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THE STEM STUDENT DIFFICULTY AND THE ROLE OF TEACHING AIDS TO INCREASE THE STUDENT INTEREST IN STEM SUBJECT: A REVIEW

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ABSTRACT

This review article focuses on the importance of a teaching aid tool in STEM education. It focuses on reducing the difficulties of STEM studies in Malaysia. The new teaching, learning and assessment (TLA) aids simplify the learning process in STEM classes. This review paper considers the need to reduce the difficulties of STEM subjects and identifies students' feedback regarding the teaching aid tools utilised for Malaysian STEM courses. This review paper here using the systematic literature review (SLR). Moreover, the action study identifies the benefits of the teaching aid tool among the students. Seventy-five papers were reviewed in this study. The study's outcome where the difficulties of subjects are constant, but the teaching tool helps simplify the learning process for the STEM students. The review study focuses on the research question-based findings and the theme and sub-themes-based findings. All articles were analysed precisely, and the study's outcome is that the difficulties of STEM courses can be sorted out using the teaching tools. Multiple types of graphical interface tools have been generated for STEM students worldwide to reduce the burden of difficulties in learning and teaching.

KEYWORDS: Teaching, Learning And Assessment (TLA), STEM, Student Feedback, Education, Teaching Aid Tool, Subject Difficulties.

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1. INTRODUCTION

The education system needs to be improved regularly to keep up with society's times and needs (Rasli, 2020). The educational system can be improved through "Science, Technology, Engineering, and Mathematics Education," abbreviated as "STEM." The term "STEM" became popular in the United States in the early 1990s (Koehler et al., 2016). Initially, the term SMET, which stands for "Science, Mathematics, Engineering, and Technology," was commonly used. However, after a while, the National Science Foundation (NSF) changed it to "STEM" to make pronunciation easier and to clarify its meaning (National Academy of Science, 2007).

The STEM initiative's goal is to produce students who are more than just knowledgeable but also can raise the number of experts in the industry in the future (Rasli, 2020). According to the (MOE, 2016), one of the indicators of a developed nation is the number of scientists/researchers. Emerging nations have more than 78 scientists/researchers per 10,000 workers. However, Malaysia had only 57 scientists/researchers per 10,000 workers in 2012, significantly lower than other developed countries, posing a challenge for Malaysia, which aspires to become a developed and high-income country by 2020 (Rasli, 2020). Therefore, the Malaysian government's Ministry of Education (MOE) has significantly strengthened STEM education to ensure that the nation's economy is always supported by qualified, skilled workers (Razali, 2021). Based on a 6% increase in the nation's economic growth and the emergence of Entry Point Projects under the New Key Economic Areas, this country intends to develop its workforce capacity of 500,000 STEM human capital requirements (Academy of Sciences Malaysia, 2015). Through the intensive production of technological inventions and innovation, these human capitals are expected to be the primary driver of the country's economic growth (Azman et al., 2018).

Azman et al. (2018) defined STEM education as "a lifelong education that includes the integrated learning of STEM-based on informal curriculum through co-academic activities and co-curriculum and informally through indirect learning for every level age of group, starting from the early childhood, primary education, lower secondary education, secondary education, tertiary education, and industrial level or community." Furthermore, STEM education emphasises concepts driven by the four Cs: communication, collaboration, creativity, and critical thinking, as contained in 21st-century learning (PAK-21) and high-level thinking skills (Lah, 2018).

In Malaysia, the Education Blueprint 2013-2025 was established, which provides a long-term plan for the sustainable transformation of Malaysia's education system (MOE, 2012). This blueprint also contains a strategy for improving information and communication technology use throughout the national education system (Ghavifekr & Mohammed Sani, 2015). Malaysia's government has consistently demonstrated its commitment to providing the best education system for its citizens. Therefore, the Malaysia Education Blueprint 2013–2025 identifies STEM education as an important agenda for preparing students for the twenty-first century. STEM education is classified into three stages in this Blueprint (MOE, 2013) in figure 1. Malaysia's government has implemented the 60:40 Science: Art policy since 1967. The policy aims to raise the proportion of students pursuing STEM education rather than pursuing art education. The policy was implemented for schools and higher education (MOE, 2013). Malaysia's STEM policies have changed and improved over time to fulfil necessities. The policies may change, but the spirit and desire remain the same: to increase the number of students pursuing STEM education in Malaysia to produce more industry experts (Hamdan, 2017).

Wave 1 (2013-2015)
STEM education quality improvement began with reinforcing the curriculum, testing and training of teachers, and the use of multi-mode learning models.

Wave 2 (2016 – 2020)
Campaigns and collaborations with related bodies are applied to raise community interest and awareness in STEM.

Wave 3 (2021 - 2025)
STEM is advancing toward excellence by increasing operational flexibility.

Figure 1: Implementation of STEM (Malaysia Education Blueprint 2013 – 2025).

2. THE NEED FOR A SYSTEMATIC REVIEW

The systematic (also known as "structured") literature review (SLR) first appeared in management research as a promising methodology for reviewing prior literature in order to bring the field closer together (Kraus, Breier, & Dasí-Rodríguez, 2020). According to Petrosino et al. (2001), a systematic review is defined as quantitatively and qualitatively recognising, combining, and evaluating all available data to produce a robust, observationally decided response to a focused research question (Mohamed Shaffril et al., 2019). When compared to traditional-style literature reviews, systematic reviews have several advantages. For example, the reviews can be bolstered through a transparent article retrieval process, a more prominent broader area of research, and more significant objectives that can control research bias. However, it encourages the researcher to produce higher-quality evidence with more significant results (Mallet et al., 2012; Mohamed Shaffril et al., 2019).

