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A Systematic Review of 21st Century Teaching and Learning Interest in Mathematics Using PRISMA

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Abstract

Mathematics requires inquisitiveness, logical reasoning, and comprehension of how things fit together. However, prior research has shown three fundamental reasons for mathematics difficulty among primary school students: mathematical language, conceptual comprehension, and talents. This survey study intends to discover trends in the effect of 21st-century learning on primary school students' passion for mathematics teaching and learning in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (P.R.I.S.M.A.) guidelines. Through the S.C.O.P.U.S. base article, 69 publications published between 2018 and 2023 that are related to 21st Century Learning have been identified. In addition, this study identifies 24 inclusion criteria publications and 45 exclusion criteria papers with supporting evidence. The trend-focused character of this study is shown by the analysis and categorization of each of these articles into three primary categories: a) preparation of teaching and learning techniques, b) Student motivation and learning environments, and c) student achievement. The results suggest that 21st-century learning and teaching strategies may help educators and academics detect research patterns based on three chosen topics.

Keywords: Learning, Mathematic for school, Technologies, Pedagogy, Motivation

Introduction

Industry, economists, and education policymakers concur that for a nation to maintain its worldwide prosperity and remain inventive and resourceful, it must develop and retain a STEM-capable workforce that can use 21st-century methods of thinking, skills, and a well-rounded work culture (Barquilla,2021; Darkhan et al., 2021). S.T.E.M. is an acronym for Science, Technology, Engineering, and Math. Several research papers have emphasised the significance of S.T.E.M. and the anticipated shortages in the skilled labour market and a nation's economy if no actions are taken to increase students' S.T.E.M. abilities (Dadang et al., 2021).

According to an increasing number of scholars, math is a crucial component of S.T.E.M. education and research, particularly when tackling complicated issues and advancing innovation (Dewi et al., 2020). This is the case because mathematics is the language of science and technology. It equips us with the fundamental tools for comprehending and describing natural processes, designing technical solutions, and analysing data for various engineering

applications. Mathematical reasoning increases problem-solving, logical reasoning, and critical thinking, making it a crucial component of S.T.E.M. areas. From developing algorithms for artificial intelligence to simulating real-world events in physics and engineering, mathematics equips individuals with the skills necessary to push the limits of science and technology.

In the past, learning arithmetic was seen as an experience that happened to the student and a means of absorbing knowledge from the instructor. When behaviourism was the dominant learning theory, the focus in math lectures was more on the teacher "covering" a clearly defined set of material than on the techniques necessary to assure students grasped the knowledge. Nevertheless, current scholars say, "It is evident that the former does not ensure the latter."

Due to changes in society and technology, today's students are expected to possess 21st-century math abilities such as quantitative reasoning, critical thinking, and problem-solving (Dewi et al., 2020). Consequently, instructors are no longer required to impart information to their students. Instead, teachers should facilitate and engage students in mathematical dialogues based on well-designed genuine exercises (Darkhan et al., 2021).

Gonzalo et al. (2021) define learning math in the 21st century as "to include the learner's thoughts or actions during learning that are meant to affect the encoding process and make it easier to learn and remember new information." Some researchers have used terms like "thinking skills" (S), "higher-order thinking processes," "cognitive and metacognitive skills," "learning skills" (S), "learning tactics," and "mediating processes" to talk about 21st-century math (Fajrina et al., 2020).

Some researchers assert that the anxiety and fear often associated with studying mathematics might impede its comprehension. Negative experiences or misunderstandings about the topic may inhibit students' motivation and interest in mathematical subjects (James, 2014). The perception of mathematics as fuzzy arises from students' different learning styles and individual preferences. The abstract nature of mathematics can contribute to its perceived fuzziness. Concepts like algebra, calculus, and advanced geometry may seem distant from real-world applications, leading students to question their relevance. Integrating mathematics with practical examples and real-life scenarios can help bridge this gap and demonstrate its significance in solving real-world problems. By linking theory to practice, learners can develop a deeper appreciation for mathematics and overcome the notion of it being an abstract and incomprehensible subject.

If, as stated by Ilma et al (2023), mathematics is about investigation, reasoning, and understanding how things go together, what may be added to mathematics training to enhance students' mathematical reasoning and sense-making? How can mathematics be taught tangibly and engagingly in the classrooms of the twenty-first century? How can mathematics be experienced through building, developing, and linking mathematical concepts? What kind of learning settings encourages pupils to develop their mathematical reasoning?

This study seeks to present a picture of mathematics education research by emphasising numerous elements of studies published in the Scopus database, beginning with the volume from the previous five years in 2018. The current study will concentrate on mathematics students' use and awareness of learning methodologies. In addition, investigating the contextual elements that influence the creation and implementation of strategies will contribute to resolving these issues.

Literature Review

Spatial Skill or Arithmetic Skill

Spatial abilities are associated with the expression of spatial interactions, one of which is movement between objects. The same is true for Arithmetic or numerical ability. Number sense, according to Gonzalo et al (2021), involves vocal counting, numerical identification, number organising, comparisons of sets and numerals, cardinality, narrative difficulties, and one-to-one correspondence.

