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Digital Interventions for Mathematics Anxiety Among Engineering Students: A PRISMA-Guided Review

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Abstract

Mathematics anxiety is a significant barrier to learning and academic performance, especially in understanding complex mathematical ideas and knowledge that can be applied in engineering. The objective of this review is to analyze the influence of digital interventions on reducing mathematics anxiety among engineering students with the help of PRISMA methodology. As a part of a literature search, articles associated with the topic have been found, evaluated, and selected based on inclusion and exclusion criteria. The results show that there is currently an abundance of research focused on the utilization of various types of digital tools like gamification applications, adaptive systems, as well as cutting-edge technological solutions like AI and VR, in helping learners acquire knowledge and decrease anxiety levels. Furthermore, there is an increasing trend towards considering psychological variables, such as motivation, self-efficacy, and attitudes, to boost the learning process. Nonetheless, at present, there is a lack of evidence about the efficiency of digital interventions in promoting learning in engineering as the field has not been widely explored in existing literature yet. In summary, the review demonstrates the current trends in studying digital technologies as the means of promoting learning while accounting for psychological factors.

Keywords: Mathematics anxiety, digital tools, engineering students, PRISMA and systematic review

Abstrak

Kebimbangan terhadap matematik merupakan penghalang utama kepada pembelajaran dan pencapaian akademik, terutamanya dalam memahami persamaan matematik yang kompleks yang digunakan secara meluas dalam bidang kejuruteraan. Objektif kajian ini adalah untuk menganalisis pengaruh intervensi digital dalam mengurangkan kebimbangan tersebut di kalangan pelajar kejuruteraan dengan menggunakan metodologi PRISMA. Sebagai sebahagian daripada carian literatur, artikel-artikel yang berkaitan dengan topik ini telah ditemui, dinilai, dan dipilih berdasarkan kriteria rangkuman dan pengecualian. Hasil kajian menunjukkan bahawa pada masa ini terdapat lambakan penyelidikan yang memfokuskan kepada penggunaan pelbagai jenis alatan digital seperti aplikasi gamifikasi, sistem adaptif, serta penyelesaian teknologi termaju seperti AI dan VR, bagi membantu pelajar memperoleh pengetahuan dan mengurangkan tahap kebimbangan terhadap matematik. Seterusnya, terdapat trend yang semakin meningkat ke arah mempertimbangkan pemboleh ubah psikologi, seperti motivasi, efikasi kendiri, dan sikap, untuk merangsang proses pembelajaran. Walau bagaimanapun, pada masa ini, terdapat kekurangan bukti mengenai keberkesanan intervensi digital dalam mempromosikan pembelajaran kejuruteraan kerana bidang tersebut masih belum diterokai secara meluas dalam literatur sedia ada. Kesimpulannya, tinjauan ini menunjukkan trend semasa dalam mengkaji teknologi digital sebagai metodologi untuk mempromosikan pembelajaran di samping mengambil kira faktor psikologi.

Kata kunci: Kebimbangan matematik, alatan digital, pelajar kejuruteraan, PRISMA dan carian sistematik

1.0 INTRODUCTION

Mathematics anxiety is an affective aspect that is known to play a vital role in affecting learners' ability to learn mathematics successfully. It can be identified through instances where individuals experience tension, fear, and anxiety, thus interfering with the ability to accomplish mathematical exercises. The empirical findings show that learners who suffer from mathematics anxiety have low self-esteem, decreased motivation, and avoid engaging in mathematical activities, ultimately leading to low academic achievement (Herman et al., 2022; Lennon-Maslin et al., 2024; Moran-Soto & Gonzalez-Pena, 2022).

Mathematics anxiety poses a significant problem in engineering education due to the complicated and abstract nature of mathematics, which includes topics like calculus, algebra, and mathematical modeling. Students in engineering must have strong problem-solving and analytical skills, which can be hindered by math anxiety because it affects cognitive processes and academic achievement. According to scientific research, mathematics anxiety is significantly linked to factors like self-efficacy, resilience, and perseverance in STEM fields, making it essential to address this challenge (Pedersen et al., 2021; Zakariya et al., 2025). The current and future need for STEM graduates highlights the importance of finding ways to help students overcome their psychological obstacles.