Meanwhile, a considerable amount of existing systematic review related to STEM education has been conducted across the globe. Nevertheless, only a limited number of studies were performed within the context of STEM subject difficulties and the types of teaching aids that increase interest in STEM subjects among students. Moreover, STEM subjects are tough and unpopular among students since they are associated with numerous calculations. This makes them harder to score and demotivates students to choose STEM subjects as an elective subject at university and STEM education at the secondary level. The current paper attempts to systematically review all the relevant literature to fill the gap by examining and identifying an aid tool that can be implemented in the teaching and learning process of any difficult STEM subject taught in higher-learning institutions. While existing systematic review articles on STEM subject difficulties and types of teaching aids tools failed to provide detailed information on the review procedures used in terms of keyword identification, screening, eligibility, and database use. Furthermore, this situation makes it difficult for future researchers to reconstruct the investigation, validate the understanding, or analyse the breadth of information. For this reason, this study is essential because it gives information on the scope and focus of peer-reviewed literature, which can help researchers deliver the prospect to understand the future attention related to STEM education that requires scholarly attention.

The current systematic review was created with the primary research question in mind:

1. How difficult the STEM subjects will be?
2. What teaching aid tools will be used?

This paper focused primarily on the STEM subject difficulty and the role of teaching aids in increasing the students' interest in STEM subjects. Aside from that, this section emphasises the necessity for a systematic review of STEM education. At the same time, the following part outlines the approach taken to solve the research question given by the current study. The third area then conducts a systematic review and synthesis of the scientific literature to distinguish, select, and analyse the relevant research issues. Finally, the last section outlines the steps that must be taken, focusing on future researchers concerning the issues addressed.

3. MATERIAL AND METHODS

This section outlines the main sub-sections used in the current study: PRISMA, resources, inclusion and exclusion criteria, the systematic review process, and data abstraction and analysis.

3.1. Prisma

PRISMA, or Preferred Reporting Items for Systematic Reviews and Meta-Analyses, is a published standard for conducting a systematic literature review. In general, publication standards must provide authors with the relevant and necessary information to evaluate and analyse a review's reliability and rigour. Furthermore, PRISMA prioritises the reviews report, which analyses randomised trials and can also be used as the foundation for reporting systematic reviews for other types of research (Moher et al., 2009; Mohamed Shaffril et al., 2019). Furthermore, PRISMA examines a large scientific literature database at a set time, allowing for an accurate search of terms related to STEM subject difficulties and teaching aids tools.

3.2. Resources

The databases that were searched were electronic and related to education. The current study's review methods were carried out using two main databases, Scopus and Web of Science, because both databases are robust and cover more than 256 fields of study, including STEM studies. Specifically, Scopus indexes 162 journals related to the keywords of the study for all the research questions. In comparison, the Web of Science (Social Science Citation Indexed) indexes 66 journals related to the research questions.

3.3. The Systematic Review Process For Selecting The Articles

Systematic searching strategies were implemented in response to the multiple keywords selected from the research question: difficulties, STEM subject, and teaching aids. Three sub-processes of systematic searching strategies were used to ensure rigorous and systematic searching: identification, screening, and eligibility.

3.3.1 Identification

The systematic review process for selecting several relevant articles for the current study consisted of three major stages. The first step is identifying keywords and searching for related and similar terms using the thesaurus, dictionaries, encyclopedia, and previous research. As a result, search strings for the Scopus and Web of Science databases were created in January 2022 after all relevant keywords were identified (refer to table 1). Next, the search was conducted on selected leading and supporting databases, employing advanced searching techniques such as the Boolean operator, phrase searching, truncation, wild card, and field code functions separately or by combining these searching techniques into a complete searching string based on the main and enriched keywords (refer table 2). The present research work, most importantly, successfully retrieved a total of 75 articles from both databases. The first stage of the systematic review process yielded 228 articles in total.

Table 1: Results of the Identification Process.

SECTION	MAIN KEYWORDS	ENRICHED KEYWORDS
RQ 1 STEM subjects' difficulty	STEM Subject Difficulties	STEM Education STEM Studies
RQ 2 Type of teaching aids	Teaching aids	Teaching Aids Tool Teaching Tool

Insert Table 2 Here

Table 2:Search String Used in Selected Databases (Scopus and Web of Science)

Database	Search String
Scopus	TITLE-ABS-KEY ((“Stem Education" OR "Stem Studies" OR "Stem Subject") AND TITLE-ABS-KEY (“Difficulties”)) TITLE-ABS-KEY (("STEM Education" OR "STEM Studies" OR "STEM Subject") AND ("Teaching Aids" OR "Teaching Aids Tool" OR "Teaching Tool"))
Web Of Science	TS= (("STEM Education" OR "STEM Studies" OR "STEM Subject") AND ("Difficulties")) TS= (("STEM Education" OR "STEM Studies" OR "STEM Subject") AND ("Teaching Aids" OR "Teaching Aids Tool" OR "Teaching Tool"))

3.3.2. Screening

Two hundred twenty-eight articles were screened based on several inclusion and exclusion criteria determined by the researchers in the first stage. The following criteria were used sequentially against article abstracts to select studies for inclusion (refer to table 3). The second stage of screening was intended to weed out duplicate articles. In this case, 26 duplicate articles were eliminated. A total of 223 articles were retained after screening were used for the eligibility process.

Table 3:The Inclusion and Exclusion Criteria.