Both spatial and numerical skills fall under cognitive talents and play an important role in problem-solving and understanding our surroundings. While spatial skill is the capacity to recognise and handle things and their spatial connections intellectually, numerical skill is the ability to understand and deal with numbers and mathematical ideas (Gonzalo et al., 2021). Both talents are essential in various professions, including science, engineering, and architecture, as well as in everyday tasks such as chart analysis, solving mathematical problems requiring spatial arrangements, and recognising geometric patterns. Furthermore, spatial and numerical skills may be developed and improved with practice, and people who excel in both areas tend to excel in other activities and occupations.

In general, arithmetic, numerical, and mathematical skills are related to highly content-specific mathematical language, and the use of this language impacts children's mathematical ability. Furthermore, Numerous academics characterise mathematics as the application of arithmetic abilities. The ability to comprehend, manipulate, and effectively apply mathematical ideas and principles constitutes arithmetic competence James (2014). Specifically, numeracy is the capacity to interact with numbers and execute fundamental mathematical operations (addition, subtraction, multiplication, division). Among them are algebraic and geometrical reasoning (Maj, 2022). Consequently, using probability, statistics, problem-solving, and logical reasoning increases procedural knowledge acquisition.

The application of arithmetic skills also incorporates students' evaluation of their classroom assessment performance and explanations of how they get right and erroneous answers, followed by formulating particular objectives to enhance their future learning (Ilma et al., 2023). Teachers may determine each student's arithmetic comprehension and competency level and identify areas where more help or intervention may be required via tests. This information enables instructors to adjust their lessons to the unique requirements of each student and give focused practice and activities to enhance their arithmetic abilities.

Moreover, when students reflect on their classroom assessment results, they can identify their strengths and shortcomings in arithmetic, get insight into their development, and establish personal learning objectives. This self-reflection helps students become more conscious of their learning process and encourages them to improve their math abilities via practice and continued engagement with the topic. Ultimately, combining classroom evaluation and student feedback improves the learning process and promotes the overall growth of students' arithmetic skills.

Predominant Factors

Understanding the keywords refers to students’ capability to perform calculations mentally and quickly is a valuable skill for everyday situations and mathematical problem-solving. This can be known through students’ ability to analyse and interpret data, including graphs, charts, and other data representations, to draw meaningful conclusions and make informed decisions.

In the 21st century, learning math is significantly influenced by various factors shaping how students' approach and understand mathematics. The first predominant factor is technology integration (Ilma et al., 2023). With the advent of interactive tools, simulations, and online platforms, math education has become more engaging and accessible. Students can now access graphing calculators, math apps, online math games, and interactive whiteboards that enhance their learning experience.

The internet and online resource have also revolutionised math education through the availability of online resources and Open Educational Resources (O.E.R.). Numerous websites, video tutorials, and digital textbooks are accessible for free or cheaply, making high-quality math education widely available to a broader audience. This vast array of resources supports self-paced learning and enables students to explore mathematical concepts conveniently (Maj, 2022).

Personalised learning is an additional crucial element of modern mathematical education. Educational technology and data analytics have enabled adaptive learning platforms to adjust the pace and content of arithmetic lessons based on each student's strengths and weaknesses. This individualised approach ensures that students get targeted guidance and challenges, creating a deeper understanding of the material (Gonzalo et al., 2021).

Project-based learning is gaining popularity as it encourages students to apply their mathematical knowledge to real-world problems. Students develop critical thinking and problem-solving abilities while learning about the importance of mathematics in daily life and diverse vocations. The same goes for the Inquiry-based learning method. Inquiry-based learning is an approach that emphasises exploration and discovery. By encouraging students to ask questions and investigate mathematical concepts themselves, this method promotes a deeper understanding of principles and fosters a love for learning. Students become active participants in their education, and the learning process becomes more engaging and meaningful.

A constructivist learning viewpoint, on the other hand, holds learners accountable for attention to teaching and participating in strategic learning behaviours. What learners do to choose, organise, and link new knowledge to what they already know influences whether or not the information is learnt and retained. James (2014). Most importantly, students should be familiar with cognitive, metacognitive, and emotional domains.

21st Century Learning Improve Cognitive, Metacognitive and Affective Domains

Getting Ready for Technological Advancements In the twenty-first century, studying mathematics may be categorised according to its specific purpose: Individual learning activities are linked to cognitive methods like elaboration and rehearsal, which act directly on incoming information and change it in ways that enhance cognitive development. Adnan and colleagues (2021). To organise and monitor the learning process, metacognitive strategies such as planning, and evaluation are utilised. Effective strategies such as self-talk are utilised to boost attention.

