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Global Teaching Approaches in Mathematics: Addressing Learning Domains for Holistic Student Development

Christian R. Repuya*
College of Education, Bicol State College of Applied Sciences and Technology, Naga City, Philippines ORCID: 0000-0002-0121-6431

Kim F. Trazona
Department of Education, Albay, Philippines ORCID: 0009-0001-5712-1343

Cris M. Acio
Camarines Norte State College, Daet, Philippines ORCID: 0009-0007-0873-1261

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To promote student learning in mathematics education, the three learning domains, namely the cognitive, affective, and psychomotor domains, must be addressed to encourage overall development and prepare students for life's challenges. This paper is a literature review of diverse studies and practices across the globe on raising student achievement, considering the three learning domains employing a systematic literature review and following the PRISMA approach, the Preferred Reporting Item for Systematic Reviews, and Meta-Analyses. Of the 200 identified research studies, 33 qualified and were included in the analyses. Findings showed that technology-based learning is the most appropriate teaching strategy for developing cognitive and psychomotor skills when learning mathematical concepts. It provides virtual and controlled settings that foster knowledge assimilation and application. In the affective learning domain, inquiry-based, representation learning, and culturally responsive learning are most effective as they increase students' involvement, learning participation, and thinking through collaborative and blended learning environments. The study recommends integrating blended learning, multiple representations, and meaningful assessments to enhance students' cognitive and problem-solving skills. Culturally responsive teaching, digital tools, and experiential learning activities to improve students' engagement, motivation, and practical application. The study recommends further research on these approaches to validate their effect on students' holistic development in mathematics education.

Introduction

Learning demands and the current level of development are already changing through the new generation objects of globalization learning environments (Zhao et al., 2023). Thus, mathematics is an academic discipline that enhances cognition and evaluates competencies required in academic and working life and individual or collective development (Niss, 2018).

* Correspondency: crrepuya@astean.biscast.edu.ph

Nevertheless, teaching practice in mathematics education exposes students and educators to the struggle to meet the emerging demands of globalization, technology inclusiveness, and a student-centered approach (Yusri et al., 2024). Such challenges call for creativity in course delivery approaches that address all learning domains, such as cognition, affect, and psychomotor domains, instrumental in shaping student character (Henriksen et al., 2021).

The cognitive domain, which is concerned with acquiring knowledge, intellectual skills, and thinking skills, is the primary domain for mathematics education. It insists on the conception and application of ideas, the analysis of problems, and the synthesis of information. Thus, it is pivotal in mathematical competence. The affective aspect deals with people's willingness and interest in numbers to avoid math phobia (Luo, 2024). At the same time, the Psychomotor domain, which is associated with physical experiences and learning implementation in terms of tangible objects and actions, provides practical problem-solving of mathematics and procedural knowledge in this area. Collectively, these domains form a coherent model of practice for teaching mathematics with learning and instruction at its center.

The approach to teaching in an era of globalization has shown possibilities in the transformation of the learning of mathematics to meet these domains comprehensively (Yusri et al., 2024). Inquiry-based learning, Project-based learning (PBL), and Blended learning are the teaching approaches that align with the cognitive domain. They ensure intellectual components without compromising the affectivity and motor aspect with intricately designed and almost real-life illustrations (Beckett et al., 2020). Education tools and applications complement this process by developing engaging educational experiences that require users to engage with content proactively and be active players (Henriksen et al., 2021).

Nevertheless, the integration of these domains in a holistic manner is still a research question in mathematics education (Ali, 2024). Research has shown that while students can cope cognitively with learning outcomes, there is a lack of a more sensitive approach to addressing their emotional and physical techniques as they solve problems or engage in computational tasks (Luo, 2024). This lack of appreciation hinders educational practices from equipping students with the complex skills required in the twenty-first-century education and work environment, thus calling for integrated curricular teaching and learning approaches that foster soft skills, hard skills, and technological knowledge use.

With this, Project-based learning (PBL) as an instructional framework combines various learning domains through student inquiry and solving practical problems (Garib, 2022). The educational community has extensively studied PBL application in STEM and engineering but lacks research on its effects on affective engagement and psychomotor skills in mathematics (Paleenud et al., 2024). Technology integrating PBL produces interactive learning spaces that activate student thinking patterns, enhance task attachment, and enable practical knowledge implementation (Beckett, 2020).

More in tune with modern technology, digital tools, and other online collaboration platforms also continue to broaden the prospects for incorporating the three domains in mathematics learning (Dooly et al., 2016). Varieties of tools like interactive simulations, games, learning platforms, and even interactive, collaborative virtual environments promote rationality, motivation, and psychomotor activity, respectively (Henriksen et al., 2021). Nevertheless, the issues of equity, teacher preparedness, and curriculum integration should be met by the teachers if the interventions are to have the best impact (Prasetiyo et al.,2023).

This study investigated the global mathematics classroom teaching approaches through a systematic literature review of the diverse studies and practices across the globe that identify the strengths and weaknesses of the approaches in raising student achievement, considering the three learning domains – cognitive, affective, and psychomotor. Further, the present study explored barriers and possibilities when teachers apply these instructional approaches within mathematics education classrooms. Specifically, it answered the following questions:

(1) What teaching and learning approaches are used globally in mathematics education to address the cognitive, affective, and psychomotor domains of learning?
(2) Based on research findings, which teaching approaches are most effective in improving students' cognitive, affective, and psychomotor skills in mathematics?
(3) What challenges and opportunities arise when implementing teaching approaches that target the domains in mathematics education?

Literature Review

Students commonly use visual representations during mathematical problem-solving while maintaining essential connections between symbols and conceptual objects, schemes, and prototypical examples. Using representations in learning yields both internal and external effects on students. Previous knowledge, personal preferences, and mathematical beliefs form internal effects that impact students through rote learning and personal experiences. In contrast, external effects derive from problem presentations and sequential mathematics curricula (Mainali, 2021). According to Buscher et al. (2022), teachers sometimes adjusted their instruction approach either by simplifying mathematical tasks or switching between different mathematical activities because they believed different classroom requirements conflicted

Other teaching approaches that improve cognitive skills are the AI implementations in education systems currently creating revolutionary changes to teaching approach as shown in Díaz (2024). Teachers using virtual reality technology develop immersive experiences for students whose situations match the style of learning content (Zhan, 2024). Digital learning resources support teacher instructional goals and education diversity in classrooms. Teachers' didactic purposes when using DLR need additional study in classroom applications (Villasmil, 2024). Good teaching practices continued to develop through teachers recognizing mobile devices as suitable learning tools and their conviction about mobile learning's emerging popularity throughout the next few years. The analysis demonstrated why educators must demonstrate favorable attitudes toward mobile learning (Aznar-Díaz et al., 2020).