Criteria	Inclusion	Exclusion
Timeline	All year	NA
Publication type/ Document type	Article, Conference Proceeding, Review articles, early access, and book chapter	Meeting abstracts, letters, editorial materials, notes, poetry
Subject Area	All countries	NA
Language	English and Malay	Non-English and Non-Malay

3.3.3. Eligibility

For the third phase, known as eligibility, 223 articles were prepared. More importantly, at this stage, the titles, abstracts, and main contents of all the articles were thoroughly examined to ensure that they met the inclusion criteria and were suitable for use in the current study to achieve the objectives of the current research. Consequently, 148 articles were removed because they did not discover STEM education directly; they are mostly related to STEM education with career benefits, and the papers did not address at least one of the review's research questions. The articles were excluded due to the need for the findings because the study focused on the subject's difficulties. However, most of the articles focus on teaching difficulties. Finally, the remaining 75 articles are ready to be analysed (refer. to Fig. 1)

3.4. Data Abstraction And Analysis

This study conducted an integrative review, one of the review techniques that analyses and synthesises various research designs (qualitative, quantitative, and mixed methods) together. This can be resolved by transforming one type into another, quantitative or qualitative data. This research option is for qualified all selected data. Thematic analysis (Braun and Clarke 2006) has been used to find, analyse, and report on themes (or patterns) in the data. Each theme is intended to capture important data information and was used to guide the development of appropriate themes and sub-themes. Moreover, the process has resulted in a total of two main themes, namely (1) Level of STEM education and (2) Relevance of the Teaching Aid Tool. Following that, the researchers resumed the process in each of the generated themes, in which any themes, notions, or ideas that have some connection with one another within that established topic will be developed as sub-themes. This process eventually has resulted in a total of five sub-themes. The findings were themed, and a record was kept throughout the data analysis process to capture the analysis's outcomes, thoughts, riddles, or any other idea related to data interpretation.

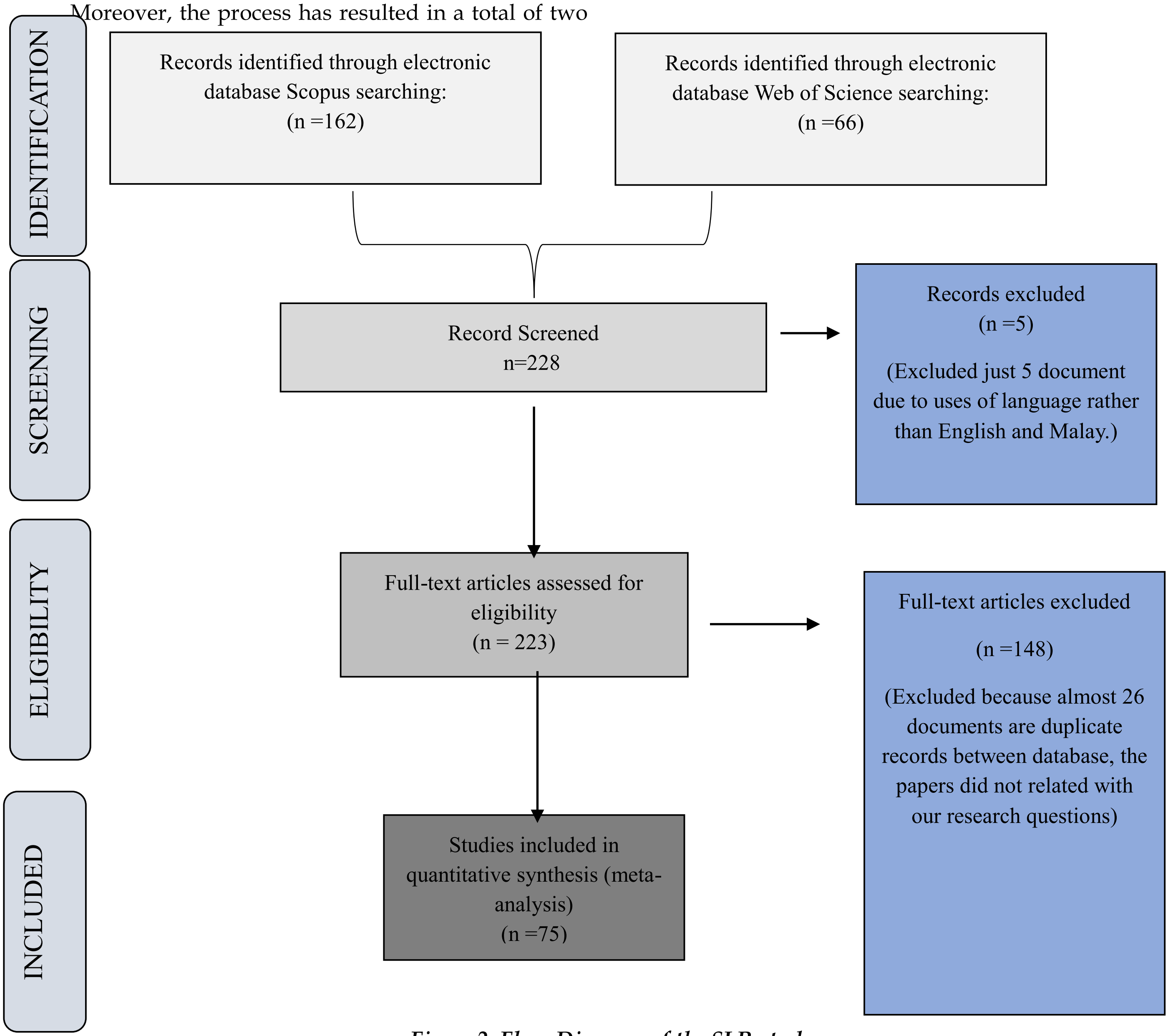

Figure 2: Flow Diagram of the SLR study
Papers were obtained after the review's identification, screening, and eligibility phases, using the Preferred Items for Systematic Review Recommendations (PRISMA 2021) technique.