In the cognitive realm, modern math education emphasizes critical thinking and problem-solving abilities. Instead of rote memorization, students are encouraged to understand mathematical concepts deeply and apply them in real-world contexts. Integrating technology, such as interactive software, graphing calculators, and online simulations, allows students to explore complex mathematical ideas engagingly and interactively (Adikayanti & Retnawati,

2022). These interactive tools enhance cognitive development by promoting active learning and analytical thinking.

In the metacognitive domain, 21st-century learning in mathematics focuses on metacognition - the awareness and understanding of one's thought processes during problem-solving. Students are encouraged to reflect on their problem-solving strategies, identify misconceptions, and self-regulate their learning. Personalized learning platforms and data analytics provide students with immediate feedback on their performance, allowing them to monitor their progress and adjust their approaches accordingly. Collaborative problem-solving activities and group discussions enhance metacognitive awareness as students articulate their reasoning and learn from their peers.

Furthermore, emotive aspects are important in 21st-century math instruction. Educators understand the need of fostering a good and inclusive learning environment that promotes students' emotional well-being. Students are encouraged to accept challenges and persevere through problems by developing a growth mindset – the concept that intellect can be grown through effort – leading to greater motivation and self-confidence in mathematics. Differentiated teaching responds to individuals' varied learning styles and preferences, ensuring that all students in the math classroom feel respected and supported.

Methodology

In this study, the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (P.R.I.S.M.A.) tool was used to establish and standardize the search strategy and identify the key components of the review question. P.R.I.S.M.A. is a systematic strategy for seeking qualitative investigation studies and mixed methods. The P.R.I.S.M.A. tool makes it easier to be forceful during investigations by identifying the critical components of non-quantitative investigation inquiries.

i.Identifying research questions

This article examines tactics, challenges, and the applicability of ways for teaching mathematical subjects by 21st-century learning philosophies. Consequently, the following research questions are formulated to direct the inquiry and guarantee that a variety of literature that focuses on these areas of interest is gathered.

1. What is the motive for the student to improve their mathematical performance?
2. What is the current state of mathematics subject achievement among students?

ii. Identify related studies

The most frequent search keywords and themes are used to analyze the development of math and 21st-century learning publications utilized worldwide. To acquire a more comprehensive overview of the literature, search terms such as "Mathematic," "21st-century education," and "S.T.E.M." are employed. Scopus' major databases have been scoured for relevant peer-reviewed literature. The descriptive essential search phrases are shown in Table 1.

Table 1
The leading search item used to issue a published article.

Essential search items used to generate published articles
"Mathematic" OR "S.T.E.M."
"21st Century Learning" OR "Modern Teaching"
"Motivation" OR "Achievement"

The P.R.I.S.M.A. checklist is then used to identify the article. The main search descriptors yielded 69 articles. Each component has been examined for the screen using the criteria listed in Table 2.

Table 2
Comprising and exclusion criteria

Criterion	**Comprising**	**Exception**
Period	2018-2023	Articles outside the year
Language	English and English	Other languages
Types of articles	Original and peer-reviewed research	Articles that are not peer-reviewed
Study focus	Mathematic only	Other residents

This procedure is continued with a deeper review iteration in which the full-text version of the article is retrieved, thoroughly studied, and validated as relevant using the author's exclusion or inclusion criteria. In the first phase, 69 entries were found in the previously stated databases. After removing the duplicate articles and books (n = 27), 42 unique papers were examined. In a subsequent step, 18 records were excluded based on titles, keywords, and abstract analysis, leaving 24 articles suitable for a thorough review. Figure 1 depicts a flow diagram summarising the results acquired in each step.