Due to the fast development of educational technology, the use of digital interventions has proved to be highly effective in solving cognitive and affective problems in math instruction. The category of digital interventions includes such diverse tools as gamification, digital game-based learning, virtual reality (VR), augmented reality (AR), AI-based interventions, and online learning systems. Such technological solutions provide students with interactive and personalized learning experiences that may increase their motivation while reducing the anxiety related to conventional teaching strategies (Christopoulos et al., 2024; Kiili & Ketamo, 2018; Turel & Ozer Sanal, 2018).

Gamification and game-based learning have garnered significant interest from academics due to their ability to make math classes more appealing and encouraging. Through the implementation of components like rewards, challenges, and feedback systems, these strategies may help foster a positive mindset towards mathematics and alleviate fear of failing (McKevitt et al., 2025; Rincon-Flores et al., 2023; Hellín et al., 2023). Similarly, online learning platforms featuring collaborative and interactive elements have been shown to increase students' engagement and motivation, thus decreasing their anxiety levels and enhancing their performance (Moliner et al., 2022; Alsswey et al., 2024).

Apart from engagement, the use of digital technologies is associated with innovative teaching methods that promote self-regulated learning and well-being. For instance, digital assessment methods and self-assessment devices allow students to develop mathematical competencies without causing any stress or increasing their anxiety since learners engage in skill development activities in less stressful situations (Barana et al., 2022; Zakariya et al., 2025). Furthermore, through the use of interactive tools and immersive environments such as virtual reality learning technologies, students can learn the material in a form of visual representation, which helps them comprehend concepts better without any stress and cognitive overload (Christopoulos et al., 2024).

Similarly, the growing body of literature indicates increased interest in the affective domain in mathematics education. Studies have explored the relationships between emotions, self-efficacy, and academic performance, revealing that consideration of emotions experienced by students is necessary for successful teaching and learning processes (Saccardo et al., 2024; Lennon-Maslin et al., 2024). In addition, systematic reviews have evaluated various digital strategies, such as digital storytelling, ICT-based education, and blended learning, which have been found effective in promoting not only cognitive but also emotional success in mathematics education (Castillo et al., 2025; de Vera et al., 2025; Pedersen et al., 2021).

Even with the continued emergence of new studies relating to mathematics anxiety and digital learning, the literature demonstrates the presence of incoherence because of its fragmented nature. The majority of studies consider mathematics anxiety as predominantly a psychological aspect, as well as the use of digital technology as a new pedagogy, while only a small portion integrates these aspects into a single theoretical perspective. Furthermore, even when numerous studies focus on various approaches to reducing mathematics anxiety, they do not provide an overview of how the use of digital technology could help reduce this problem.

The present trends, however, reveal a tendency towards the analysis of sophisticated technologies, such as artificial intelligence, virtual reality, and immersive learning. These efforts have gained additional momentum owing to the recent outbreak of the COVID-19 disease. With the continuous development of scientific literature in the area, there appears to be a potential for transformation of the field of digital mathematics education, where not only cognitive factors but also emotional aspects will come under consideration (Alabdali et al., 2023; Ersozlu, 2024). However, what is evident at the moment is the absence of a detailed overview of these developments. The following research aims to tackle these challenges through a systematic literature review approach based on the PRISMA checklist guidelines. The PRISMA guidelines provide an organized strategy for locating, selecting, and reviewing relevant literature studies, which improves the credibility and repeatability of the literature review process. With its four main stages, namely identification, screening, eligibility, and inclusion, the PRISMA guidelines facilitate the systematic analysis of huge volumes of literature.

Thus, this research will endeavor to undertake a systematic review and synthesis of the literature concerning digital technologies used to manage students' mathematics anxiety, especially in engineering mathematics education. In particular, the objective of this research is to (i) determine the digital technologies used to manage mathematics anxiety, (ii) assess any trends within the literature in terms of methods used by researchers, and (iii) establish the geographical distribution of such studies. Through an exhaustive evaluation of the current trends and research methodologies, the present study makes a contribution towards the growing literature base on digital mathematics education.