Implementing digital learning technology in universities offers exceptional possibilities for designing adequate cognitive learning spaces that can benefit present-day and future emergencies. The flexibility of online learning environments that provide both temporal and spatial/geographical flexibility allows numerous students with diverse constraints, such as parenthood alongside the remote location of residence or part-time enrollment, to access potentially high-quality university instruction (Hofer et al., 2021). A team of volunteer lecturers operates Math education through joint efforts, which produce platform content by creating and reviewing educational materials and questions. The platform offers questions that students need to interact with for improved knowledge acquisition (Flamia et al., 2024). The Problem-based learning concept demonstrated success, which makes it suitable for Ghanaian teacher education programs where it serves as an instructional strategy for transferring mathematical knowledge and skills and facilitating accurate generalizations. Pre-service teachers developed student-centered approaches because PBL combined interactive teaching with facilitator-student interaction, enabling students to cooperate to achieve goals through group teamwork and improved student-to-student communication (Boye et al., 2023).

Through online teaching, students gain fundamental roles in developing their academic content. Students gain active participation through the system when needed while benefiting from a wide range of available study resources. The online assessment, as described in the articles, educates students while challenging them to show comprehension through different virtual platforms, simultaneously improving their digital proficiency and virtual presentation and communication abilities (Casadesús et al.,2024).

It is difficult for lecturers to attempt assessment practice modifications and implement multiple approaches stipulated by modern learning assessment without receiving feedback from students and decision-making stakeholders (Mardiana et al., 2020). The teacher requires extensive knowledge of mathematics and awareness of contemporary but traditional mathematical applications and must grasp the psychological factors and child development aspects of children in our current technological era. Additionally, they should comprehend present student inclinations in interpersonal communication. Teacher workload was a major influence as they taught Mathematics across different (by age) classes throughout one academic year (Tarasenkova et al., 2020).

The teachers must distinguish active learning practice from adding more content into tight lesson periods. Mathematics Teacher Educators make judicious choices for instructional tasks, facilitating students' ability to reason and solve problems. Students' content knowledge growth occurs when Mathematics teacher educators model instructional approaches that future teachers will need while teaching them how to create valid mathematical arguments along with a group discourse approach. MTEs prepare pre-service teachers to fulfill mathematics classroom expectations (Litster et al.,2020) by providing dynamic learning activities for maths content subjects combined with explicit discussions of their benefits for both personal comprehension and their future students' math learning achievement.

Traditional games and livelihood activities demonstrated the mathematical concepts in traditional practices. Traditional games and livelihood activities validate that mathematics is an essential cultural phenomenon. The students acquired novel mathematical understanding through culturally relevant instructions, increasing their numerical interest (Samaupan, 2019).

The educational approach that employs realistic mathematics principles in smart mobile teaching devices fundamentally influences children between 4 and 6 years old for multiplication learning outcomes. Students learn multiplication more effectively by implementing smart mobile devices than traditional approaches. Traditional teaching techniques have minimal influence on multiplication reproduction in 4–to 6-year-olds. (Fotini, 2019). Students gain valuable understanding through their experience of learning with internet technology. With the Internet, students can learn anytime and anywhere without physical contact with their instructors. Utilizing Moodle as a learning platform improves students' academic results (Handayanto, 2018). The educational approach to mathematics learning through Realistic Mathematics Education alongside blended learning produces substantial differences compared to classic instructional techniques. The study outcomes of mathematics lessons demonstrated substantial growth in the students following the blended learning-based RME model beyond the findings in classes adopting a conventional educational approach (Sari et al., 2020).

Technical capabilities hold importance, but students have less digital competency than teachers anticipate, so informational aspects and social factors prove to be essential. Effective teaching with Technology occurs through collaborations between instructors and students to develop student-driven practices that are differentiated and situation-based for shared education. Understanding Big Data teaches students and teachers to recognize BD operational principles and the data they wish to present through BD systems. Integrating BD into education enhances educational management systems and enables people to gain deeper self-knowledge and develop their skills effectively. BD helps researchers investigate Malaysia's educational sector in greater depth, according to Jia et al. (2022).

The assessment of student achievement needs to change because students must have new abilities and knowledge that can be adapted to the global economic era of the 21st century. In this era, students not only need a basic understanding but also need to think critically, analyze, and make decisions. Helping students develop these skills will make a difference and represent a new assessment approach (Mardiana et al., 2020).

The PBL Realistic Model principles allow student-teachers to carry out learning activities effectively, according to Rivdya et al. (2018). Chemlal et al. (2023) proposed incorporating sustainable education into educational teaching and learning procedures. On the other hand, implementing audiovisual technology assistance enables teachers to share vast content with students while demanding minimal work to deliver in less time. Audiovisual Technology provides assistance that helps students cope with mathematics learning obstacles while making the lesson both captivating and effective for primary school students in grades 7-9 during their didactic lectures. Research outcomes could benefit from a distinct examination of audio versus video components, which would provide additional details on TA effectiveness, and teachers can implement multiple student evaluation approaches and explore teaching Mathematics with devices including smart boards and iPads, etc. (Alshatri et al., 2019).

Method

Research Design

The study utilized a systematic literature review (SLR) approach. Through SLR, researchers acquire pertinent research studies (such as articles, conference proceedings, books, and dissertations) by implementing a systematic approach (Carrera-Rivera, 2022). The SLR approach combines scientific evidence regarding specific research questions by presenting all published evidence for the study and examining evidence quality openly and repeatedly (Lame, 2019). The study adopts Kitchenham's (2004) three-stage systematic literature review framework with elaborations by Xiao and Watson (2019). The stages include planning, review process, and report preparation, all with images to elaborate on the explanations.

Application Process and Data Analysis

As shown in Figure 1, the planning includes the development of a working parameters formula for the operational standards, articles to be included or excluded, and the identification of the review process to be done (Zakariya, 2022; Tagscherer & Carbon, 2023). The planning stage requires the formulation of operational standards (Zakariya, 2022), specifications for articles, the specification of inclusion/exclusion criteria, and the definition of the review process to be undertaken (Tagscherer & Carbon, 2023).

Figure 1. Procedure Review Process

The review stage encompasses three key activities: defining data sources, data abstraction, and data analysis, with full compliance with operational norms. Meanwhile, the last stage, reporting, involves expressing an opinion through conclusions and recommendations supported by implications and research limitations.

Data Source & Abstraction

In this study, the researchers conducted the article selection process with the help of the Publish or Perish application, with special consideration given to the articles listed in the Scopus database. Databases have a significant role in this process since they contain the publication metadata and bibliometric measures for the validity and accuracy of the results (Yusri et al., 2024).

Initially, the articles were retrieved by entering a list of carefully selected phrases such as Teaching Approaches, Cognitive, Affective, and Psychomotor. These keywords focus on articles published in a specific 2018-2024 timeframe to include recent work relevant to this field.

Table 1 *Inclusion and Exclusion Criteria*

Criteria	Inclusion	Exclusion
Types of Research	Quantitative, Qualitative, Development, Mix Approach	Review
Language	English	Other than English
Article type	Research article	Books, chapter books, and proceedings
Year of Publication	2018-2024	2017-below

By searching through the Scopus database available through publish or perish, articles were searched using the keywords and yielded 200 articles. After this, the articles were further subjected to an eligibility assessment based on the inclusion and exclusion criteria, as shown in Table 1. This step is instrumental in excluding many irrelevant or low-quality research proposals in the final examination and remaining relevant to the set research objectives. After the screening, 33 research articles qualify for the review.