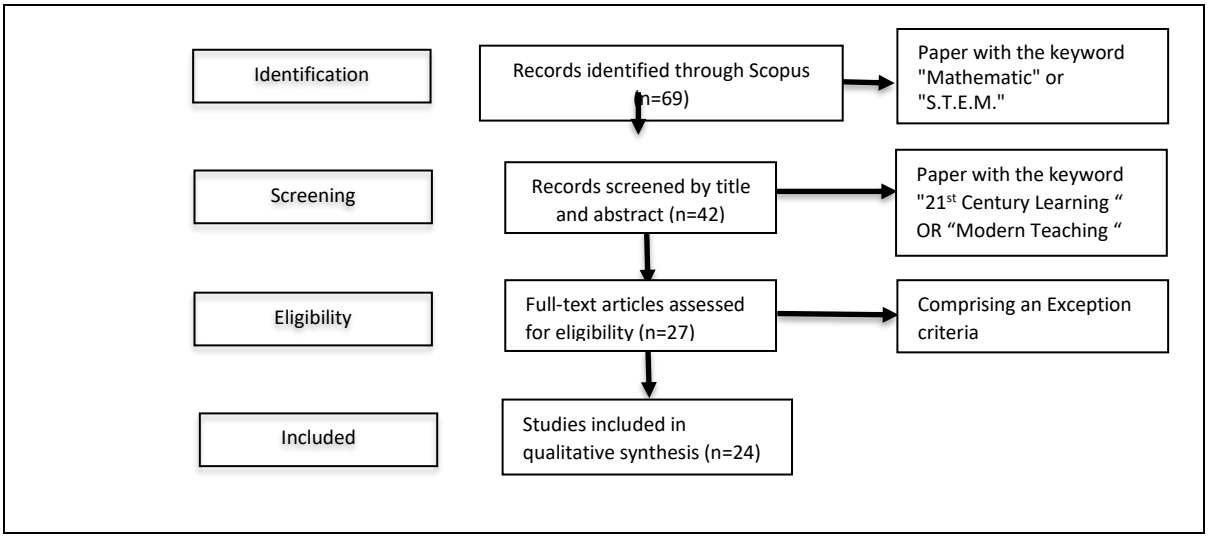

Figure 1. Image of Prisma for article selection. Source: http://www.prisma-statement.org/

Table 3
The search string

Database	Search String
Scopus	TITLE-ABS-KEY ("Mathematic" OR "S.T.E.M.") AND TITLE-ABS-KEY ("21st Century Learning" OR "Modern Teaching")) AND PUBYEAR > 2017 AND PUBYEAR < 2024 AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "cp") OR LIMIT-TO (DOCTYPE, "ch") OR LIMIT-TO (DOCTYPE, "re"))

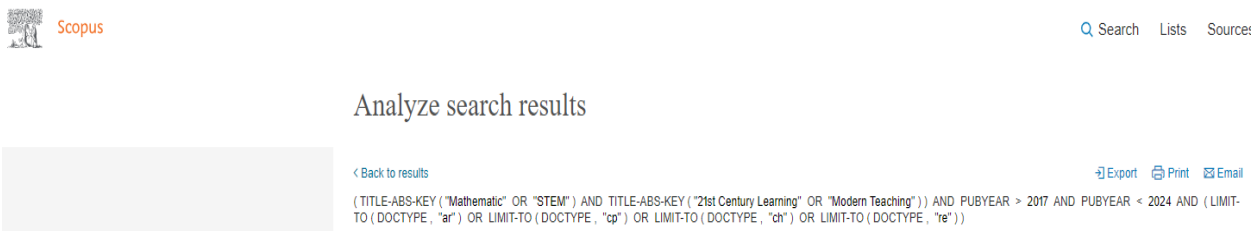

Figure 2: The procedure to include and exclude the access document.

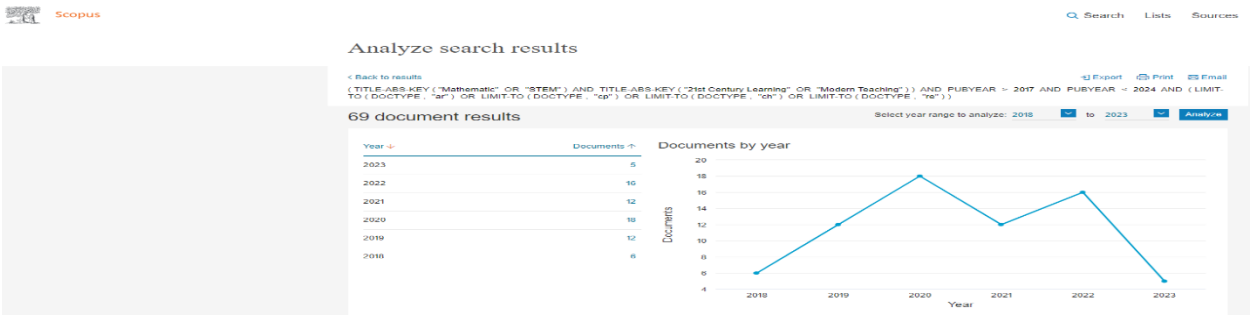

Figure 3: Distribution of articles by years

Results

Figure 4 until Figure 7 presents all the articles selected and analysed based on the list of authors, authors' affiliation, author country and subject area.

