methodologies that foster critical thinking, problem-solving, and analytical skills are essential for navigating the financial aspects of economics effectively.

Edgeworth emphasizes the integration of mathematical methods in the teaching of political economy, arguing that this approach enhances students' analytical and critical thinking abilities (Edgeworth, 1889). By engaging with mathematical models and quantitative techniques, students gain a more comprehensive understanding of economic theories and political frameworks. Similarly, Singh et al. (2016) examine the extent to which college-level mathematics instruction aligns with the development of mathematical thinking necessary for economic analysis (Singh et al., 2016). Their study identifies a persistent gap between traditional mathematics teaching and the practical cognitive skills required in economics, suggesting a need for pedagogical reform. They advocate for an integrated approach that combines theoretical instruction with practical, problem-based exercises, thereby encouraging students to apply mathematical reasoning directly to economic contexts.

Petruk et al. (2023) further contribute to this discourse by focusing on the role of statistical methods in developing mathematical competencies essential for resilience of an economy (Petruk et al., 2023). The authors highlight the importance of statistical literacy and analytical proficiency in interpreting economic data. They recommend the inclusion of statistical software and empirical data analysis tools in teaching, which can enhance students' capacity to

make informed, evidence-based economic decisions. This competency enables students to better understand economic trends and contribute to economic resilience.

Rutherford (1960) also supports pedagogical strategies that build a strong mathematical foundation, advocating the use of practical economic examples to contextualize abstract mathematical concepts (Rutherford, 1960). Such an approach helps students recognize the relevance of mathematics in economics and promotes mathematical thinking from the early stages of education. In a similar vein, Rosado and Ribeiro (2022) argue that the use of information technology (IT) facilitates dynamic and interactive learning environments. These technologies allow students to visualize complex mathematical ideas and apply them in real-time economic scenarios. By leveraging IT tools, educators can offer more personalized and effective instruction, thereby deepening students' comprehension and appreciation of mathematics in economics (Rosado & Ribeiro, 2022).

3.1.4. Effective Pedagogical Methods and Strategies for Teaching Mathematics to Economics Students

Under the theme of pedagogical methods and teaching strategies, Tran discusses the implementation of the CDIO (Conceive – Design – Implement – Operate) framework in mathematics education for economics students. This model emphasizes experiential learning and the application of knowledge to real-world situations, aligning instructional practices with industry expectations and professional competencies (Tran, 2019). The CDIO approach facilitates problem-solving and critical thinking by integrating theory into practical application. Similarly, Landgärds (2018) investigates how to structure mathematics teaching at the university level to effectively enhance the mathematical competence of economics students (Landgärds, 2018).

In addition, Nickson and Smith (1973) explore innovative strategies for teaching elementary mathematics tailored specifically to the needs of students in economics, contributing further to the development of effective instructional approaches in this field. Strategies such as flipped classrooms, where students review lecture material at home and engage in problem-solving during class, and peer teaching, where students explain concepts to one another, are examined with the aim of making learning more interactive and student-centered (Nickson & Smith, 1973). A key recommendation from the project is that all undergraduates studying economics at Cambridge should take a diagnostic test in basic mathematics relevant to economics upon entry. Students would be grouped into three categories of their choice, each representing distinct teaching methods: those in group A would receive lectures, computer classes, course booklets, and weekly exercises; those in group C would be exempt from computer classes and course booklets; students in group B would be provided with self-learning programs and the option to attend problem classes, along with a shorter set of exercises. Additionally, a group D of students would be exempt from learning elementary mathematics. The results indicated that self-learning and problem classes are considered challenging for students with lower scores, but most students found them helpful, as group B had the lowest percentage of students dropping out. The computer class was assessed as more difficult than their basic needs. This suggests that students should be placed according to their levels to improve teaching outcomes Shibata et al. (2016) propose solutions to improve the quality of education: teachers will support learning during non-lecture hours or create an extra-curriculum activity for Fail and Pass students (Shibata et al., 2016). In addition, it is also necessary for students who are not good at math to motivate them to choose math. Lucas and Paulo (2023) emphasizes the role of mathematical modeling in addressing economic and environmental challenges. It advocates for incorporating modeling techniques into the mathematics curriculum for economics students, enabling them to apply mathematical methods to real-world sustainability issues (Lucas & Paulo, 2023). The approach helps students develop analytical skills and an understanding of how mathematics can inform policy and decision-making.