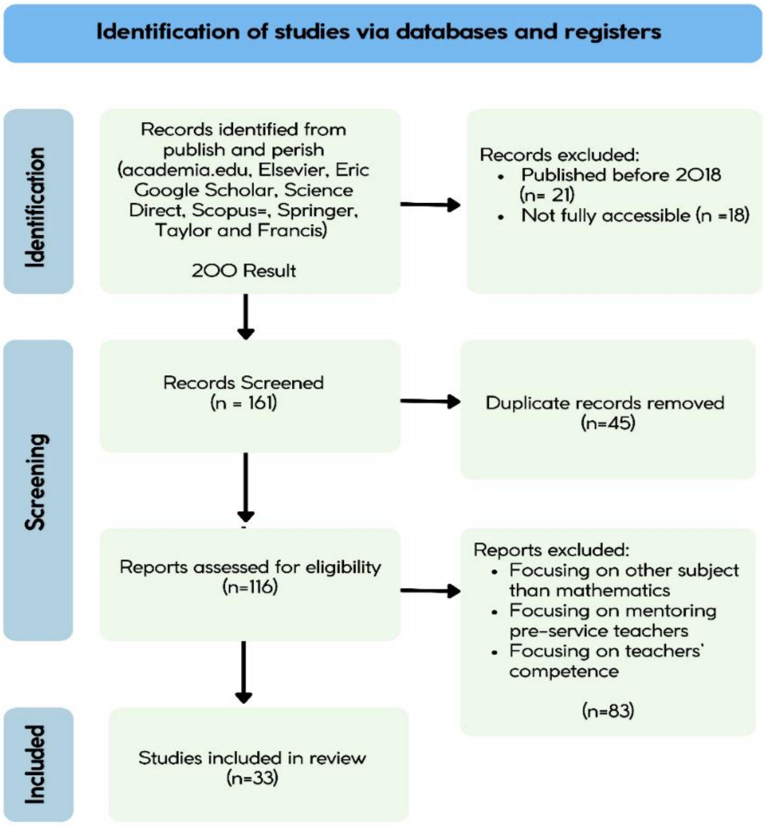

Figure1.PRISMA Flow Diagram 2020 of Literature Research and Review Process

There are specific directions concerning the conduct and reporting of literature searches in the systematic review processes, which are important for making the processes transparent and rigorous. This study followed the PRISMA approach, the preferred reporting Item for systematic reviews and meta-analyses. The main aim of PRISMA is to help systematic reviewers report transparently the reason for the review, the conducted review approach, and the obtained important findings. This study follows the four key phases outlined in PRISMA: The key themes include identification, screening, eligibility, and inclusion (Page et al., 2021). Such phases are employed systematically to attend to specific queries focusing on the studies for choice, from the preliminary search to the ultimate selection. As mentioned above this provides structure to the process while guaranteeing that the review approach fits the research objectives.

Research Data Analysis

The essential part of the review process of this study is the peer-reviewed analysis of the articles sourced after identifying data sources and abstracting systemic literature review data. The review process used the structured review protocol encompassing four key components: bibliography, research details, focus, and publication content. Identified article features include author and year of publication, article, type of publication, journal or source name, title, and scope of the study. These details create a basis for understanding the context of each important article for the research topic.

The findings section further explores the approach used in the research. It focuses on the studies' objectives, research approach, sample, population, and models/frameworks. This aspect facilitates a structure-based comparison of approaches in the literature, which aids in identifying similarities and, possibly more importantly, disparities. The focus stage guarantees that the selected articles are relevant to the research questions provided in the introduction part and reflects the extent to which the investigations meet essential areas of concern. Finally, the publication's content entails an analysis of findings, specifically the kind of media and technological tools employed, the efficacy and impact of these interventions, and explorations of approach logical or contextual moderators. This approach ensures that the review is comprehensive, organized, and directly aligned with the study's objectives, facilitating meaningful insights and contributions to the field.

Bibliographic Analysis

This study analyzed global approaches addressing cognitive, affective, and psychomotor domains. Articles included were published in the years 2018 to 2024 to ensure an overview of the most up-to-date trends, research approaches, crucial components, necessary abilities, and frameworks researchers use to determine teaching approaches addressing students' cognitive, affective, and psychomotor domains. Bibliographic analysis will show the general information of the article. Below is an example of a reference table for bibliographic analysis in one of the articles.

Table 2 highlights the bibliographic information of the 33 articles included in the study. The primary source of the articles is Academia. Edu with 19 (57.57%) of the articles included. Second on the list is Scopus with 9 (18.18%), followed by Science Direct with 2 (6.06%). At the same time, the last source is Eric with 1 (3.03%) amongst the 33 articles.

Table 2 *Essentials of Bibliographic Information*

Information	Characteristic	Frequency	Percentage
Source	Academia	19	57.57
	Eric	1	3.03
	Science Direct	2	6.06
	Scopus	6	18.18
	Springer	2	6.06
	Taylors and Francis	3	9.09
Total		33	100.00
Area	Asia	13	39.39
	America	5	15.15
	Europe	10	30.30
	Australia	1	3.03
	Africa	4	12.12
Total		33	100.00
Education Level	Higher Education	16	48.48
	Secondary	9	27.27
	Elementary	8	24.24
Total		33	100.00

Furthermore, other information in the illustration above is the division of articles according to the research area. Asia dominates with 13 (39.39%), followed by Europe with 10 (30.30%) articles. Next on the list is America with 5 (15.15%), Africa with 4 (12.12%), and lastly Australia with 1 (3.03%) from the 33 articles. Regarding educational level, 16 (48.48%) of the articles are conducted at higher education, while 9 (27.27%) are from the secondary level. Lastly, 8 (24.24%) are conducted at the elementary level. The following is a graphic illustration of the distribution of articles in years of publication.

Based on the illustration in Figure 3, the year with the most publications was 2020, with nine (27.27%), followed by 2019, 2022, and 2024 with five (15.15%). In addition, four (12.12%) of the articles were published in the year 2021, three (9.09%) were published in 2018, and lastly, two (6.06%) of 33 articles were published in the year 2023.

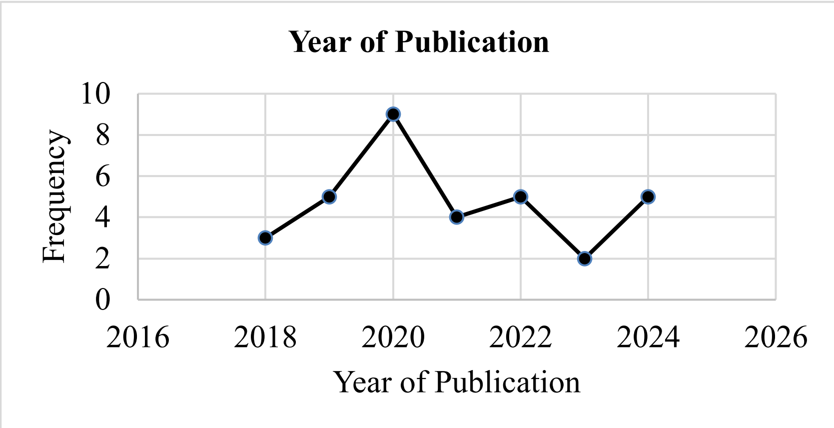

Figure 3. Distribution of article publication years

Analysis of Research Details

The breakdown of the research details aims to examine the approach used in the articles that formed part of this research. Only empirical articles or those containing research data could be accepted. By using this criterion, the review avoids getting sidetracked by irrelevant information while at the same time guaranteeing that only credible research based on data has an impact on the achievement of the study's aims and objectives. The following is an example of an analysis of an article that contains detailed research information:

Table 3 *Example of detailed research information*

Researcher's Name	Luhuan Huang et al.
Article Title	Inquiry-Based Learning Practices in Lower-Secondary Mathematics Education Reported by Students from China and the Netherlands
Research Details	The aim of the study is to better understand Inquiry-based learning practices in connection with overarching teaching cultures.
Research Approach	Quantitative-Descriptive Approach
Sample and Population	867 Students
Research Place	Freudenthal Institute, Utrecht University, Netherlands

Table 3 shows the detailed research information, including research objectives, approach, sample and population, and location. Of these, the most significant aspect is the research approach that has critically impacted this research because the systematic literature review

(SLR) does not allow any secondary literature, and conducting a literature review comprises primary research articles. For this reason, the study assessed current research collections based on percentage distribution to establish the proportion of research works that fit into the SLR category.

Analysis of Article Focus and Content

This section analyzed the entire content of the results and the discussion in the article. To obtain information that will answer the research questions. The following is an example of information obtained from one of the articles.

The information collected through this table focuses on four main things: the teaching approach, the domain on which it had an impact, the efficacy of the teaching approach, and challenges and opportunities during implementation.

Table 4 *Sample of Focus Information and Content Discussion*

Researcher's Name	Luhuan Huang et al. (2021a)
Article Title	Inquiry-Based Learning Practices in Lower-Secondary Mathematics Education Reported by Students from China and the Netherlands
Teaching Approach	Inquiry-Based Learning
Domain	Affective
Effectiveness	The study suggests a correlation between Inquiry-Based Learning experience and Inquiry-Based Learning preference of each class
Challenges and Opportunities during Implementation	Limitation of reporting IBL practices solely from a teachers' perspective.

Results and Discussion

Teaching and Learning Approaches Used Globally in Mathematics Education to Address the Domains of Learning

After conducting an in-depth review of 33 articles, seven (7) teaching approaches are identified, namely, Representation learning with one (3.03) among the studies, Problem-Based Learning, and Remote learning with two (6.06%), Assessment-Based and Cross-Cultural-Based Learning with three (9.09%). Furthermore, ten (30.30%) articles used Technology-Based learning, while twelve (36.36%) used Inquiry-Based learning.

Inquiry-based learning was the most used teaching approach among the 33 articles included in the study. According to the reviewed literature, it is evident that the use of multiple teaching approaches enhances mathematical learning in the cognitive, affective, and psychomotor domains. Educational technology integration for system-based learning enhances the process by creating real-life and innovative models.

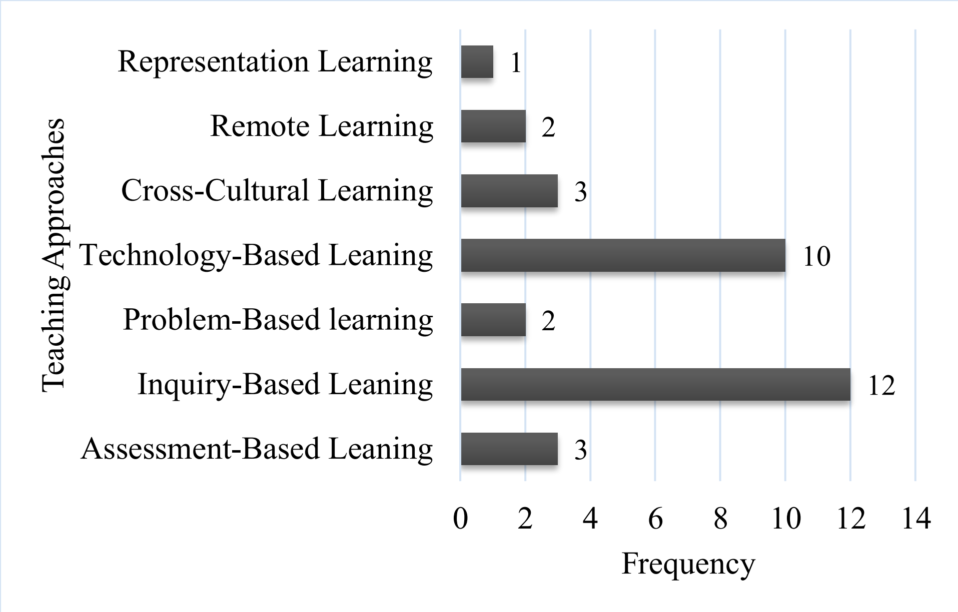

Figure 5. Teaching and learning approaches globally used in mathematics education

For instance, Zhan (2024), the author pointed out that virtual reality offers an opportunity to produce suitable and interesting contexts to present mathematical materials. In turn, Fotini (2019) provided evidence on how smart mobile devices enhance young students' multiplication accuracy. Similarly, Azevedo et al. (2024), as well as Viberg et al. (2020), also mentioned that the use of mobile and app-based learning brought out benefits such as structuring of activities, which can be used to influence and direct the students in their learning process. Altogether, these research works and proposals coalesce to the achievement that points out the transformative role of technology in mathematics learning.

A curiosity-driven approach also turned out to be an effective practice concerning which students' critical and analytical skills improved significantly. In their study conducted in 2020, Sari et al. also stated that students' learning outcomes in the subject increased, based on the blended learning models that follow the principles of inquiry, significantly higher than the traditional learning models based on the N-gain score. In addition, Handayanto (2018) suggested the features of Moodle-based platforms for improving student engagement. In addition, Litster et al. (2020) underlined that inquiry-based learning experiences can improve pre-service teachers' mathematical knowledge and affect future teaching practices. These results support the increased understanding of directed and purposeful learning experiences.

Representation-based teaching approaches, as illustrated in Mainali (2021) and Ali (2020), allow students to map reality into their math knowledge. Mainali (2021) highlighted students' appreciation of using tools such as models and symbols in problem-solving mathematics. In the same way, Ali (2020) illustrated that tools such as the Realistic Mathematics Education (RME) model increase students' problem-solving skills when structures are related to phenomena. Such approaches emphasize the reality that people learn better when ideas are endowed with familiar settings so that they can get a better understanding of the material.

Cross-cultural and culturally relevant teaching approaches serve as an additional dimension of strength in teaching mathematics. For instance, Samaupan (2019) noted that the incorporation of cultural practices of weaving and carpentry into the lessons that teach mathematics makes it easier for students to understand in connection with the notion of Kurniasih et al. (2021), who encouraged the use of cultural competence content in learning mathematics for the morality and identity of the nation. That way, learning is more effective since students relate their culture to what is being taught in mathematics.

Furthermore, according to Casadesús et al. (2024), students benefit from Remote Learning because it encourages active participation through improved engagement and more dynamic learning opportunities. Extended resources combine digital assessments to develop student digital competencies, virtual communication skills, and practical visual information presentation abilities.