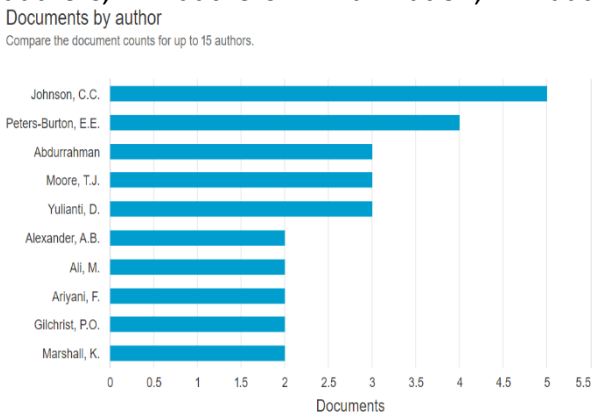

Figure 4: Distribution by authors

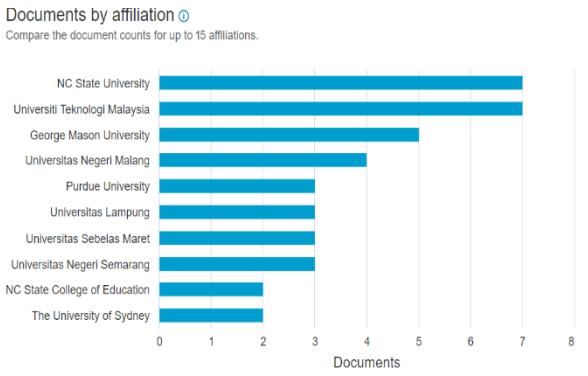

Figure 5: Distribution by authors' affiliation

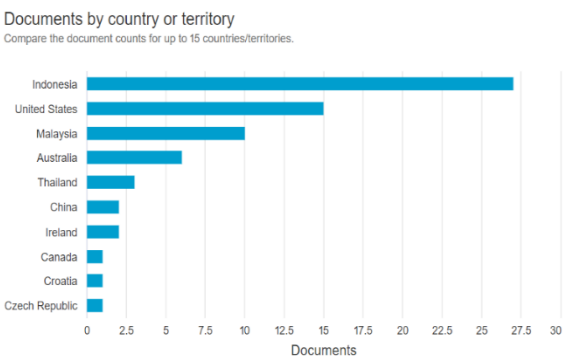

Figure 6: Distribution of articles by country-of-origin

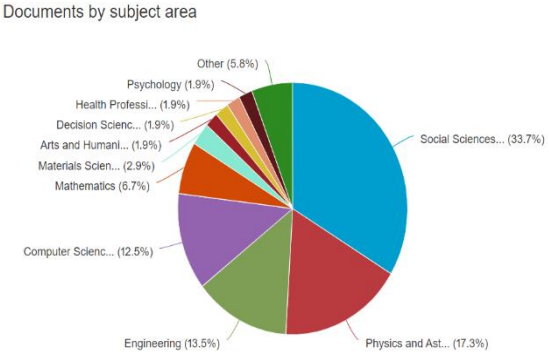

Figure 7: Distribution of articles by subject

Table 4

Distribution of 'what', 'who' and 'how'

No	Author	Year	Origin	Purpose/ Objective	Study Design/ Tool/ Method	Outcome
1	Adnan, M et al.,	2021	Malaysia	This research aimed to see how prepared Universiti Pendidikan Sultan Idris trainee instructors were to incorporate 21st-century. This research aims to learn about the teaching and learning of mathematics in schools.	Survey questionnaire (n=40).	The findings revealed that engineering and mathematics were the most challenging to incorporate into learning. And crucial to the learning process in the twenty-first century.
	Nasir et al.,	2023	Malaysia	This research aims to determine the degree of S.T.E.M.P.L. practises among S.T.E.M. instructors in lower secondary schools in Malaysia's Southern Zone.	Survey questionnaire (n=556).	Provide significant differences in S.T.E.M.P.L. practices based on the subjects taught and no significant relationship between S.T.E.M.P.L. practices. There are considerable variances in S.T.E.M.P.L. practises depending on the topics taught, but no significant association between S.T.E.M.P.L. practises and S.T.E.M. instructors' teaching experience.

3	Abdul Hanid M.F et al	2022	Malaysia	This study intends to investigate the impact of combining Augmented Reality apps with Computational Thinking in Geometry Subjects.	Survey questionnaire (n=124).	The influence of instructional methods that combine Augmented Reality applications and Computational Thinking on students' Computational Thinking, Visualization Skills, and Geometry Topic achievement.
4	Fitriyah C.Z et al.	2023	Indonesia	The goal of this study was to investigate the S.T.E.M. aspects that occurred during theme learning	Qualitative Technique: Learning video observation techniques was conducted by 20 respondents.	According to the data, engineering and mathematics were the most difficult to integrate into learning. And vital in the twenty-first-century learning process.
5	Royhana, U. Widiatsih, A. Atmaja, I.W.W. Septory, B.J.	2021	Indonesia	The purpose of this study is to research students' creative thinking skills and the use of the R.M.E. learning model for enhancing students' creative thinking skills in solving issues using comparative material.	Mixed method (qualitative method and quantitative method) n=70	Compared to material, the implementation of realistic mathematics education (R.M.E.) influences students' creative thinking abilities in problem-solving.
	Dewi A.K., Slamet S.Y., Surya A., Syawaludin A.	2020	Thailand	This research examines Elementary School Students' Problem Critical Thinking Skills in Mathematical Learning in Thailand.	Quantitative Technique: Mathematical problems and interview (n=32)	Third-grade children in Thailand do not yet have ideal math problem-solving abilities. The findings of this research give information regarding the abilities of primary school students to solve mathematical problems that still need to be improved.