2.0 METHODOLOGY

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach was designed in 2005 and described by Moher et al. (2009) for conducting systematic reviews. A PRISMA review should determine the inclusion and exclusion criteria for the diverse sources related to the research question or topic of interest. For example, the inclusion criteria for the study can be English language articles, while articles from particular fields, such as medicine, can be excluded. A systematic review consists of four steps: identification, screening, eligibility, and inclusion. First, the main keywords are expanded using different approaches for finding many relevant articles in the database. Second, articles are chosen according to predetermined criteria for inclusion or exclusion of them in the search results in the database based on the type of article and its relevance. Third, in the eligibility step, articles are examined in detail considering the title, abstract, methodology, results, and discussion. Finally, the fourth step involves the selection of appropriate articles according to all criteria.

The PRISMA approach has proven to be an important tool in systematic reviewing and has been used widely in various fields (Moher et al., 2009). The strengths associated with PRISMA are best appreciated in the context of online learning for both learners and instructors. Firstly, the PRISMA approach outlines a systematic search process that involves identification, screening, eligibility, and inclusion, thus helping in conducting systematic literature search and potentially aiding in self-regulation among online learners. Secondly, the step-by-step process helps in guiding postgraduate learners and researchers in carrying out thorough literature searches to identify relevant sources.

Thirdly, PRISMA makes the systematic review process more transparent by helping readers understand the process of review, tracing information back to its source, and assessing the credibility of the results obtained.
In this study, a PRISMA-based review is employed as the methodology to investigate the application of digital interventions to reduce mathematics anxiety in engineering students. The data analysis process involves a literature review of mathematics anxiety in elementary, primary, secondary, and higher education levels as well as the application of digital learning devices. The data analysis processes involve (a) determining the systematic reviews associated with mathematics anxiety; (b) developing research questions on mathematics anxiety and digital tool intervention; and (c) screening research articles using data mining techniques.

2.1 Identifying the Need for a Review

Before undertaking a PRISMA Guided-Review, it is important to first assess whether such a study is truly necessary. This involves checking if a literature review already exists that addresses the research questions of interest. To determine this, a search of existing systematic reviews should be conducted to see if they adequately answer the research questions under investigation.

The searches were made within four electronic databases such as Scopus, Web of Science, Google Scholar, and ScienceDirect. The selection criteria for using these databases involved their worldwide availability, large number of articles, indexing quality, and ease of access for searching scientific publications. The keywords employed were “Mathematics Anxiety Among Students” and “Digital Tool”. Applying keywords and other related terms, 27 articles were obtained in Scopus, 34 articles in Web of Science, 30 articles in Google Scholar, and 1 article in ScienceDirect. All together, 92 articles were obtained in the above databases regarding reviews. According to the analysis of findings from these databases, it can be stated that there are previous works have dealt with the research problem raised in the current study. The reason is that the topics of Mathematics Anxiety and Digital Tool are different research directions, and there are several studies investigating the combination of a Digital Tool strategy and Mathematics Anxiety.

2.2 Research Questions

Once the actual need for conducting a PRISMA review in this study was established, the next step involved formulating the research and mapping questions. To begin with, the research question (RQ) was:

RQ: How is the digital tool intervention can overcome mathematics anxiety among engineering students?

Meanwhile, the six Mapping Questions (MQs) posed were:

MQ1: How many relevant studies on digital tool and mathematics anxiety were retrieved from each database?
MQ2: What keywords are most frequently used in studies on digital tool and mathematics anxiety?
MQ3: How are studies on digital tool and mathematics anxiety distributed by year?
MQ4: What research methodologies are employed in studies on digital tool and mathematics anxiety?
MQ5: In which countries are studies on the implementations in studies on digital tool and mathematics anxiety has been conducted?

2.3 Data Mining

Metadata from scientific articles were obtained by searching for data online through database searches that resulted in data being extracted in PDF form. The articles selected for analysis were then analyzed using Mendeley software to remove any duplicity from the titles. All researchers were involved in coming up with the protocol, performing the search, and extracting initial data from the databases. Peer review was done manually to ensure that the quality of the articles selected was appropriate. Data mining was performed iteratively and incrementally, with different stages involving different processes. The PRISMA flowchart describing the process is provided in Figure 1.