4. RESULT

General Result

The result here focuses on the general result. The document type, publication year and the literature studies method are listed under the general result. This result section explains the outcome of the publication year precisely, together with the type of documents and the type of research method used in these studies.

4.1. Publication Year of the Review

The publication year of the articles gained from the literature review is from 2022 to 2006. The total number of articles is 75. The outcomes produced 75 papers indicated that the number of published papers on STEM education difficulties and the teaching aids used in these STEM subjects has received increasing attention and grown considerably in recent years.

Table 4: The Publication Year of the Articles.

Publication Year	Number of Articles
2022	4
2021	14
2020	13
2019	13
2018	6
2017	6
2016	6
2015	6
2014	4
2013	2
2006	1

The number of publications showed an increasing trend from 2006 onward. For the year 2021, the number of published articles was 14, with the highest number of articles used in this literature. Besides, the lowest number of articles used in this study is 1 from 2006. Table 4 shows the publication year and the total number of articles. These are the articles from the publication year of 2022: Kara (2022), Sarı et al. (2022), and Deniz et al. (2022).

4.2. Type of Document of the Review

In this section, the 75 papers have been split into three types of documents. The types of documents that are found in these papers are (1) proceeding papers, (2) journal articles, and (3) book chapters. Furthermore, the review of the 75 papers revealed that most papers dealing with STEM education-based studies were published as conference papers rather than articles. Therefore, this literature used the highest number of proceeding papers, 42, and the lowest will be 1, the book chapter. The below table shows the number of document types. This book chapter is Eleweke (2014)

Table 5: Types of Documents.

Type of Documents	Number of Articles
Articles	32
Proceeding Paper	42
Book Chapter	1

4.3. Research Method of the Literature

In this review paper, there 3 types of research methods were identified (1) Qualitative Method, (2) Quantitative Method and (3) Mixed Method. The total number of articles analysed for the type of method is 75. The highest number of articles used in this literature is the qualitative method analysis with 27 articles such as Moid et al. (2021); Ajay Krishnan & Deshpande (2021); O'Byrne et al. (2018); (Mitra et al. (2015); Tziortzioti et al. (2019) and Papadopoulou et al. (2017). On the other hand, the least number of articles used the quantitative method analysis with 22 articles such as Kushnir et al. (2020), Bernareggi et al. (2019), and Neves (2020). Table 6 below shows the type of research method with the number of articles.

Table 6: The types of Research methods of the Articles

Research Methods	Number of Articles
Qualitative Analysis	27
Quantitative Analysis	22
Mixed-Method Analysis	26

4.4. Discussion

The discussion explains the research question-based findings and the theme and sub-theme-based findings. There are two research questions for this review study. Based on the research questions, the articles were analysed separately. This part explains the literature review of general journal studies. The theme and sub-theme-based findings will captivate the literature based on the journals reviewed.

4.5. Research Question-Based Findings

The research question-based findings are split into two research questions which are (1) STEM subject difficulties and (2) The teaching aid tool used in STEM. The total number of articles for research question one is 53, and for the second research question is 22 articles. All these articles will be discussed based on the needs of the review.

4.5.1. Stem Subject Difficulties

STEM is important because it instils a passion for innovation and promotes critical thinking. STEM, in addition to the benefits of learning science, technology, engineering, and math, aids in problem-solving and inquisitive learning, which boost success across a wide range of jobs and disciplines. Many reasons contribute to a lack of interest in STEM topics across demographics, including a lack of understanding of employment opportunities, a perception of unpopular subjects, inadequate preparation in core courses, and a lack of mentors, particularly representative mentors for minorities and women. STEM education and research are rapidly acknowledged worldwide as critical to national development and production, economic competitiveness, and societal well-being (So, 2021). This view may explain why students with a history of mathematical failures think they cannot build the essential knowledge to pursue further education in STEM (science, technology, engineering, and mathematics) courses (Lima et al., 2019). This difficult connection with mathematical concepts begins in elementary school when children are exposed to arithmetic (Lima et al., 2019). Perceptions of traditional education, as well as many misconceptions about what STEM education is, all contribute to difficulties (Spyropoulou & Kameas, 2020).

STEM (science, technology, engineering, and math) courses are inherently difficult to move online with no preparation or instructor training due to the constant use of laboratory experiences, group projects, and the common use of "chalk talks," all of which present unique challenges and necessitate the use of technology that offers to perform remotely (Pagoto et al., 2021). The difficulties have been discussed in many different aspects, such as in subjects, the perception of difficulties in subjects, the perception of difficulties in STEM and many more. The most frequently mentioned concepts in terms of how teachers try to deal with the difficulties that arise from the operating framework were (a) adaptation of educational programs based on the schedule, (b) communication with parents about STEM education to ensure they fully comprehend STEM education methodology and acknowledge its benefits, and (c) proper equipment preparation before each lesson start, in order to test and arrange them (Spyropoulou et al., 2020). Science, technology, engineering, and mathematics (STEM) disciplines are the most likely to create learning difficulties for migrant students. STEM instructors' perceptions of migrant students and their position strongly influence classroom instruction and after-school help and tutoring (Wang and Yang, 2021).