Pickering and Watson (1986) highlights the effectiveness of self-paced activity, which allows students to progress at their own pace. While most students appreciated this approach, some weaker students were less enthusiastic, expressing frustration at the lack of clear instructions (Pickering & Watson, 1986). Additionally, students shared varying levels of interest in translating economic problems into mathematical form, demonstrating the challenge of

moving beyond rote learning. Small group work receives mixed reviews; most students find asking questions and stimulating ideas beneficial, although a few prefer to study alone. Despite these challenges, the majority felt their mathematical abilities improved each year, increasing their confidence for future applications. We assessed some research on the impact of internet technology on teaching mathematics to economics students, which mainly includes the use of online resources, virtual classrooms, and digital collaborative tools. Integrating these technologies enhances flexibility in learning, provides access to a wealth of information, and supports professional development by familiarizing students with digital tools used in the industry. This emphasizes the benefits of information technology in making complex mathematical concepts more understandable and engaging for students (Rosado & Ribeiro, 2022; Sanina, Artyukhina, Dendeberya, Savadova, & Nasikan, 2019).

Marr and Grove (2010) address the issue of creating rich resources to support distance learning. METAL (Mathematics for Economics: Enhancing Teaching and Learning) is a three-year project funded by HEFCE under Phase 5 of the Fund for the Development of Teaching and Learning (FDTL5) (Marr and Grove 2010). The project aims to maximize student attendance, engagement, and participation in econometrics by providing a comprehensive and accessible interactive toolkit of diverse and flexible resources. This goal is achieved through the development of an online question bank of math teaching and assessment materials specifically related to economic concepts, interactive video units connecting math concepts with economics, and teaching and learning guides that offer innovative and interactive mathematics teaching methods for economics students. An interactive website (www.metalproject.co.uk) has been created to present these resources, facilitate distance learning, and promote student autonomy and ownership of the program's processes. Mišútová and Mišút (2023) have further confirmed that the proposed teaching model used in teaching mathematics obtained statistically significant results. This study also demonstrated that this model significantly improves the success rate of most students on the second attempt (Mišútová & Mišút, 2023).

3.1.5. Using Information Technology in Teaching Mathematics for Economics Students

Information technology plays a crucial role in education. To enhance teaching effectiveness, lecturers utilize software for designing lectures and applications to connect with students. These tools enable activities such as sending documents, assigning projects, and creating chat groups for learning and teaching. In courses like Probability and Mathematical Statistics, lecturers also employ statistical data analysis software (Mišútová & Mišút, 2023). Internet technologies further expand students' academic knowledge and professional skills while fostering continuous self-development and self-improvement. Among these modern, interactive educational technologies, web quests stand out as a method for promoting students' professional growth (Sanina et al., 2019). Additionally, students recognize the value of mathematics in developing thinking and problem-solving skills and express satisfaction with the use of information and communication technology tools in their learning (Rosado & Ribeiro, 2022).

3.1.6. Lecturers' Ability to Apply Their Subject-Specific Knowledge in Instructional Settings

Singh et al. (2016) focuses on examining the alignment between teaching practices in college mathematics and the development of students' mathematical thinking (Singh et al. 2016). As a result, subject-specific knowledge was proven to be important in promoting mathematical thinking among college students, since instructors' subject-specific knowledge influences their instructional approaches, thereby affecting student learning outcomes. Jeschke et al. (2019) emphasizes the importance of identifying the factors where instructors' expertise is utilized, which contribute to successful teaching practices and instructional strategies tailored to the unique requirements of mathematics and economics education (Jeschke et al. 2019). Kuhn et al. (2020) also proposes the correlation between mathematics and economics teaching acquisition, with the experiment showing intricate relationships between teachers' generic attributes, domain-specific knowledge, and instructional skills in the context of mathematics and economics education.