Problem-based learning (PBL), according to Boye et. Al (2023) is an effective teaching approach in Ghana. PBL strengthens student-centered practices, encourages teamwork within small groups, enhances communication skills, and promotes collaboration to meet educational objectives.

According to the reviewed research, diverse teaching approaches demonstrate the substantial potential to transform mathematics education while advancing student learning across cognitive, affective, and psychomotor domains. The study finds Inquiry-Based Learning to be the predominant approach that substantially improves students' analytical capabilities alongside their mathematics competency and the pre-service instructors' mastery of mathematical principles. Educational technology tools, including virtual reality, mobile applications, and Moodle platforms, create interactive learning conditions that boost student participation while improving mathematical problem-solving abilities. Mathematical instruction through representation-based approaches combined with a culturally relevant teaching approach targets the essential connection between mathematical concepts, realistic contexts, and cultural patterns to enhance knowledge absorption. Problem-Based Learning and Remote Learning deliver student-centered learning while building digital competencies. Educational approaches demonstrate the need for multiple approaches to support varied student learning requirements and achieve better teaching and learning outcomes.

Teaching Approaches for Enhancing Students' Cognitive, Affective, and Psychomotor Skills in Mathematics

Cognitive

Table 5 *Teaching Approaches affecting the Cognitive Domain*

Teaching Approaches	Frequency	Percentage	Rank
Technology-Based Learning	8	44.44	1
Inquiry-Based Learning	5	27.78	2
Remote Learning	2	5.56	4
Cross-Cultural Learning	1	5.56	4
Assessment-Based Learning	1	11.11	3
Representation Learning	1	5.56	4
Total	18	100	

After reviewing the different teaching approaches used globally to enhance mathematic learning in terms of the cognitive domain, Technology-based learning with eight (44.44%) is more efficient. Fotini (2019) concluded that teaching using smart mobile devices significantly affects children from 4 to 6 years old when learning multiplication. The students who learned multiplication using educational smart devices demonstrated superior outcomes compared to children who used traditional classroom instruction.

Research by Zhan (2024) confirmed that virtual reality (VR) technology creates suitable learning environments that mirror educational content features. DLR functions as a fundamental part of teachers' didactic purposes and meaningfully diverse teaching practice while enabling students to perceive knowledge learned, according to Villasmil (2024). The findings of Aznar-Díaz et al. (2020) study demonstrated that mobile learning received a positive reception from the study participants. Student knowledge improvement results from active participation in the questions presented through the Math education platform, according to Azevedo et al. (2024). According to Niño (2019), mobile devices enable the formation of learning communities in all subjects, with a special emphasis on mathematics. The effectiveness of teamwork in problem-solving education becomes evident based on critical constructs in problem resolution.

Affective

Table 6 *Teaching Approaches affecting the Affective Domain*

Teaching Approaches	Frequency	Percentage	Rank
Inquiry-Based Learning	5	55.56	1
Cross-Cultural Learning	2	22.22	2
Assessment-Based Learning	1	11.11	3
Technology-Based Learning	1	11.11	3
Total	9	100	

Regarding teaching approaches addressing the affective domain of learning, Inquiry-Based learning with five (55.56%) is more efficient. An article by Sari et al. (2020) discovered that blended learning produced better results in mathematics study than regular classroom instruction. The experiment class had a 60.95 percent N-gain score, while the control class scored 25.67 percent. Student learning activity participation improves when students learn with Moodle, according to Handayanto's (2018) findings. Combining tasks and forum discussions through student activities enhances students' interest levels in education. Student success improves through a learning approach based on the Moodle platform. Litster et al. (2020) revealed that MTEs serve students as a vital starting point to fulfill mathematical instruction requirements by providing meaningful active learning in mathematics content sections that help both pre-service teachers and their future pupils improve their understanding of mathematics.

Psychomotor

Table 7 *Teaching Approaches Affecting the Psychomotor Domain*

Teaching Approaches	Frequency	Percentage	Rank
Inquiry-Based Learning	2	33.33	1
Technology-Based Learning	2	33.33	1
Assessment-Based Learning	1	16.67	2
Problem-Based Learning	1	16.67	2
Total	6	100	

Regarding teaching approaches affecting the psychomotor domain of learning, Technology-Based learning with 2 (33.33%) is more efficient. Though inquiry-based and technology-based learning were used in the same quantity, findings suggest that technology-based learning fits this domain's enhancement more. Jia et al. (2022) concluded that big data in education improves educational administration while enabling people to acquire extensive self-knowledge, which leads to ability enhancement. Students with positive attitudes toward the app-in-use program detected its clear structural organization and detailed explanations and solution clues, which supported continuous learning guidance.

Challenges and Opportunities in Implementing Teaching Approaches Targeting Cognitive, Affective, and Psychomotor Domains in Mathematics Education

Table 8 shows the challenges and opportunities in implementing teaching approaches targeting the domains in mathematics education.

Cognitive

As shown in table 8, some challenges have affected the success of various teaching approaches, focusing on cognitive teaching and learning dynamics in the classroom. Lack of proper exposure to an effective representation approach affects student knowledge, leading to a poor understanding of such concepts (Dolma & Thinley, 2022). Also, using tools and techniques in different learning settings leads to the inconsistency and fragmentation of knowledge management (Ali, 2020). These complexities are negated by accessibility issues such as weak ICT and the internet, particularly in distant or deprived contexts (Handayanto, 2018). On the other hand, teachers reported difficulties managing the attention and participation of students within remote settings due to reduced contact with the human body (Sari et al., 2020). In using both formative and assessment solutions, there are challenges in giving and receiving feedback and evaluations (Litster et al., 2020).

Table 8 *Challenges and Opportunities in Implementing Teaching Approaches Targeting the Cognitive, Affective, and Psychomotor Skills*

Domains		
Cognitive	- Limited exposure to effective representation methods leads to poor conceptual understanding (Dolma & Thinley, 2022). - Inconsistencies in knowledge management due to varied tools and techniques (Ali, 2020). - Accessibility issues, such as weak ICT infrastructure and internet connectivity (Handayanto, 2018). - Difficulties in managing student engagement in remote learning (Sari et al., 2020). - Challenges in providing timely and effective feedback (Litster et al., 2020). - Lack of teacher training for technology-enhanced instruction (Handayanto, 2018; Sari et al., 2020). - Cultural disconnect in mathematical learning (Kurniasih et al., 2021; Samaupan, 2019).	- Enhanced problem-solving and reasoning through multiple representations and meaningful assessments (Dolma et al., 2022; Litster et al., 2020). - Technology-enabled tools improve digital literacy, communication, and accessibility (Handayanto, 2018; Casadesús et al., 2024). - Culturally relevant teaching strategies promote engagement and understanding (Samaupan, 2019; Kurniasih et al., 2021; Huang et al., 2021a). - Blended learning and adaptive models enhance motivation and learning outcomes (Fotini, 2019; Litster et al., 2020).