STEM education has recently received more attention in Vietnam. However, the design and arrangement of STEM subjects for teaching are still uneven, causing difficulties for instructors during teaching (Linh & Huong, 2021). As students respond to questions, the next question's difficulty raises or lowers depending on their responses. According to the author, if students answer questions incorrectly, more focused training can be delivered more detail (Lameres & Plumb, 2017). STEM course that subject mathematics training that is isolated from life demotivates pupils and stops them from succeeding in mathematics; as a result, prejudice and fear develop towards mathematics, and mathematics is regarded as difficult (Deniz and Kurt, 2022). STEM education stressed that students develop inquiry learning abilities, become science and technology literate, and are nurtured as persons who create changing living situations through acquiring engineering skills even though it is difficult to persuade (Kara, 2022).

Some studies discussed the misconception of STEM studies toward students with disabilities. Additionally, parents' and teachers' preconceptions that kids with disabilities cannot succeed in STEM are a barrier, resulting in a lack of motivation to attend STEM courses (Eleweke, 2014). Finally, parents see educational professionals' disinterest and general school cultures as reasons children with disabilities avoid STEM topics and vocations (Eleweke, 2014).

4.5.2. Types Of Teaching Aid Tools Used In STEM

The first traces of such approaches appear in scientific education in the 1960s, notably as a response to the failure of traditional teaching practices, which were no longer enough to handle the ever-growing amount of knowledge via merely memorising by heart (Brtnová Čepičková et al., 2016). STEM education is a method of teaching that includes science, technology, engineering, and mathematics. It educates pupils on computational thinking and focuses on real-world problem-solving applications. As STEM education is a learning technique that integrates numerous disciplines, uncertainty and discrepancies in understanding the process among users from diverse subjective backgrounds might emerge, particularly among pre-service instructors with less teaching experience (Poonpaiboonpipat, 2021). A teaching aid is anything that a teacher uses to help educate or make a lesson more engaging for pupils. Teaching aids can take nearly any shape. Pictures, films, charts, flashcards, and objects such as three-dimensional models or instructional gadgets are among the most prevalent. The students of STEM preferred multiple types of ways of learning. The kinesthetic (hands-on) mode was the recommended learning style for most students, either alone or in conjunction with other learning methods as multimodal (Gad et al., 2019).

The used teaching style displays an interactive learning environment that supports student engagement, retention, and involvement, ultimately leading to STEM inventions. As instructional aids, various digital resources such as PowerPoint presentations, films, online simulations, interactive quizzes, and unique games were utilised (Abouhashem et al., 2021). In addition, several digital teaching materials were used throughout the course sessions, such as PowerPoint, videos, online games, simulations, puzzles, and others. These digital resources served as effective moderators in actively engaging pupils for an extended period (Abouhashem et al., 2021).

Teaching aid tools can contribute to students learning more effectively in an inquiry-based learning environment assisted by cooperative technology. Students' explanation-based understanding should be ascribed to innovative views (Wang et al., 2021). One way to implement STEM education in Vietnam is the engineering design process (EDP) (Linh et al., 2021). Moreover, the author Basu et al. (2016) explains that computational thinking (CT) is thought to effectively promote students' knowledge of science and math topics because it parallels the key principles of science, technology, engineering, and mathematics (STEM) education. The author also explains that the initial CTSiM research was largely aimed at learning how students utilised the system and the difficulties they faced when developing scientific models using the system—aspects examined by evaluating students' video data. At the same time, they worked on the system with one-on-one tailored instruction (Basu et al., 2016).

Besides, the author Sarı et al. (2022) states that algorithmic thinking and programming have become a vital aspect of STEM education with the increased usage of computational software in STEM professions. Throughout history, graphic representations of information have been utilised for communicating, educating, and keeping cultural archives of essential information. This study by Beyette and Texas (2019) uses the DIME system technique to simplify the STEM course subject. However, students in many STEM fields taking programming classes continue to confront challenges. A lack of effective tools to address such challenges might impact students' motivation (Chandramouli & Heffron, 2015). The study by Chandramouli and Heffron (2015) leverages a learner-centric, user-friendly Virtual Environment (VE) to teach programming topics to encourage interactive and enjoyable learning for STEM subjects.

The deeper analysis of misunderstandings can help us identify and eradicate student misconceptions, as well as enhance teaching techniques and students' level of knowledge in beginning general physics courses, particularly in the topic of dynamics (Hockicko et al., 2019). Furthermore, it has been found that video games boost learning in STEM courses by 7 to 40% compared to the typical lecture course method (Da Silva Neves Lima et al., 2020). As technology advances and games become increasingly complex, the industry expands and draws a larger audience (Da Silva Neves Lima et al., 2020). Most of the aims of this effort on teaching aid tools were not only to create appropriate lab modules but also to shift the student's attention away from programming and onto the concepts or theories given in lecture (Howell et al., 2006).

Table 7: Classification Of Articles According To The Type Of Teaching Aid Tools.