Kuhn et al. (2020) conducted a comparative study involving both pre-service and in-service teachers to investigate the factors influencing educators' capacity to effectively apply subject-specific knowledge within instructional settings (Kuhn et al. 2020). Their findings highlight the multifaceted nature of teaching competence, particularly in integrating disciplinary content into practice. Maxwell explores the role of mathematics in economics education, focusing on how educators incorporate mathematical concepts into teaching economic principles. The study emphasizes the necessity for teachers to possess a strong command of both mathematics and economics to facilitate students' understanding (Maxwell, 1993). By analyzing the use of mathematical frameworks to elucidate economic theories, Maxwell underscores the importance of interdisciplinary proficiency in enhancing instructional effectiveness and fostering deeper student understanding.

3.1.7. Integrating Interdisciplinary Knowledge in Teaching and Learning Mathematics

The integration of interdisciplinary knowledge into mathematics education emerges as a central theme across multiple studies. Agah advocates for the convergence of mathematical instruction with economic principles to better prepare students for addressing real-world economic challenges (Agah, 2020). This interdisciplinary orientation aims to enhance graduates' ability to apply mathematics to complex economic problems. Similarly, Mardanov and Khasanova (2014) argue for curriculum reforms that merge mathematical theory with practical economic applications, thereby improving student understanding and employability (Mardanov & Khasanova, 2014). Lucas and Paulo (2023) further extend this discussion by illustrating the utility of mathematical modeling in tackling issues related to economic and environmental sustainability, thus demonstrating mathematics as a potent interdisciplinary problem-solving tool (Lucas & Paulo, 2023). Collectively, these studies highlight how interdisciplinary approaches can enrich mathematics education, making it more relevant, engaging, and impactful across diverse domains.

3.1.8. Developing Economic Research Capacity Through Effective Mathematics Education Models

Mišútová and Mišút (2023) propose a teaching model for mathematical and informatics subjects that integrates digital technologies and emphasizes the development of transversal competencies. This model aims to improve didactic effectiveness and support the cultivation of research capacity in economics (Mišútová & Mišút, 2023). Many students who struggle with mathematics often haven't studied it thoroughly in high school. These students should be encouraged to dedicate extra time to their studies, with teachers offering additional lectures outside of regular class hours to support them. Students who find mathematics challenging often avoid it, yet mathematical knowledge is essential for specialized subjects and employment exams. Creating an environment where students recognize the importance of mathematics early on is crucial (Shibata et al., 2016). Educational mathematical webquests foster the professional self-development and self-organization of economics students (Sanina et al., 2019). The effectiveness of mathematical models as tools for planning, predicting, and aiding decision-makers in addressing sustainability challenges is well recognized (Lucas & Paulo, 2023). Proper organization of the educational process and promoting self-directed learning among students contribute significantly to their academic progress (Mardanov & Khasanova, 2014). The importance of effective student-centered learning is underscored, with learner-to-learner communication in digital learning environments highlighted as a key example of the social aspect of learning, aligning with the social-constructivist model (Landgärds, 2018).

3.2. University Lecturers' Perceptions of These Core Themes of Mathematics Education in Economics

Based on the eight core themes of mathematics education in economics identified above, we conducted a survey of lecturers teaching at universities and colleges for economics majors, with the following results (Table 2 shows the results of some typical survey questions):

Most lecturers consider mathematics to be of great importance in analyzing and solving economic problems, with 68.2% rating mathematics as "very important" and 31.8% as "important." This underscores the indispensable role of

mathematics in training economics students, enabling lecturers to understand and address complex economic issues. Additionally, lecturers frequently connect mathematical concepts to real economic problems during lectures, with 68.2% doing so regularly. This is a positive sign, indicating lecturers' efforts to interconnect mathematical theory with economic practice.

Table 2. Results of some survey questions.