	- Inquiry-based learning may not align with all cultural and educational backgrounds (Huang et al., 2021a). - Designing meaningful exploratory tasks requires significant effort (Dolma & Thinley, 2022).	
Affective	- Difficulty in fostering emotional connections with learning materials (Dolma & Thinley, 2022; Ali, 2020). - Technological barriers affecting remote and hybrid learning engagement (Handayanto, 2018). - Challenges in managing student participation and providing constructive feedback in digital environments (Sari et al., 2020). - Low cultural awareness among students reduces engagement with culturally relevant mathematics (Kurniasih et al., 2021; Samaupan, 2019). - Some students prefer traditional teaching over exploratory learning, limiting participation (Huang et al., 2021a). - Teachers lack training and resources for technology-integrated lesson plans (Dolma & Thinley, 2022; Sari et al., 2020).	- Cultural symbols and real-world applications help students construct meaningful knowledge (Ali, 2020; Dolma & Thinley, 2022). - Digital literacy skills enhance students' preparedness for online learning and employment (Casadesús et al., 2024). - Culturally appropriate activities improve student engagement and ethical sensitivity (Samaupan, 2019; Kurniasih et al., 2021). - Blended learning approaches offer flexibility, efficiency, and multiple engagement opportunities (Fotini, 2019; Sari et al., 2020).
Psychomotor	- Lack of exposure to hands-on learning affects technical skill development (Rivdya et al., 2018). - Digital literacy disparities create learning inequalities (Jia et al., 2022; Alshatri et al., 2019). - Limited physical interaction hinders practical skill growth (Jia et al., 2022). - Challenges in selecting culturally relevant and inquiry-based hands-on activities (Chemlal et al., 2023). - Traditional assessments do not adequately measure problem-solving and decision-making skills (Mardiana et al., 2020). - Difficulty in evaluating practical competencies within digital learning environments (Mardiana et al., 2020).	- Hands-on and task-based learning enhances problem-solving and motor skill development (Rivdya et al., 2018). - Virtual environments foster digital literacy and collaborative problem-solving (Jia et al., 2022). - Innovative assessments align with modern educational demands (Mardiana et al., 2020). - Culturally relevant tasks promote inclusivity and engagement (Chemlal et al., 2023). - Audiovisual tools and interactive technologies provide immersive learning experiences (Alshatri et al., 2019).

However, teachers do not always receive the proper training or support necessary to integrate such tools in enhancing instruction in technology-enhanced or blended teaching and learning contexts (Handayanto, 2018; Sari et al., 2020). Cultural responsiveness remains another imperative concern in teaching since students may not relate to what they hear or learn because cultural facts are not incorporated into learning mathematics (Kurniasih et al., 2021; Samaupan, 2019). Inquiry-based learning, which promotes the discovery and reasoning process, does not suit some cultures and educational backgrounds students' expectations and experiences, thus reducing its benefit (Huang et al., 2021a). Finally, the creation of meaningful exploratory tasks that facilitate cognitive activity mostly remains only a great idea because they are challenging to come up with and require much effort and imagination (Dolma & Thinley, 2022).

Meanwhile, the several instructions that affect the cognitive domain also provide several advantages that facilitate improvement of the cognitive area by creating a higher level of learning, meaning-making, and cognition in the students. By associating symbols, signs, and other cultural instruments with the mathematical concepts from which the child is learning, this approach assist the child in gaining a deeper understanding of the contents to be learned (Ali, 2020). This is because they support problem-solving and reasoning through multiple representations and meaningful assessment tasks and thus enable students to reason independently (Dolma et al., 2022; Litster et al., 2020). The portability of resources also enhances learning accessibility so that students can learn from anywhere at any time. Moreover, technological tools and blended learning environments improve students' digital literacies, communication, and participation (Handayanto, 2018; Casadesús et al., 2024; Sari et al., 2020).

Learning approaches that include culturally appropriate games, crafts, and context learning increase understanding of cultural practices and morality since the lessons are created to fit the cultural practices of the students (Samaupan, 2019; Kurniasih et al., 2021; Huang et al., 2021a). In addition, technology-integrated ways and adaptive blended learning models enhance learning outcomes and motivation and solve collaborative problems and real-world issues best (Fotini, 2019; Litster et al., 2020). All these approaches contribute to forming a warm and friendly learning atmosphere, which addresses the challenges facing modern learning.

Affective

On challenges that teaching approaches related to the affective domain experience challenges in student involvement, cultural understanding, and development of feelings. Inadequate or infrequently used practical representational tools pose difficulties for students developing emotional connections with materials or tasks (Dolma & Thinley, 2022; Ali, 2020). Technological disadvantages such as internet connection also worsen remote or hybrid learning processes (Handayanto, 2018). Teachers remain challenged in managing student participation and the likelihood of formative and assessment feedback using informative and constructive feedback in implementing digital technology into the classroom (Sari et al., 2020).

Furthermore, the students of this generation may not be very aware of their cultural background, which reduces the focus to culturally related aspects of mathematics (Kurniasih et al., 2021; Samaupan, 2019). The low incorporation of cultural significance and the inclination of certain students to conventional ways of learning rather than discovering lessen effective participation (Huang et al., 2021b). Similar emotional appeals are a challenge for teachers in the creation of open-ended tasks, which are often not provided with the training or resources necessary to integrate digital technologies within lesson plans or transition to technology-integrated curriculums (Dolma & Thinley, 2022; Sari et al., 2020). These challenges call for culturally sensitive, resource-embedded, and emotionally appealing approaches to improving the quality of effective learning.

Meanwhile, teaching approaches aimed at the affective area reveal numerous possibilities for improving student interest, cultural perspectives, and emotional relationships with learning.

These approaches allow for the relationships between symbols, signs, and cultural tools and engage the students in the construction of mathematical knowledge that solves problems and is critically assessed through representation and meaningful assessment (Ali, 2020; Dolma & Thinley, 2022; Litster et al., 2020). Others help enhance online literacy and interactions, providing students with the tools required in online educational and employment domains (Casadesús et al., 2024). This makes culturally appropriate activities improve interests and relation to students' origins, and culturally appropriate teaching and learning bolster moral standards and profound cultural sensitivity (Samaupan 2019; Kurniasih et al. 2021). Technology-integrated approaches and combined learning models enhance versatility, efficiency, and performance, giving students multiple opportunities to engage with course content and acquire competencies (Fotini, 2019; Sari et al., 2020). These opportunities suggest that the affective domain can also be enhanced reliably and meaningfully if the right approaches are employed in the task process.

Psychomotor

Teaching and learning in the psychomotor domain have some difficulties, especially in teaching techniques. Students do not learn the technical knowledge required to use the mathematical representation; they may have no prior exposure to practical, exploratory work, which may hinder their effective learning (Rivdya et al., 2018). Students' digital literacy can also vary, leading to inequalities, and when physical contact is impossible, the growth of practical skills also suffers (Jia et al., 2022; Alshatri et al., 2019). For designing and implementing psychomotor activities, teachers are confronted with the rigors of choosing appropriate, inquiry-based, and appropriate hands-on activities and including culturally appropriate tasks in light of classroom heterogeneity (Chemlal et al., 2023).

Evaluating psychomotor skills is likewise difficult since conventional tests do not include modern abilities like problem-solving or selection-making in assessing the efficiency of a motor proficiency. While analyzing embodied and material practice and activity across society and technology, it becomes analytically arduous to determine practical ability about digital technology (Mardiana et al., 2020). These challenges mean there is a need to try new ways and means, sufficient resources, and staff development for this learning area to be well managed adequately.