Types of Teaching Tool	Articles
Slides, Books, Comics, Lectures	(Bevz & Dmytriienko, 2020); (Yin et al., 2019); (Adnan et al., 2019); (Brtnová Čepičková et al., 2016); (Whyte et al., 2020); (Mitra et al., 2015); (Moid et al., 2021); (To Khuyen et al., 2020); (Aldahmash et al., 2019a); (Batdi et al., 2019); (Tziortzioti et al., 2019); (Robert & Carlsen, 2017); (Papadopoulou et al., 2017); (Carlson & Bremmer, 2006); (Song, 2020); (Seymour Elaine, 1997); (Wang & Yang, 2021); (Verdugo-Castro et al., 2020); (Sorge, Lee, & Wilkinson, 2015); (Maltese et al., 2014); (Spyropoulou & Kameas, 2020); (Burrows et al., 2006), (Kara, 2022); (Eleweke, 2014)
Videos, Puzzles, Electronic Tools	(Abouhashem et al., 2021); (Boulton et al., 2017); (Loh et al., 2013); (License, 2018); (Sarı et al., 2022); (Da Silva Neves Lima et al., 2020); (So, 2021); (Papadopoulou et al., 2017); (Espejo Mohedano et al., 2018); (Tsiastoudis & Polatoglou, 2018); (Potkonjak et al., 2016); (Lima et al., 2019); (Pande & Chandrasekharan, 2014); (LaMeres & Plumb, 2019); (Weinberg, 2020); (Linh & Huong, 2021); (J.Schaefer, 2022); (Leandro et al., 2021); (Rodríguez et al., 2017)
Software and Applications	(Howell et al., 2006); (Ha & Fang, 2013); (Zubitur & Sánchez, 2017); (Costa et al., 2015); (Ajay Krishnan & Deshpande, 2021); (Shekhar et al., 2014); (Sonthitham & Thongchaisuratkrul, 2020); (O'Byrne et al., 2018); (Kushnir et al., 2020); (Tezza et al., 2020); (Neves, 2020); (Bernareggi et al., 2019); (Hockicko et al., 2019); (Jeong & González-Gómez, 2021); (Aldahmash et al., 2019b); (Barrett & Hegarty, 2016); (PO-HSIN HUANG et al., 2019); (Chandramouli & Heffron, 2015); (Prescod et al., 2018); (Wahono & Chang, 2019); (Kruatong Siriporn, 2018); (Marchisio et al., 2021); (Poonpaiboonpipat, 2021); (Lameres & Plumb, 2017); (Basu et al., 2016); (Kim et al., 2020); (Tilden et al., 2021); (Deniz & Kurt, 2022); (Gad et al., 2019); (Beyette & Texas, 2019); (Pagoto et al., 2021)

4.6. Theme and Sub-Theme Based Findings

This section of theme and sub-theme explains the findings more precisely. In this review, there is 2 level of theme. Theme (1) is the Level of STEM education with 3 sub-themes, (a) Primary level, (b) Secondary level and (c) University level and the theme (2) is the Relevance of Teaching Aid Tool with 2 sub-themes, (a) An efficiency usage of teaching aid tool and (b) Student feedback towards teaching aid tools.

4.6.1. Level of STEM Education

STEM is a common acronym in education nowadays (Poonpaiboonpipat, 2021). STEM education has characteristics such as being student-centred, promoting students' high-level thinking abilities, giving students problem-solving skills, and allowing them to retain the material they have learned for a longer time (Kara, 2022). It is an educational policy that begins in kindergarten and continues through post-doctoral studies, bringing topics such as Technology and Engineering into the currently different domains of Natural Sciences and Mathematics (Tsiastoudis & Polatoglou, 2018). It is feasible to assert that academic accomplishment levels in STEM-based classrooms vary depending on implementation timeframes (Tziortzioti et al., 2019). The level of education in STEM can be divided into 3 levels which are (1) Primary level, (2) Secondary level and (3) University level. The practices of STEM education in multiple countries begin at the primary and secondary levels. In Malaysia, there is a specific course at the pre-university level for STEM courses.

4.6.2. Primary Level

The STEM educational practices and teaching methods in schools are insufficient to develop individuals to the standards expected by 21st-century society (Deniz & Kurt, 2022). STEM education in elementary and secondary schools can assist kids in becoming interested in STEM jobs and producing a STEM-educated workforce that can fulfil the expectations of business and industry in a complex and technology-driven environment (Poonpaiboonpipat, 2021). The findings further showed that, due to national curriculum requirements, primary school instructors concentrated more on reading and mathematics and less on scientific understanding (Wang et al., 2021).

Besides, Lima et al. (2019) explain that the primary level faces difficulty connecting with mathematical concepts in elementary school when children are exposed to arithmetic. Students who struggle with elementary arithmetic operations (addition, subtraction, multiplication, division, and exponentiation) will ultimately reach algebraic methods, which need prior arithmetic knowledge. The problem begins to take shape in this situation (Lima et al., 2019). This study by So (2021) proposed that including mathematical analysis into STEM practices for assessing design solutions allows students to recognise the links between what they learn in school and what is necessary for a STEM profession.

4.6.3. Secondary Level

At present, introductory undergraduate STEM education training is provided as part of a secondary school mathematics course as one instructional technique (Poonpaiboonpipat, 2021). Furthermore, problems occur and must be handled even outside of STEM fields, making modelling a crucial component of courses that do not belong to a scientific domain. As mathematical modelling is a broad concept, it is typically difficult to give a specific and unique description of it. Mathematical (Marchisio et al., 2021). This study explains the impacts of high school pupils utilising the DIME map to understand advanced physics topics were found to be positive in this pilot research in the STEM course (Beyette & Texas, 2019).

STEM education prepares students to tackle current challenges using an interdisciplinary approach, allowing them to get access to the necessary information and skills (Tziortzioti et al., 2019). However, due to the difficulties, the STEM strengthens higher-order thinking abilities, puts theoretical information into practice and transforms it into products and inventions, and stresses the enhancement of students' inventive and productive talents (Tziortzioti et al., 2019).