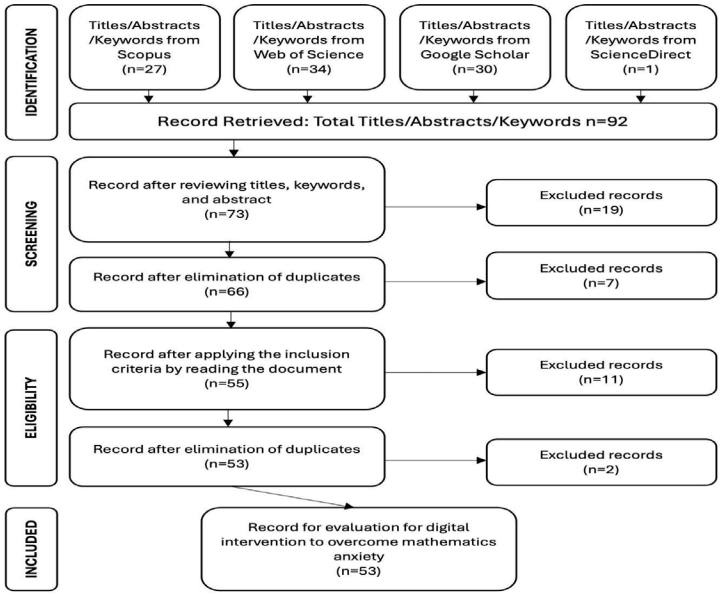

Figure 1 A prisma-framework regarding digital interventions for mathematics anxiety among engineering students

In the initial phase, article identification results were obtained by searching five selected databases from 2020 to 2025. A total of 92 articles were retrieved from the database.

The results from the database searches were downloaded as PDF files and subsequently organized using the Mendeley application. Mendeley automatically identifies and removes any duplicate article titles from the collection. After duplicates were eliminated, the next step involved extracting data using a range of filters to ensure the selection of relevant articles.

In the second phase, the items collected during the first phase were moved to the third sheet, where the inclusion and exclusion criteria were applied. Only publications that met all the inclusion criteria were allowed to proceed to the next phase.

During the first phase, 19 items were deleted, and between the first and second phases, 7 items were eliminated. After meeting the inclusion criteria, 11 articles were eliminated, leaving 55 articles for the quality criteria process. The following are the criteria for exclusion: (a) The research has no relation to mathematics anxiety among students; (b) The research is unrelated to digital tools in education; (c) The study addressed digital tool Approach, but not in the context of education; (d) The research examined mathematics anxiety, but not in the context of education; (e) The published article is neither the result of research nor a review of the relevant literature; (f) Article is not written in English; and (g) Publication articles are neither freely accessible nor available via subscription.

The focus of the third stage, literature review, is publication feasibility. The articles obtained in the second phase are then revised. The objective of the third reading stage is to answer questions based on the problem formulation. The following quality criteria are utilized: (a) Not clearly aligned with mathematics anxiety among students; (b) The publication's purpose is not clearly aligned with digital tool in education; (c) Some studies do not propose an appealing qualitative, quantitative, or mixed methodological approach; (d) Some studies disregard the limitations encountered during the research process; and (e) At least one of the two systematic literature review research questions was not addressed.

After the third stage was completed another 2 articles are eliminated then 53 articles qualified for the evaluation phase. Each article is processed in order to respond to research and mapping questions. The following section shows the result or outcome of the analysis of the systematic mapping question.

■3.0 RESULTS AND DISCUSSION

In this section, this study analyses five mapping questions outlined in the methodology section. The following presents the results of the systematic mapping analysis.

MQ1: How many relevant studies on digital interventions for mathematics anxiety in engineering mathematics were retrieved from each database?

The database search was completed on 5 March 2026 across four sources: Web of Science, Scopus, Google Scholar, and ScienceDirect After the identification, screening, and eligibility stages of the PRISMA process, 53 studies met the inclusion criteria and were included in the final review. The distribution of these studies across the selected databases is presented in Figure 2.