7	Mohd C.K.N.C.K., Shahbodin F., Sedek M., Samsudin M.	2020	Malaysia	This research aims to provide game-based learning for autistic youngsters to learn fundamental maths.	Quantitative Technique: Mathematical problems in GBL	The goal of GBL is to encourage autistic youngsters to study and concentrate while doing so. Furthermore, GBL has been shown to stimulate pupils to learn, and it has been unanimously accepted that adopting GBL is the most effective teaching approach for boosting learning.
	Fajrina S., Lufri L., Ahda Y.	2020	Indonesia	This article examines S.T.E.M. as a learning strategy for developing students' talents, focusing on the "Four Cs" of the twenty-first century. Being competitive in the information and knowledge era becomes one of the "Four Cs" talents.	Review	S.T.E.M. aims to instil in pupils' lifelong skills in critical thinking, deductive reasoning, teamwork, and discovery as well as 21st-century competencies. The "Four Cs" of innovation and learning in the 21st century are critical thinking, creativity, communication, and cooperation. S.T.E.M. aims to instil in pupils' lifelong skills in critical thinking, deductive reasoning, teamwork, and discovery as well as 21st-century competencies. The "Four Cs" of innovation and learning in the 21st century are critical thinking, creativity, communication, and cooperation.

9	Sufa F.F., Gunarhadi, Akhyar M., Yusuf M.	2020	Indonesia	This study covers the ways for encouraging collaborative abilities in young children to acquire mathematical ideas.	Mixed method (qualitative method and quantitative method) n=70	Children must be encouraged to participate in collaborative activities in order to solve mathematical problems in novel ways. Children enjoy motor sensory activities in which they may connect with their classmates and the environment via assigned projects to solve in groups.
10	Syafitri E., Saragih S., Sari N., Anim A., Umami R., Batubara I.H., Rahmadani E.	2023	Indonesia	The purpose of this research was to determine if there was a difference between students' average pre- and post-test scores on the P.B.L.	Pre-experimental research: Parametric statistical analysis	Learning to employ the P.B.L. (Project Based Learning) model via the S.T.E.M. method helps increase students' critical thinking skills.
11	Nasution M.D., Ahmad, Mohamed Z.	2021	Indonesia	This study aimed to find out what students felt about project-based learning methodologies.	Survey questionnaire (n=63).	Students have highly positive assessments of excellent student learning outcomes. And students' views of the learning model's adherence to topic features are quite high.
12	Ilma AZ, Wilujeng I, Widowati A, Nurtanto M, Kholifah N	2023	Indonesia	Using publications from national and international journals, the content analysis aimed to determine trends in S.T.E.M. or STEAM education research in Indonesia.	Review (n=63)	Combined with S.T.E.M. or S.T.E.M. learning, project-based learning, problem-based learning, and inquiry are the primary learning paradigms. The key focuses of S.T.E.M. or STEAM education are critical thinking skills, scientific literacy, and learning outcomes.

13	Shurygin V., Anisimova T., Orazbekova R., Pronkin N.	2023	Russia	The purpose of the research was to examine the effect of the conventional method of teaching mathematics and its application on the conceptual and procedural knowledge, problem-solving skills, and learning motivation of students.	Survey questionnaire (n=72).	The results of this research corroborate previous scholarly articles describing the favourable influence of the MalMath programme on academic achievement and student motivation. The theoretical and practical consequences of this study are centred on the prospects for future theoretical research and practical implementation of mobile apps in the process of learning mathematics, comparing MalMath's efficacy to that of other applications.
14	Adikayanti L., Retnawati H.	2022	Worldwide	The purpose of this essay is to go more into the PJBL-STEM hypothesis, particularly those aspects connected to creativity and problem-solving skills in mathematics learning.	Review	The contribution is to increase instructors' and students' comprehension of the idea of PjBL-S.T.E.M. so that teachers may improve students' creativity and problem-solving skills while studying mathematics.

15	Jung Y.J., Choi G.W., Kim S.H.	2022	Worldwide	The purpose of this article is to conceptualise design-based education (D.B.E.) in S.T.E.M. educational contexts, to present examples of existing D.B.E. practises, and to explore the gaps in current D.B.E. practises.	Review	D.B.E. is well-aligned with S.T.E.M. education in the twenty-first century because it may enhance learner-centered pedagogy, critical thinking, collaboration, interest-driven learning, and integrated S.T.E.M. learning. For enhanced learning experiences, it is necessary to place more attention on particular strategies for integrating S.T.E.M. education into D.B.E. and on methods for preparing educators for D.B.E.
16	Johnson C.C., Peters-Burton E.E., Moore T.J.	2022	Worldwide	The research background utilised to frame the integrated S.T.E.M. method, which employs problem- and project-based learning to engage students in real learning experiences aligned with 21st-century learning, is reviewed in this study.	Review	The document provides an overview of the five real-world themes that organise the S.T.E.M. Road Map curricular modules: Cause and effect, progress and innovation The Represented World, Long-Term Systems, and Enhancing the Human Experience
17	Xu S.-R., Zhou S.-N.	2022	China	This study investigated the impact of students' attitudes toward science, technology, engineering, and mathematics (S.T.E.M.) on their capacity to learn in the twenty-first century.	Survey questionnaire (n=779).	Respecting S.T.E.M. attitudes across disciplines is highlighted by this finding. Students' views toward engineering and technology are particularly helpful to enhancing their 21st-century learning skills.