4.6.4. University Level

STEM degrees have experienced an increase in employment demand over the previous decade (Deniz et al., 2022). STEM is commonly used to designate topics directly related to the hard sciences. This statistic demonstrates that some gender stereotypes between men and women still exist in society and are difficult to overcome. To address this issue, organisations frequently have opted to create efforts to encourage STEM careers in many areas of society (Rodríguez et al., 2017). Gender disparities in STEM (Science, Technology, Engineering, and Mathematics) higher education are a reality of difficulties faced (Verdugo-Castro et al., 2020). Rather than the gender disparities, the focus on subjects and courses is much needed for STEM studies. Despite its importance, it is not uncommon to see university students struggling with the use of Mathematics to create models, even when mathematical entities that play a role in solving a problem are part of secondary school study programs and should thus be familiar to students who do not have a specific background in Mathematics (Marchisio et al., 2021). The difficulties can develop at any point during the modelling process, including the grasp of the problem, the translation into mathematical formulae, the resolution process, and even the interpretation of the findings for the university students (Marchisio et al., 2021). The author Marchisio et al. (2021) made recommendations on measuring modelling skills based on real-world experience at the University of Ulster, where students confronted real-world difficulties in both a third-year industrial placement and a return to university for their final year.

Our research has revealed that students attending both universities have difficulty learning basic mechanical principles and theories (Hockicko et al., 2019). In addition, undergraduate science students may have difficulties rehabilitating inquiry skills, content, and self-regulated learning abilities (Pagoto et al., 2021). Fifty per cent of students who begin a degree programme in the sciences and 60 per cent who begin a degree course in mathematics drop out by their senior year, compared to 30 per cent of students in the social sciences and humanities (Robert & Carlsen, 2017). Seymour and Hewitt (1997) demonstrated that a shocking 90% of students quitting STEM majors identify bad teaching as one of their concerns, prompting educational scholars to study the relationship between teaching quality and retention (Robert et al., 2017).

Table 8: The classification of Levels of STEM specifically.

STEM Level	Articles
Primary Level	(Adnan et al., 2019); (Boulton et al., 2017); (Brtnová Čepičková et al., 2016);(Ajay Krishnan & Deshpande, 2021); (Loh et al., 2013); (Whyte et al., 2020); (Moid et al., 2021); (Wang & Yang, 2021)
Secondary Level	(Yin et al., 2019); (Abouhashem et al., 2021); (Costa et al., 2015); (Shekhar et al., 2014); (Mitra et al., 2015); (O'Byrne et al., 2018); (Kushnir et al., 2020); (Tezza et al., 2020); (To Khuyen et al., 2020); (Aldahmash et al., 2019a); (Batdi et al., 2019); (Tziortzioti et al., 2019); (Lima et al., 2019); (Carlson & Bremmer, 2006); (Song, 2020); (Wahono & Chang, 2019); (Linh & Huong, 2021); (Deniz & Kurt, 2022); (Kara, 2022); (Rodríguez et al., 2017)
University Level	(Bevz & Dmytriienko, 2020); (Howell et al., 2006); (Ha & Fang, 2013); (Zubitur & Sánchez, 2017); (Sonthitham & Thongchaisuratkrul, 2020); (License, 2018); (Neves, 2020); (Sarı et al., 2022); (Da Silva Neves Lima et al., 2020); (Bernareggi et al., 2019); (Hockicko et al., 2019); (Jeong & González-Gómez, 2021); (So, 2021); (Papadopoulou et al., 2017); (Espejo Mohedano et al., 2018); (Aldahmash et al., 2019b); (Tsiastoudis & Polatoglou, 2018); (Potkonjak et al., 2016); (Robert & Carlsen, 2017); (Barrett & Hegarty, 2016); (Pande & Chandrasekharan, 2014); (PO-HSIN HUAN et al., 2019); (Chandramouli & Heffron, 2015); (Prescod et al., 2018); (Seymour Elaine, 1997); (Kruatong Siriporn, 2018); (Verdugo-Castro et al., 2020); (LaMeres & Plumb, 2019); (Sorge et al., 2015); (Weinberg, 2020); (J.Schaefer, 2022); (Marchisio et al., 2021); (Maltese et al., 2014); (Poonpaiboonpipat, 2021); (Lameres & Plumb, 2017); (Leandro et al., 2021); (Basu et al., 2016); (Kim et al., 2020); (Tilden et al., 2021); (Gad et al., 2019); (Spyropoulou & Kameas, 2020); (Burrows et al., 2006); (Beyette & Texas, 2019); (Eleweke, 2014); (Pagoto et al., 2021)

4.7. Relevance of Teaching Aid Tool

STEM education focusing on real-life applications offers students experience and collaborative learning opportunities. It helps them acquire experimentally scientific concepts, problem-solving, inquiry, and inquiry learning abilities (Kara, 2022). STEM education has captivated the curiosity of many countries, and it may be regarded as a significant highlight in the innovation of teaching techniques in many countries throughout the world in recent years (Linh et al., 2021). Multiple ways will use teaching aid tools. Effective mathematics integration into STEM education necessitates changes in teaching and learning opportunities (Poonpaiboonpipat, 2021). The teaching tools hold on the relevance of the usage, leading to the efficiency and the students' feedback after using teaching aid tools.