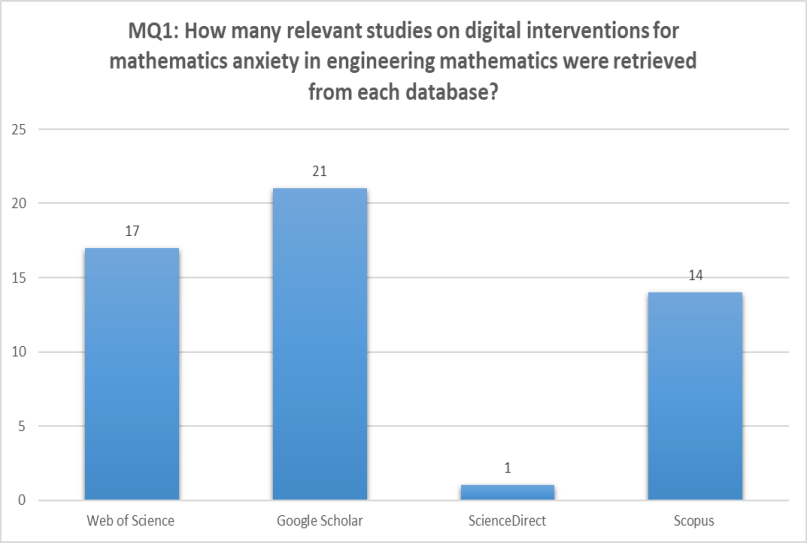

Figure 2 Distribution of retrieved studies across databases

Based on Figure 2, Google Scholar contributed the largest number of included studies (n = 21), followed by Web of Science (n = 17) and Scopus (n = 14). Only one study was identified through ScienceDirect (n = 1). These findings suggest that digital interventions addressing mathematics anxiety in engineering mathematics are distributed throughout numerous big indexing platforms, rather than a single database. It is not unexpected that a greater number of studies were in Google Scholar and Web of Science since both databases serve as a huge multidisciplinary citation index for a wide range of academic publications and conference proceedings.

A significant number of the studies that were included came from Google Scholar, which is well-known for its wide range of publication types and fields. However, earlier studies have shown that Google Scholar's indexing and ranking algorithms may change over time, which may affect the reproducibility of search results in systematic reviews (Haddaway et al., 2015; Gusenbauer & Haddaway, 2020). Thus, it is usually best to utilize Google Scholar as a secondary search tool instead of the main one in systematic literature reviews.

For ScienceDirect, only one study has been found on the digital interventions for mathematics anxiety in engineering mathematics. One possible explanation is that ScienceDirect mainly functions as a publisher-specific full-text platform rather than a multidisciplinary citation database.

Generally, results from the MQ1 search suggest that studies related to digital intervention for mathematics anxiety in engineering mathematics are spread out over many databases. This highlights the need to use several databases when searching for systematic literature reviews to ensure that no relevant information is overlooked.

MQ2: What keywords are most frequently used in studies on digital interventions for mathematics anxiety in engineering mathematics?

Table 1 shows the most frequently used keywords in studies on digital interventions for mathematics anxiety in engineering mathematics.

Table 1 List of keywords in related studies

Keyword Category / Core Term	Frequency (Source Mentions)
Mathematics / Math*	21
Mathematics Anxiety	14
Mathematics Education	8
Technology / ICT	7
Game-Based Learning	6
Motivation	5
Calculus	4
Higher Education	4
Self-Efficacy	4
Attitude	3
Digital Tools	3
Engineering / STEM Education	3
Intervention	3
Students	3
Algebra	2
Assessment	2
Virtual Reality	1

The terms “mathematics” and “mathematics anxiety” continue to be the main subjects of interest, which is evidenced by their high frequency of occurrence among the keywords in the literature review. This implies that anxiety related to mathematics education is recognized as an important impediment to the achievement of students in technical courses. Individuals suffering from mathematics anxiety tend to show unique behaviors and cognition when dealing with mathematical problems. In some cases, when presented with long and complex equations, mathematics anxious individuals tend to find the assignment as stressful and difficult to comprehend, making it hard for them to concentrate on the process of computation and analysis.

By using game-based applications in complex mathematics subjects such as Calculus and Algebra, educators aim to lower students’ emotional barriers, enabling them to engage with difficult concepts in a more interactive and less stressful learning environment. This is because game-based approaches incorporate elements such as immediate feedback, incremental challenges, and reward systems, as well as interactive and progressively challenging gameplay, which help sustain motivation, reduce fear of failure, and encourage active participation. Such features can shift students’ focus toward achieving in-game goals and progression, rather than experiencing stress when dealing with mathematical tasks.

Going further beyond hardware and software concerns, one can point out the necessity to account for psychological factors related to the learner’s mental state. First, the frequent occurrence of terms such as Motivation, Self-Efficacy, and Attitude proves the fact that successful digital interventions presuppose the ability to help students believe in themselves. When working in Higher Education and the field of Engineering/STEM Education, digital technologies allow the provision of instant feedback, which is essential to achieve progressive mastery of competencies. It allows for building a student’s confidence and resilience, which is

essential when dealing with the difficult curriculum that an engineering course entails. Moreover, an attitude plays a key role in learning engineering disciplines since it defines how ready the learner is to solve problems and deal with challenging subjects. Motivation is another factor that guarantees success due to its ability to ensure effective and focused study.