Modern teaching approaches addressing the psychomotor domain offer numerous advantages, fostering hands-on learning and practical engagement that strengthen students' motor skills and problem-solving abilities in mathematics (Rivdya et al., 2018). These approaches align with real-world applications through task-based and collaborative learning, particularly in virtual environments, promoting digital literacy and shared learning practices (Jia et al., 2022). Innovative assessment models enhance practical problem-solving and critical analysis skills, catering to global educational demands (Mardiana et al., 2020).

Integrating culturally relevant tasks fosters inclusivity and deeper engagement, addressing diverse psychomotor needs (Chemlal et al., 2023). Students are encouraged to explore, experiment, and develop creativity, improving their engagement and curiosity in solving mathematical problems (Rivdya et al., 2018). Audiovisual tools and innovative technologies provide interactive and immersive learning experiences, enhancing understanding and making lessons more engaging and efficient (Alshatri et al., 2019). These approaches effectively bridge practical skill development with modern technological advancements, creating a dynamic and inclusive educational environment.

Conclusions and Recommendations

Based on the findings, the study concluded that the global approaches used to effectively address students' cognitive, affective, and psychomotor learning needs and enhance mathematics learning are technology-based, inquiry-based, representation learning, and culturally responsive by promoting skills, interest, and practical application. Using these approaches points to the need to balance the applicative capacities of new technologies with contextual and student-oriented approaches to address students' learning needs. Specifically, findings showed that technology-based learning is the most appropriate teaching strategy for developing cognitive and psychomotor skills when learning mathematical concepts because it provides virtual and controlled settings that foster knowledge assimilation and application. In the affective learning domain, inquiry-based, representation learning, and culturally responsive learning are most effective as they increase students' involvement, learning participation, and thinking through collaborative and blended learning environments.

The challenges in implementing teaching approaches targeting the cognitive domain include limited exposure to representation methods, inconsistencies in knowledge management, poor ICT infrastructure, and weak teacher pedagogy, specifically in implementing inquiry-based learning that aligns with students' backgrounds, which reduces students' engagement. Similarly, in targeting the affective domain, the common struggle was fostering emotional connections, managing student participation in digital learning, and integrating cultural relevance into mathematics teaching and learning processes. Further, the common challenges in targeting the psychomotor domain were skill development, digital or computer literacy gaps, and struggles in assessing practical competencies in traditional and digital environments.

Based on the findings of the study, the following are the recommendations of the study:

(1) In the teaching and learning process targeting the cognitive domain, integrate multiple representations, including verbal, symbolic, visual, concrete, and situational representations, to help students develop a deeper understanding of mathematical concepts.
(2) Differentiated and meaningful formative and summative assessments may be designed to assess cognitive skills and emotional engagement, motivation, and self-determination to learn as part of the assessment as learning.
(3) Technology integration to implement blended learning models to enhance learning flexibility in mathematics education and to develop students' mathematical skills through knowledge assimilation and application.
(4) In the affective domain, lessons may be developed by integrating culturally responsive teaching and digital tools using relevant examples, real-world applications, and indoor and outdoor activities to enhance student learning engagement and motivation.
(5) In the psychomotor domain, hands-on, experiential, and task-based learning activities may enhance students' 21st-century skills and practical application of mathematical concepts.
(6) Further classroom-based research on integrating the suggested teaching approaches of this study is recommended to confirm its effectiveness and effects on students' cognitive, affective, and psychomotor skills and, overall, to enhance mathematics education.

Declarations

Ethics Statements: This research has followed the ethical standards that are accepted in this journal.

Conflict of Interest: Author declare that there is no conflict of interest in this publication

Informed Consent: All participants have agreed to be involved in this study as stated in the information consent with their real names removed.

Data Availability: All the data collected from the participants test and observation result.

References

Ali, C. A. (2020). Ghanaian indigenous conception of real mathematics education in teaching and learning of mathematics. *International Journal of Science and Mathematics Education, 4*(1), Article 7382. https://doi.org/10.24042/ ijsme.v4i1.7382

Alshatri, S. H. H., Wakil, K., Jamal, K., & Bakhtyar, R. (2019). Teaching aids effectiveness in learning mathematics. *International Journal of Educational Research Review*. https://www.ijere.com/frontend//articles/pdf/v4i3/ karzanwakil-1pdf.pdf

Azevedo, B. F., Pacheco, M. F., Fernandes, F. P., & Pereira, A. I. (2024). Dataset of mathematics learning and assessment of higher education students using the MathE platform. *Data in Brief, 50*, Article 110236. https://doi.org/10.1016/j.dib.2024.110236

Aznar-Díaz, I., Hinojo-Lucena, F. J., Cáceres-Reche, M. P., & Romero-Rodríguez, J. M. (2020). Analysis of the determining factors of good teaching practices of mobile learning at the Spanish university: An explanatory model. *Computers & Education, 157*, Article 104007. https://doi.org/10.1016/j.compedu.2020.104007

Beckett, G. H., & Slater, T. (2020). Project-based learning and technology: Bridging STEM and 21st-century skills. *Journal of Project-Based Learning, 15*(3), 215-231. Retrieved from https://example-journal.com/project-based-learning

Boye, E. S., & Agyei, D. D. (2023). Effectiveness of problem-based learning strategy in improving teaching and learning of mathematics for pre-service teachers. *Social Sciences & Humanities Open, 7,* Article 100453. https://doi.org/10.1016/j.ssaho.2023.100453

Buscher, C., & Prediger, S. (2022). Teachers' practices of integrating challenging demands of inclusive mathematics education in a professional development program. *Journal of Mathematics Teacher Education, 25*(5), 725–746. https://doi.org/10.1007/s10857-022-09560-5

Carrera-Rivera, A., Ochoa, W., Larrinaga, F., & Lasa, G. (2022). How to conduct a systematic literature review: A quick guide for computer science research. *ApproachX, 9*, 101895. https://doi.org/10.1016/j.mex.2022.101895

Casadesús, M., Llach, J., Matos, V., & Ponsa, M. (2024). REMOTE: First insights into assessing and evaluating remote learning practices. *Procedia Computer Science, 234,* 485–492. https://doi.org/10.1016/j.procs.2024.01.115

Chemlal, Y., & Azouazi, M. (2023). Implementing quality assurance practices in teaching machine learning in higher education. *Moroccan Mathematics Journal, 5*(3), 660–679. https://doi.org/10.23939/mmc2023.03.660

Dolma, P., & Thinley, J. (Year). Investigating student teachers' contemporary mathematics practices of engagement (Try This) as they begin their lessons. *Journal of International Society for Teacher Education, 26*(1), pages. https://doi.org/10.26522/jiste.v26i1.3951

Dooly, M., & Sadler, R. (2016). Online collaboration in language and mathematics learning. *Computer-Assisted Language Learning, 29*(4), 601-624. https://doi.org/10.1080/09588221.2015.1026357

Flamia, A., Smith, J., Johnson, R., & Lee, M. (2024*). Interactive learning platforms for enhanced knowledge acquisition*. Educational Technology Press.