Question 1	**In your opinion, how important is mathematics in analyzing and solving economic problems?**				
Rating level	**Very important**	**Important**	**Slightly important**	**Neutral**	**Not important**
Number	15	7	0	0	0
Proportion	68.2%	31.8%	0%	0%	0%
Question 2	Do you regularly relate mathematical concepts to real economic problems in your teaching?				
Rating level	Frequently	Sometimes	Rarely	Never	
Number	15	7	0	0	
Proportion	68.2%	31.8%	0%	0%	
Question 3	Are you interested in applying active teaching methods in your mathematics classes?				
Rating level	Very interested	Interested	Slightly interested	Not interested	
Number	14	8	0	0	
Proportion	63.6%	36.4%	0%	0%	
Question 4	To what extent would you like to apply the following teaching methods in your classroom?				
Rating level	Not at all	Slightly	Moderately	Quite a lot	Very much
Case study teaching	1	0	4	8	9
Flipped classroom method	0	2	6	10	4
Mathematical modeling teaching method	0	0	2	9	10
CDIO approach	0	1	7	6	6
Question 6	How frequently have you applied these methods in teaching mathematics to economics students?				
Rating level	Never	Rarely	Occasionally	Frequently	Very frequently
Case study teaching	1	2	5	6	8
Flipped classroom method	5	5	5	4	3
Mathematical modeling teaching method	0	2	4	10	6
CDIO approach	7	3	8	4	0

Regarding active teaching methods, survey results show that most lecturers are interested in applying active teaching methods in mathematics, with 59.1% of lecturers reporting being "very interested" and 36.4% being "interested." However, the reality reveals a gap between intention and practice. Although lecturers wish to apply active teaching methods, the methods they predominantly use are still traditional (95.5%). The case study teaching method has been applied by 77.3% of lecturers, and the mathematical modeling teaching method is used by 68.2% of lecturers.

One of the main difficulties that lecturers face when teaching mathematical concepts in an economic context is that students find it challenging to grasp abstract concepts. This reflects the challenge of helping students understand and apply mathematics to real-life situations. Furthermore, the lack of time to help students both understand mathematical concepts, relate them to real-world scenarios, and practice with exercises is also a major difficulty lecturers face. However, most lecturers (72.7%) believe that applying active teaching methods can help mitigate these challenges.

The ability to apply mathematical thinking to economics is considered the most essential skill that students need to develop to meet current labor market demands, with 90.9% of lecturers agreeing. This emphasizes the necessity of training students not only to master mathematical knowledge but also to have the ability to apply this knowledge to real economic problems. Lecturers also agree that the benefits of developing mathematical thinking associated with economics through teaching mathematics are significant, with 77.3% of lecturers strongly agreeing and 18.2% agreeing.

Survey results indicate that lecturers frequently use information technology (IT) in teaching, with 77.3% of lecturers 'regularly' utilizing IT tools. This underscores the importance of IT in making lectures more engaging and supporting the teaching process. Nearly all lecturers acknowledge that IT assists them in teaching and enhances the engagement of lessons.

4. DISCUSS THE RESULTS OF TEACHING MATHEMATICS TO ECONOMICS STUDENTS

Effectively teaching mathematics to economics students involves understanding and addressing specific challenges and opportunities. Based on a theoretical review of 23 articles and survey results on teaching mathematics to economics students in Vietnam, eight main content areas have been identified that contribute to the effectiveness of mathematics education for economics students.

Mathematics is fundamental in economics, providing tools for analysis, decision-making, and problem-solving. Numerous studies underscore the essential role of mathematics in enhancing financial literacy and economic understanding. Mathematics supports the efficient allocation of resources and promotes sustainability across economic, environmental, and ecological dimensions. Furthermore, it serves as a crucial bridge between theoretical constructs and practical applications. By incorporating diverse examples from everyday life and integrating concepts from other disciplines, educators can make mathematics more relevant, accessible, and engaging for students.

One of the persistent challenges faced by students is interpreting complex symbols and graphs, which are core components of economic analysis. The abstract nature of mathematical concepts often appears disconnected from real-world economic issues, leading to reduced engagement. To address this, educators must adopt instructional strategies that promote deep conceptual understanding. Integrating mathematical modeling into the curriculum has proven effective in developing analytical skills and enhancing students' ability to apply mathematics to practical problems. Higher-order mathematical thinking is also essential for understanding complex financial systems and making data-informed decisions. Therefore, fostering critical thinking, problem-solving abilities, and analytical skills through quantitative techniques deepens students' knowledge of economic theory.