18	Yulianti D., Sugianto, Ngafidin K.M.	2022	Indonesia	This research aims to build 4C abilities in students by studying Physics in Mechanics using a Science, Technology, Engineering, and Mathematics (S.T.E.M.) method.	Quasi-experiment one-group pretest-post-test design	The study instrument includes essay assessments to assess creative and critical thinking abilities and observation sheets to assess teamwork and communication abilities. Data analysis revealed that students' 4C abilities improved; the average is in the medium range.
19	Maj S.P.	2022	Australia	Cognitive Load Optimisation is a new quantitative Science of Learning theory.	Survey questionnaire (n=100).	Extensive research demonstrates that Cognitive Load Optimisation may significantly improve teaching and learning outcomes in all S.T.E.M. subjects at all educational levels, including elementary and secondary school, college, and university. Extensive research demonstrates that Cognitive Load Optimisation has the potential to significantly improve teaching and learning outcomes in all S.T.E.M. disciplines at all educational levels, including elementary and secondary school, college, and university.
20	Åhman S., Nguyen J., Aghaee N., Fuchs K.	2021	Sweeden	This qualitative study intends to analyse the factors that impact students' participation while using Student Response Systems in a classroom augmented by technology.	Deepth Interview (n=14)	The study adds to the body of knowledge by filling a research gap identified as requiring additional perspectives from graduate students in a S.T.E.M. programme in southern Sweden.

21	Perdana R., Apriani A.-N., Richardo R., Rochaendi E., Kusuma C.	2021	Indonesia	Describing and comparing the outcomes of the specified attitudes based on the domain of S.T.E.M., 21st-century abilities, and gender, this study was both descriptive and quantitative.	Survey questionnaire (n=132).	There was no substantial variation in student grades. Before integrating STEM-based learning and 21st-century skills, educators and policymakers should have understood student attitudes, according to these studies.
22	Parno, Supriana E., Widarti A.N., Ali M.	2021	Indonesia	This research aims to determine the efficacy of 7E L.C. and STEM-Based 7E L.C. models in boosting students' C.T.A.	Survey questionnaire (n=62).	The various beginning states and learning procedures influenced the improvement of students' abilities. Both, however, are independent of one another.
23	Barquilla M.B., Cabili M.T.	2021	Philippines	This study aims to enhance students' conceptual understanding and performance by using the improved module.	Experimental and control group interpretation for quasi-experimental design	This study was both descriptive and quantitative, explaining and comparing the outcomes of the specified attitudes based on the domains of S.T.E.M., 21st-century abilities, gender, and grade level.
24	Darkhan B. Toibazarov, Sabyrkul M. Seitova, Ryskul Tasbolatova, Zhenis A. Omarov, Saltanat N. Ibrayeva	2021	Europe	The objective of this article is to evaluate existing scientific, practical, and theoretical works, with a focus on the pertinent concerns used in the education of future mathematics educators, in order to assess the current situation and provide potential remedies.	Survey questionnaire (n=107).	This study demonstrates teachers' and scientists' interest in and awareness of the didactic objective of applied orientation in mathematics education, as well as the use of applied activities in the learning process. The author suggests a definition for the word "applied problem" based on use analysis and didactic approach.

Discussion

Preparation of Teaching Mathematics With 21st Century Learning Method

Higher-order thinking skills (HOTS) are essential for teachers and students to cultivate in order to improve the overall quality of mathematics instruction (Abdul Hamid, 2022; Adnan et al., 2021). The challenge of education in the twenty-first century is to deliver teaching on HOTS

while managing a more dynamic classroom. A pleasant and safe classroom must include basic amenities such as a blackboard, a word wall, and sufficient space (Barquailla & Cabili, 2021).
As part of a 21st-century learning paradigm, mathematics instruction and learning must migrate from traditional to technology-based, creative, and innovative approaches (Dadang, 2021; Dewi et al., 2020). Therefore, school teachers need assistance in identifying projects that employ a variety of technologies and information sources to perform effective and high-quality teaching and learning that is relevant to recent advances (Farina et al., 2020). To meet future expectations, teachers must maintain current knowledge (curriculum content) and skills (pedagogy of education).
According to James (2014), teachers who are consistently motivated and passionate have a beneficial effect on student learning and achievement. Mohd et al. (2020) investigated teachers' knowledge, emotion, and competency-based learning in a comparable research (C.B.L.). A successful teaching and learning (T&L) method combines knowledge with interest. The results are congruent with the findings of Nasir's study from 2023, which revealed that 87.4% of teachers had time to update and develop their skills.
In addition, the results of this study are compatible with those of past research, such as Nasution's (2021) study, which demonstrated that teachers have a high level of expertise. In addition, Peter (2019); Dewi (2020) revealed that instructors must be competent in all aspects of the teaching and learning process, especially in terms of cognitive abilities. Ahman (2021) found that 94.4% of respondents were aware of the formation in her study on the level of preparedness of mathematics teachers in Johor Bahru for implementing the standard primary school mathematics curriculum. According to Yulianti (2022), mathematics teachers are not well equipped to conduct School-Based Assessment (PBS). According to the open-response study, instructors cited more responsibilities and time constraints, which necessitated greater proficiency in implementing 21st-century T&L in the classroom.
Strong interest, knowledge, and skills were shown by respondents in ideas, attributes, and kinds, as well as in the integration of mathematics. This suggests that the majority of respondents were familiar with and exposed to 21st-century learning and its implementation in the classroom from an early age.