4.7.1. An Efficiency Usage of Teaching Aid Tool

Although online and virtual learning has been steadily increasing, many institutes were unprepared for a substantial transformation due to the COVID-19 pandemic (Jeong et al., 2021). In this covid pandemic situation, the studies and teaching have been a huge conflict due to all on the internet only. The face-to-face classes have been flipped towards the online classes. The efficient teaching aid tools be used in this situation more efficiently. In general, the flipped classroom entails offering the student videos, texts, games, and anything related to the material that will be covered in the classroom prior to its occurrence (Leandro et al., 2021). In response to the many realities of internet access and technical equipment resources, classes that could be carried out in the students' homes were carefully thought out and organised. The previously indicated motivational tactics were implemented (Leandro et al., 2021). Along with STEM courses, the flipped classroom technique, a type of active teaching methodology, has recently attracted much interest in higher education (Jeong et al., 2021).

This course is not only a knowledge acquisition course for students, but a practice centred on hands-on learning and projects. As a result, rather than a simple written exam evaluation, it is required to employ various evaluation methods to determine whether the learning objectives have been reached (Kim et al., 2020). Kim et al. (2020) discussed that the STEM course created the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) paradigm, and the educational efficacy was assessed using test instruments. The efficiency of the tools leads to the understanding based on the implementation of relevant technologies by merging mathematics and science teaching and learning processes with engineering practices (Deniz et al., 2022).

This study created software-based virtual laboratories so, regardless of whether the latter is utilised for on-site or remote work, the advantages of a virtual laboratory over a physical laboratory should be specified at this point (Potkonjak et al., 2016). The efficiency of learning sequences is the face-to-face classes involving the direct theoretical, experimental, and computational classes rather than the online ones. This made the students not feel the reality of the STEM course studies during the pandemic (Aldahmash et al., 2019).

As a result, this discovery provides insights and implications for educators to work even harder to improve STEM integration, notably through the use of technology, in order to promote students' competency in diverse STEM activities (So, 2021). Interactive computer graphics software in spatial teaching is becoming increasingly prevalent as computer technology progresses (Ha & Fang, 2013). Besides, STEM comics have been created as one of the phases in creating useful teaching aids for the primary level students (Adnan et al., 2019). STEM comics is a specialised comic for Year One pupils that combines science and maths into a single comic (Adnan et al., 2019).

4.7.2. Student Feedback Towards Teaching Aid Tool

The students gave feedback before and after using the teaching aid tool. Feedback can be defined as the transmission of evaluative or corrective information regarding an action, event, or process to the originating or controlling source is also possible. First and foremost, the activities explored the theoretical underpinnings of STEM education, the engineering design process, its application in scientific classes, and in-class application examples (Sarı et al., 2022). Based on the author Sarı et al. (2022), the programming process makes the students seek answers to problems by applying their algorithmic thinking abilities. According to Leandro et al. (2021), the active learning tactics appear to be a suitable option for ensuring that the student remains attentive for nearly the whole class because, unlike traditional teaching methods, the student is encouraged to create dialogues with the monitor.

The students' feedback shows that as a result of resolving the issues identified, online classes would be more participatory in a virtual and online setting for future deployment by providing active instruction techniques and educating future students to teach STEM subjects (Jeong et al., 2021). They underlined emotions as the most important factor for teachers and students to consider while delivering virtual and online classes. They used their results to better prepare themselves for future sessions (Jeong et al., 2021). It is encouraging to discover that students were capable of incorporating STEM activities to varying degrees into STEM projects. It is noted that greater attention should be placed on promoting the incorporation of computing technology activities (So, 2021). Thus, effective teaching modalities with supporting resources are required, as is the use of real-world examples and challenging problems to motivate students, as well as the promotion of interactive and collaborative learning so that students can adopt inquiry-based learning methods and collectively solve complex problems (Shekhar et al., 2014).

According to the study by Sonthitham and Thongchaisuratkrul (2020), as a result, this research can help increase knowledge and understanding about software control systems in agricultural STEM studies, as well as encourage teachers to use teaching aids and techniques based on STEM education. In addition, it can help transfer knowledge and understanding of modern agricultural technology to students. Classroom tools, lab kits, and workbooks are self-sustaining for educators in their classrooms and other teachers through resource sharing (Mitra et al., 2015).

5. CONCLUSION AND RECOMMENDATIONS

STEM faculty should be prepared to engage all students in their lessons as more students with disabilities to pursue careers in STEM fields due to the difficulty of the STEM subjects and the lack of effective teaching aids. Through this Systematic Literature Review (SLR), we discovered 75 articles relevant to our study. The 75 findings of this study can be used to identify STEM subject difficulties and the role of teaching aids in increasing student interest in STEM subjects. These 75 findings were discovered across multiple studies. They could help inform future professional development and teacher initiatives aimed at improving teacher efficacy in STEM instruction and integration and identify specific difficulties experienced by students.

Furthermore, we also started some teaching aid tools regarding integration, approach, and application of STEM subjects' content in solving contextual problems. Everyone must value STEM education, regardless of students or teachers/lecturers, to improve student learning outcomes while preparing students for the future. As a whole, this SLR paper suggested the need for comprehensive STEM education professional development or training, collaborative efforts between STEM subject teachers through lesson studies or professional learning communities, as well as collaborations with local STEM expertise or community of practice to facilitate STEM education implementation at the primary, secondary, and university level. This study identifies the most common difficulties STEM students encounter and the teaching aid tools for STEM subjects that make it easier for them to learn. Meanwhile, more research is needed to determine who influences students' STEM interests and perceptions of STEM subjects, as most students' decisions are influenced by those around them. It is also critical to investigate student intentions and the stakeholders who influence students to pursue their further in STEM fields.

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