Incorporating statistical methods and software into instruction improves students' capabilities to interpret and analyze economic data. Innovative teaching approaches such as the CDIO (Conceive-Design-Implement-Operate) framework, flipped classrooms, and peer teaching foster interactive and contextually relevant learning experiences. Diagnostic assessments help identify students' competencies, target support, and individualize instruction. Additionally, the use of online platforms and virtual classrooms enhances flexibility, accessibility, and the comprehension of complex mathematical ideas.

The success of mathematics education in economics depends significantly on educators' ability to integrate subject-specific knowledge into teaching practices. Comparative studies reveal that instructors who demonstrate proficiency in both mathematics and economics greatly contribute to student learning and understanding. Interdisciplinary approaches that combine mathematical theory with practical economic applications are particularly effective in preparing students for real-world challenges. The application of mathematical modeling to address issues related to economic and environmental sustainability highlights the potential of such integrative strategies.

Furthermore, self-paced learning and collaborative groups facilitate deeper engagement with mathematical content. The integration of IT creates dynamic, interactive learning environments that encourage student autonomy

and independent exploration. Digital tools and resources also support distance education, ensuring that students can access quality learning opportunities regardless of location.

5. CONCLUSION

A systematic literature review on mathematics education for economics students identifies key insights and effective practices to enhance instructional quality. Synthesizing findings from 23 scholarly articles and lecturer surveys conducted in Vietnam, the review highlights eight critical content areas essential for improving the teaching and learning process. These findings provide a foundation for developing more effective, contextually relevant pedagogical strategies that address existing challenges and support student competency in applying mathematical knowledge to economic contexts.

5.1. Mathematics as a Basic Tool in Economic Analysis

Mathematics provides indispensable tools for economic analysis, decision-making, and problem-solving. Its effective integration allows students to better understand financial systems and abstract economic concepts, highlighting the necessity for strong quantitative competencies.

5.2. Barriers, Challenges, and Opportunities in Mathematics Education

Students and educators alike encounter obstacles such as interpreting complex symbols and graphs and applying abstract concepts to real-world scenarios. However, these challenges also present opportunities to improve curricula and adopt more innovative, engaging teaching methods.

5.3. Developing Thinking Skills in Mathematics Instruction

Encouraging higher-order thinking, critical analysis, and data-driven problem-solving is vital. Methods that integrate statistics and real-life applications foster deeper learning and prepare students to operate effectively in complex economic environments.

5.4. Instructional Approaches and Learning Strategies in Mathematics Education

Interactive pedagogical approaches such as CDIO, flipped learning, and peer instruction help contextualize mathematical concepts. Tailored instruction and the use of online learning tools further support student-centered and competency-based education.

5.5. Instructors' Competence in Applying Subject-Specific Knowledge

The integration of mathematics into economics instruction is most effective when educators are proficient in both disciplines. Professional development and comparative pedagogical research highlight the need for interdisciplinary expertise.

5.6. Interdisciplinary Integration in Mathematics Education

Bridging mathematical theory with practical economic applications prepares students for real-world problem-solving. Interdisciplinary learning particularly through modeling proves valuable in tackling problems such as economic and environmental sustainability.

5.7. The Integration of Information Technology in Mathematics Instruction

Digital tools enhance the teaching and learning of mathematics by offering interactive, flexible, and personalized learning experiences. These technologies promote student engagement, autonomy, and comprehension.

5.8. Innovative Teaching Models for Enhancing the Effectiveness of Mathematics Education

Models that emphasize hands-on learning, practical applications, and statistical literacy significantly enhance students' analytical abilities and capacity for economic research. Personalized approaches and collaborative groups further enrich learning.

In summary, the systematic review highlights the importance of a holistic, multi-integrated approach to teaching mathematics to economics students. By identifying the challenges and leveraging innovative instructional practices, interdisciplinary frameworks, and digital technologies, educators can significantly improve students' mathematical proficiency and their ability to apply such knowledge to economic issues. This comprehensive strategy is essential for preparing graduates to navigate and contribute meaningfully to the increasingly data-driven and complex economic landscape.

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Appendix

Survey for Lecturers Teaching Mathematics in Economics Programs in Vietnam.