Student Motivation, Mathematics Learning, and Twenty-First Century Competencies

Overall, respondents demonstrated a high degree of interest, knowledge, and skills in concepts, qualities, and classifications, as well as a high level of interest, knowledge, and skills in incorporating mathematics into their studies. This suggests that the majority of respondents were familiar with and exposed to 21st-century learning and its implementation in the classroom from an early age. Overall, respondents demonstrated a high degree of interest, knowledge, and skills in concepts, qualities, and classifications, as well as a high level of interest, knowledge, and skills in incorporating mathematics into their studies. This suggests that the majority of respondents were familiar with and exposed to 21st-century learning and its implementation in the classroom from an early age.
According to Xu and Zhou (2022), students are also interested and often ask teachers questions during T&L activities in order to comprehend math courses. The results indicate that when students are highly driven, they are ready to acquire new approaches and abilities and satisfied when they successfully complete arithmetic homework. Students should continually develop their math study objectives and learning practises in order to improve their test performance. In addition, the learning technologies improve their interest in the subjects.

They may invite others to join them in asking questions and studying in groups if they have mastered mathematics.

Student Performance

After applying 21st-century skills-based learning, the student's ability in studying mathematics is strong based on references gained between 2018 and 2023. During mathematical learning exercises, students often ask the lecturer for clarification. According to Syafitri et al. (2022), there are students that think positively because they have confidence in their ability to achieve great results in Mathematics. In addition, they frequently assess mastery of the test-learned mathematical concepts. In addition, family, friends, and teachers often encourage youngsters to work diligently to achieve success in Mathematics subjects.

This conclusion is reinforced by Royhana (2021), which demonstrates a significant percentage of above 80.0%. Items with a high frequency of the phrase "Mastering Mathematics helps students get great test results in other S.T.E.M. courses". Nasution and Rohani Ahmad (2021) examined the relationship between mathematical solution success and student learning strategies.

Perdana et al. (2021) did an analogous research on the learning style and motivation of first-semester engineering mathematics students. The twenty-first-century learning idea is driven by learning style, which pushes students to incorporate real-world events and mathematical applications into the curriculum. This helps students to comprehend the significance of their education and the application of mathematics in diverse industries and professions.

Consequences of The Study

It is quite simple to incorporate 21st-century abilities into classroom education. In the twenty-first century, the use of technology in the classroom is one of the highlights of schooling. This is because technology in T&L helps students to develop a variety of skills, including communication, teamwork, critical thinking, and problem-solving, among others. This skill may be beneficial to students during T&L instruction in the classroom and may also be applicable in the workplace. Incorporating 21st-century skills into mathematics education stimulates students and positively affects instructional staff, such as teachers (Nasir, 2023). Within the context of schooling, 21st-century skills are vital. This is because, in the modern day, technology is essential for every student and teacher to fulfil their assigned obligations.

Conclusion

Education is the lifeblood of societal and national progress. With a well-planned education system, the nation is presumed to have succeeded in its responsibilities to maintain a quality education system. Quality education is an endeavour to produce a new-century generation. Various teaching approaches and methods are required to generate exceptional pupils in several subjects, particularly learning and soft fields. If the teacher's approaches and methods are not varied, the pupils will get bored. As a result, understanding 21st-century skills is essential for instructors and students to master learning and teaching activities in the classroom in a non-boring and enjoyable environment (Maj, 2022).

This research aimed to determine the degree to which attitudes, motives, and successes in mathematics learning may influence 21st-century abilities in today's children. According to the survey findings released in 2018-2023, student motivation and performance in

mathematics have improved. This demonstrates that students are pleased with incorporating 21st-century skills frameworks into these topics.

Furthermore, instructors and students may determine pupils' levels of weakness and lack of mastery of 21st-century abilities by examining their attitude, motivation, and degree of success. Furthermore, this research may assist instructors in developing teaching approaches that are more creative and inventive, fascinating, and reflective of 21st-century learning.

As a result, changes in teaching and learning must emphasise the mastery of 21st-century skills by conducting more pupil-centred activities and exposing them to today's global needs, as well as enhancing students' soft skills to meet the challenges in the real world, whether in the world of work or matters about society and community.

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