The frequency of keywords shows that modern developments in "Digital Interventions" have gone past merely converting textbooks into digital versions. Instead, they include the creation of an entire ICT infrastructure that combines technical excellence with psychological encouragement, thus ensuring that not only is mathematical competency attained but also emotional preparedness for the workforce is developed.

MQ3: Distribution by year

Based on the 66 sources provided, there are 54 unique articles and 12 duplicates. Table 2 presents the distribution of each unique article categorized by its year of publication, followed by a list of the removed duplicates.

Table 2 Distribution of selected research articles by publication year

Publication Year	Frequency (n)	Percentage (%)	Primary Research Themes & Keywords
2020	4	7.5%	Online class adaptation, Transmedia in STEM, Active learning in Physics.
2021	4	7.5%	Academic integrity, Gender effects in math gaming, Game-based learning detection.
2022	3	5.7%	University math challenges, Peer tutoring, Self-awareness.
2023	4	7.5%	Dyscalculia, Neuroscience, Augmented Reality (AR), Blended learning protocols.
2024	11	20.8%	Math anxiety reduction, Storytelling, Primary education, STEM careers.
2025	27	50.9%	AI Literacy, VR-based learning, PRISMA systematic reviews, Meta-analyses, Self-efficacy.
Total	**53**	**100%**	

Recently published data demonstrated fast and significant progress in this area, characterized by an increase in the annual number of publications around three and four publications per year from 2020 to 2023 then it started increased to 11 and 27 publications per year recorded in 2024 and 2025 respectively. It should be noted that not only does the increase indicate rapid growth in the number of publications; it also signifies a turning point in their nature. Early publications (2020-2023) addressed the topic of digital tools' overall implementation, while more recent publications (2024-2025) focused on certain psychological factors, for example, anxiety and self-efficacy, together with the utilization of new technologies, such as Artificial Intelligence (AI) and Virtual Reality (VR).

Finally, the field seems to be maturing in terms of its methodology. The fact that many systematic reviews and meta-analyses were published in 2025 demonstrates a move from the stage when scholars conducted preliminary exploration towards synthesis of available results into a solid body of knowledge.

Recent developments in digital math research indicate an observable trend towards a specific direction. First, most scholarly articles focus on using digital technology to improve learning and teaching processes. Additionally, it can be observed that much of the existing research involves a shift to the implementation of innovative modalities. This means that modern technologies, such as generative artificial intelligence, adaptive chatbots, and immersive virtual reality have become not just auxiliary but active elements of learning, aiming to decrease the gaps between learners and provide sustainable education.

It is equally interesting to note that there is a tendency in digital math education to move research focus towards the emotional aspect. As it was mentioned before, early works focused on improving students' performance while current research focuses on fostering their overall health by creating a space where students feel comfortable enough to learn mathematics. For example, there is considerable interest in creating digital empathy, especially when developing games and interactive tools that help students overcome anxiety related to the subject. Therefore, the evolution of research trends suggests that digital mathematics have shifted from being about providing information only to using adaptive technology that improves academic learning and emotional well-being at once.

MQ4: What research methodologies are employed in studies investigating digital interventions for mathematics anxiety in engineering mathematics?

Figure 3 presents the research methods used in studies investigating digital interventions for mathematics anxiety in engineering mathematics.