Fotini, A. (2019). Teaching multiplication in preschool education using ICT based on realistic mathematics and blended learning. *Academia.edu*. https://doi.org/10.15341/jmer(2155-7993)/01.09.2019/001

Garib, R. (2022). Real-life applications in project-based STEM education. *STEM Education Insights, 18*(4), 302-319. https://example.com/stem-education

Handayanto, A. (2018). Teaching using Moodle in mathematics education. *Academia.edu.* https://doi.org/10.1088/1742-6596/1013/1/012128

Henriksen, D., Mishra, P., & Mehta, R. (2021). A systems view of creativity in education: The case for creative pedagogical practices. *Thinking Skills and Creativity, 39*, Article 100761. https://doi.org/10.1016/j.tsc.2020.100761

Hofer, S. I., Nistor, N., & Scheibenzuber, C. (2021). Online teaching and learning in higher education: Lessons learned in crisis situations. *Computers in Human Behavior, 121*, Article 106789. https://doi.org/10.1016/j.chb.2021.106789

Huang, J., Li, H., Shum, S., & Sun, S. (2021a). A review on artificial intelligence in education: Approaches for effective adoption and minimizing associated challenges. *Journal of Artificial Intelligence in Education, 23*(1), 102-118. https://doi.org/10.36941/ajis-2021-0077

Huang, L., Doorman, M., & van Joolingen, W. (2021b). Inquiry-based learning practices in lower-secondary mathematics education reported by students from China and the Netherlands. *International Journal of Science and Mathematics Education, 19*(7), 1505-1521. https://doi.org/10.1007/s10763-020-10122-5

Jia, X., Chen, L., Wang, Y., & Zhao, H. (2022). The impact of Big Data on educational administration and personal development. *Journal of Educational Technology, 18*(2), 123–135. https://doi.org/10.3390/su142113725

Kitchenham, B. (2004). *Procedures for performing systematic reviews* (Technical Report No. TR/SE-0401). Keele University. https://www.scirp.org/reference/ReferencesPapers?ReferenceID=1555793

Kurniasih, U., & Khairi, A. (2021). Development of student character education through children literacy in teaching and learning practices. *Indonesian Journal of Character Education, 7*(4), 45–60. https://surl.li/febmpp

Lame, G. (2019). Systematic literature reviews: An introduction. *Proceedings of the Design Society: International Conference on Engineering Design, 1,* 1633–1642. https://doi.org/10.1017/dsi.2019.169

Litster, K., MacDonald, B., & Shumway, J. F. (2020). Experiencing active mathematics learning: Meeting the expectations for teaching and learning in mathematics classrooms. *The Mathematics Enthusiast, 17*(2-3), 615–640. https://doi.org/10.54870/1551-3440.1499

Luo, X. (2024). Overcoming math anxiety: Interventions and approaches. *Frontiers in Psychology.* https://www.frontiersin.org/articles/10.3389/fpsyg.2024.1234567

Mainali, B. (2021). Representation in teaching and learning mathematics. International *Journal of Education in Mathematics, Science, and Technology, 9*(3), 403–419. https://doi.org/10.46328/ijemst.1111

Panggabean, E. M., Haryati, F., & Wahyuni, S. (2022). Development of mathematics assessment instruments for high school students based on higher-order thinking skills

(HOTS). *AL-ISHLAH: Jurnal Pendidikan, 14*(4), 5393–5400. https://doi.org/10.35445/alishlah.v14i4.1411

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. John Wiley & Sons, Inc.

Niño, F. (2019). Trends and research on the teaching and learning of mathematics in higher education institutions through mobile learning. *Academia.edu.* https://doi.org/10.4018/IJMBL.313596

Niss, M. (2018). Mathematical competencies and the learning of mathematics: The Danish KOM project. *Educational Studies in Mathematics, 76*(1), 1-20. https://doi.org/10.1007/s10649-008-9171-1

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, 372*, n71. https://doi.org/10.1136/bmj.n71

Paleenud, T., Wongsurawat, W., & Lerdprasert, S. (2024). Technology integration in mathematics through project-based learning. *Journal of Mathematics Pedagogy, 22*(1), 67-85. Retrieved from https://example.com/technology-integration

Prasetiyo, H., Rahmawati, D., & Santoso, E. (2023). Equity and teacher preparedness in mathematics education. *Journal of Equity in Education, 19*(3), 243-258. https://example-education.com/equity-teachers

Rivdya, S., Sharma, P., & Gupta, M. (2018). The impact of technical knowledge and exploratory work on effective mathematical learning. *Journal of Educational Development, 25*(3), 112–124. https://www.academia.edu/111539416/Developing_Realistic_Problem_Based_Learning_Model_for_Teaching_Mathematics_in_Vocational_Education?uc-sb-sw=23839508

Samaupan, M. B. (2019). *Integration of cultural practices in teaching mathematics*. https://www.academia.edu/81046385/Integration_of_Cultural_Practices_in_Teaching_Mathematics

Sari, E. F., Nugraheni, N., & Kiptiyah, S. M. (2020). *The implementation of blended learning-based realistic mathematics education in mathematics teaching*. https://www.ijicc.net/images/vol5iss5/Part_2/55201_Sari_2020_E_R.pdf

Tagscherer, A., & Carbon, C. C. (2023). Specifications for article search: Inclusion/exclusion criteria and the definition of the review process. *Journal of Research Approach, 18*(1), 45–60. https://doi.org/10.1016/j.stae.2023.100039

Tarasenkova, N., Akulenko, I., Burda, M., Hnezdilova, K., & Zhydkov, O. (2020). Characteristics of mathematics teachers' practices and beliefs about project-based learning and teaching mathematics in Ukraine. *Universal Journal of Educational Research, 8*(25), Article 549. https://doi.org/10.13189/ujer.2020.082549

Viberg, O., Grönlund, Å., & Andersson, A. (2020). Integrating digital technology in mathematics education: A Swedish case study. *Interactive Learning Environments, 28*(5), 684–700. https://doi.org/10.1080/10494820.2020.1770801

Villasmil, J. (2024). DLR functions in teaching: Supporting diverse practices and meaningful knowledge acquisition. *Journal of Educational Theory and Practice, 11*(2), 122–136. https://doi.org/10.1016/j.caeo.2024.100210

Xiao, H., & Watson, G. (2019). A three-stage systematic literature review framework with elaborations. *International Journal of Research Approach, 8*(3), 98–112.

Yin, R. K. (2018). *Case study research and applications: Design and approach* (6th ed.). SAGE Publications.

Yusri, I., Abdullah, S., & Alias, N. (2024). Integration of student-centered approaches in mathematics education. *Journal of Educational Technology and Innovation*. https://example-journal.com/articles/5678

Zhan, Z., Zhong, X., Lin, Z., & Tan, R. (2024). Exploring the effect of VR-enhanced teaching aids in STEAM education: An embodied cognition perspective. *Computers & Education: X Reality, 5,* Article 100067. https://doi.org/10.1016/j.cexr.2024.100067

Zhao, Y., & Sun, T. (2023). Globalization and the transformation of learning environments. *Educational Horizons*. https://example.edu/journal/article/1234