I. Personal Information

1. Please specify the university where you are currently teaching:
2. [University Name]
3. Please indicate your years of teaching experience:

   < 5 years

   5 - 10 years

   > 10 years
4. Please specify the mathematics course you are currently teaching:
5. [Course Name]

II. The Importance of Mathematics in Economics

Teachers, please tick the appropriate box.

Question 1: In your opinion, how important is mathematics in analyzing and solving economic problems?

	Very important
	Important
	Slightly important
	Neutral
	Not important

Question 2: Do you regularly relate mathematical concepts to real economic problems in your teaching?

	Frequently
	Sometimes
	Rarely
	Never

III. Teaching Methods

Question 3: Are you interested in applying active teaching methods in your mathematics classes?

	Very interested
	Interested
	Slightly interested
	Not interested

Question 4: To what extent would you like to apply the following teaching methods in your classroom? (1: Not at all - 5: Very much)

Methods	**Rating Level**				
	1	**2**	**3**	**4**	**5**
Case study teaching					
Flipped classroom method					
Mathematical modeling teaching method					
CDIO approach (Conceive-Design-Implement-Operate)					
Other: [Please specify]					

Question 5: Which of the following teaching methods have you applied in your mathematics instruction? (You may select multiple answers)

	Case study teaching
	Flipped classroom method
	CDIO approach
	Traditional teaching method
	Other: [Please specify]

Question 6: How frequently have you applied these methods in teaching mathematics to economics students? (1: Never - 5: Very frequently)

Methods	**Rating Level**				
	1	**2**	**3**	**4**	**5**
Case study teaching					
Flipped classroom method					
Mathematical modeling teaching method					
CDIO approach (Conceive-Design-Implement-Operate)					

Question 7: Which method do you find most effective in helping students connect mathematics with real economic problems?

	Case study teaching
	Flipped classroom method
	CDIO approach (Conceive-Design-Implement-Operate)
	Traditional teaching method
	Other: [Please specify]

Question 8: Do you have any suggestions to support the application of active teaching methods in teaching mathematics?

[Please note your suggestions]

IV. Challenges and Opportunities

Question 9: What challenges do you encounter when teaching mathematical concepts in an economic context?

	Difficulty in connecting mathematics with real economic issues
	Students struggle to grasp abstract concepts
	Lack of appropriate materials and resources
	Other: [Please specify]

Question 10: Do you think that applying active teaching methods can help alleviate these challenges?

	Yes
	No
	Not sure

Question 11: What difficulties have you encountered in applying active teaching methods? (You may select multiple answers)

	Lack of supporting materials
	Difficulty in lesson preparation
	Students lack interest
	Lack of time to implement
	Lack of support from the institution
	Teaching methods not aligned with course content
	Students are passive learners
	Other: [Please specify]

V. Developing Mathematical Thinking in Economics

Question 12: In your opinion, what mathematical skills do economics students need to develop to meet the demands of the current labor market? (Select all skills you deem necessary)

	Mathematical modeling skills
	Teamwork skills
	The ability to apply mathematical thinking to economics
	Data collection, analysis, and processing skills
	Problem-solving and decision-making skills in economic analysis
	IT skills
	Other: [Please specify]

Question 13: Do you believe that developing mathematical thinking related to economics through teaching mathematics courses is beneficial for students?

	Strongly agree
	Agree
	Neutral
	Disagree
	Strongly disagree

VI. Use of Information Technology

Question 14: Do you use information technology tools (software, applications, etc.) in your teaching?

	Frequently
	Sometimes
	Rarely
	Never

Question 15: Does information technology assist you in teaching and make lessons more engaging?

	Yes
	No
	Not sure

VII. Effectiveness Assessment and Suggestions

Question 16: How effective do you find active teaching methods in developing mathematical thinking related to economics?

(1: Not effective - 5: Very effective)

Methods	**Rating Level**				
	1	**2**	**3**	**4**	**5**
Case study teaching					
Flipped classroom method					
Mathematical modeling teaching method					
CDIO approach (Conceive-Design-Implement-Operate)					

Question 17: In your opinion, how can the development of mathematical thinking related to economics be improved for students through active teaching methods?

[Please note your suggestions]

Question 18: Do you have any other comments or suggestions regarding the teaching of mathematics at economics universities?

[Please note your suggestions]

Thank you for participating in the survey!