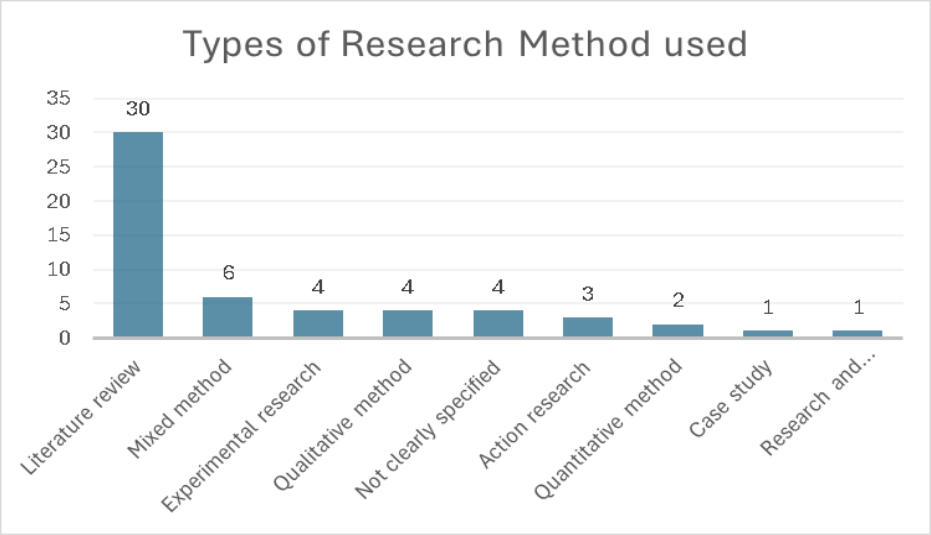

Figure 3 Types of research method used in the literature

This graph represents the methodology distribution of articles exploring the effectiveness of digital intervention in cases of math anxiety among engineering mathematics students. The most commonly used approach is literature review, where researchers conduct their investigation by synthesizing previous research using systematic review, scoping review, and meta-analysis approaches, accounting for 30 studies in total. This demonstrates a high prevalence of secondary data analysis methods. Next is mixed-method research, which involves both qualitative and quantitative methods. Experimental research, qualitative research, and research without a specified methodology have been conducted four times each. Other methods include action research, quantitative research, case study, and other research methods.

It seems that the current trend of research favors the synthesis of previous research findings rather than collecting new data. It means that the future research in this area should focus on conducting experimental research and quantitative and qualitative research based on case studies. In addition, the use of mixed methods is indicative of increased interest in more complex research approaches, which include not only statistical data but also students' personal experience.

MQ5: In which countries are studies on the implementation of mathematics anxiety and digital interventions in Education conducted?

As shown in Figure 4, the geographical distribution of digital interventions for mathematics anxiety has been studied in different regions. From the results, it was found that Indonesia had the highest number of papers with nine studies, whereas Malaysia had four studies. Other countries, such as Hong Kong and Italy, have published three studies. On the other hand, Australia, Brazil, Ecuador, Finland, Ireland, Nepal, Turkiye, United Kongdom, United States, Vietnam, Canada, Chile, China, Colombia, Croatia, Germany, Greece, Iran, Norway, Philippines, South Africa, Spain, Taiwan, and The Gambia have published either one or two papers.

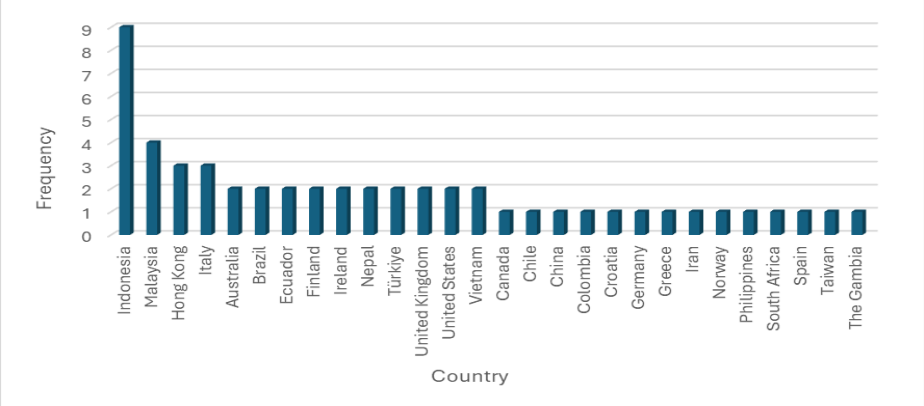

Figure 4 The classification trend of studies on digital interventions on mathematics anxiety by countries

The current trend suggests that digital approaches aimed at reducing mathematics anxiety have become a worldwide topic (Ersozlu, 2024). Many scientific studies have been devoted to the analysis of the effectiveness of using digital resources, gamification techniques, and interactive learning environments to motivate students and reduce their anxiety (Hellín et al., 2023). The platform promotes a cooperative and competitive environment that encourages students to participate in class activities (Alsswey et al., 2024). Global distribution reveals that mathematics anxiety has been recognized as an important issue influencing students' academic achievements, involvement, and perseverance in STEM fields (Moran-Soto & Gonzalez-Pena, 2022).

Since the topic being studied carries international relevance, it is crucial to analyze the geographic distribution of the research in question. Determining the geographical areas from which research is performed would provide insights into the purpose and focus of regional research, technological advancement, and educational improvement (Alabdali et al., 2023). For this reason, this PRISMA review aims to determine the geographical distribution of research related to mathematics anxiety and digital learning through 53 identified scholarly sources.

It is evident that research related to mathematics anxiety and digital learning carries great significance internationally. However, it is mainly done in specific geographic regions. It is apparent that there is dominance by Southeast Asian nations, especially Indonesia, in the field due to the increased involvement of technology in education.

4.0 CONCLUSION

The current research utilized systematic review as the methodology, which is based on the PRISMA framework, aimed at understanding the influence of digital tools on mathematics anxiety. According to the findings, there is no doubt that mathematics anxiety is still a problem that influences negatively on the academic success, engagement, and motivation of students. At the same time, modern development of digital technologies allows overcoming these problems through an exciting and active process of learning mathematics.

In terms of review results, digital interventions that include gamification, digital games, virtual reality, artificial intelligence, and digital assessment are considered. All these methods provide an opportunity for creating an encouraging, engaging, and safe learning environment to participate actively in mathematics activities. In addition, gamification, interaction can promote positively the learners' motivation towards the discipline and change their attitudes to mathematics (Barana et al., 2022; Rincon-Flores et al., 2023; Zakariya et al., 2025). Specifically, digital assessments significantly diminish the level of mathematics anxiety because of the decreased stress connected with taking examinations.

Another important point to highlight is the growing trend associated with the affective domain of mathematical study. While earlier, researchers only focused on cognitive achievements, today, scholars pay more attention to affective factors such as learners' feelings and behaviors while studying mathematics (Saccardo et al., 2024; Lennon-Maslin et al., 2024). This affective turn in mathematics reflects the new view of the process of acquiring mathematical knowledge.

At the same time, the literature shows a tremendous increase in publications in this sphere in recent times, mainly between 2024 and 2025. The primary reason for this development appears to be associated with the advancements in AI, immersive technologies, and changes following the pandemic period. Importantly, mathematics anxiety is also considered globally important, which can be seen from the greater number of publications worldwide, including in Southeast Asia.

However, despite the progress made thus far, certain limitations still exist. First, the body of literature in question is rather fragmented, as there is no sufficient link between technology-based innovations and psychology. Furthermore, there is a clear necessity for empirical evidence that would explore the long-term effectiveness of digital tools in teaching mathematics. Finally, the development of integrative models combining pedagogy, technology, and psychology should be considered a priority for future work.

In summary, the present systematic review highlights the critical importance of digital technologies in revolutionizing the field of mathematics education through the solution of cognitive and affective issues. According to the results, the future of mathematics education will be determined by the creation of dynamic, interactive, and emotion-sensitive educational settings enabled by cutting-edge technologies, including artificial intelligence and virtual reality. Through the provision of a detailed overview of the current state of affairs in digital mathematics education, the present review aims to advance the field further and enhance students' learning experience.

5.0 RECOMMENDATION

Future studies should concentrate on developing cross-cultural frameworks and universally applicable interventions to more effectively reduce mathematics anxiety. It will be important to increase international cooperation to get a better knowledge of mathematics education worldwide.

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Co-Author Contribution

The authors contributed collaboratively to the development of this study. Author 1 was responsible for identifying suitable methods, conceptualizing the overall research idea, drafting the methodology section, and compiling the manuscript. Author 2 conducted the search for an appropriate journal, prepared the introduction and conclusion sections, and performed the final review and editing of the manuscript.

Authors 3, 4, 5 and 6 contributed by generating and analyzing the results, as well as writing the results section. All authors reviewed and approved the final version of the manuscript.

Declaration Of Ai-Generated Content

During the preparation of this manuscript, the authors used artificial intelligence (AI) tools to assist with language refinement and grammar checking. All content was carefully reviewed and edited by the authors, who take full responsibility for the final version of the manuscript.

Conflicts of Interest

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper

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