



A Review of Studies on Math Teaching Methods

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ABSTRACT

A method is one of the factors that determine the quality of education in general and is a key pedagogical element to ensure effective teaching in particular. Mathematics is not only the abstract study of numbers, space, and change but also the paradigms for proving hypotheses by mathematical inferences and the application of knowledge to problems in different areas of life. Teaching mathematics is a system of concepts, theories, methods, and teaching activities. This is determined by the teaching methods and methods, which determine the effectiveness of learning and applying mathematics, that teachers organize for learners to solve tasks or exercises to deepen learned knowledge or develop and operate. apply math knowledge in practice. The article finds many aspects of math teaching methods, depending on the purpose and audience, and suggests using a single method or a combination of methods to effectively apply not only to learners but also to their needs suitable for pedagogical students.

Keywords: education settings, math teaching, teaching method

A. INTRODUCTION

The content of mathematics is abstract, logical, and general. Therefore, in order to help learners, learn math well, it is necessary to ensure a balance between learning theory and applying theory to solve specific problems. Besides, it is necessary to have the support of devices such as handheld computers and electronic computers to explore knowledge and solve mathematical problems. Mathematics education at all levels plays a very important role because it helps students build and develop mathematical competence and apply it in practice. To bring about effective math teaching, changing math teaching methods in a positive way is being applied by many schools today. So what are the effective and commonly used active teaching methods for math? Teaching needs to be appropriate to students' cognitive abilities and levels, with attention paid to the needs and cognitive abilities of each subject. Organizing teaching in a constructive direction means that students will be the ones to actively seek, discover, and make their own inferences to solve problems.

Though there are varied of math teaching and relevant to math teaching methods, some main tendencies are: 1) visual, by computer-aided instruction (Aqda et al., 2011), virtual math objects (Bos, 2009), ICT teaching-learning methods (Cunská & Savicka, 2012), web-page links (Khorasani, 2012), math platform accessible (Maćkowski et al., 2018); 2) the questioning: verbal math problem-solving performance (Babakhani, 2011), effective pedagogies (Hunter Revell & McCurry, 2013), mastery teaching methods (Jerrim & Vignoles, 2016); 3) problem solving: the design of tasks (Álvarez et al., 2020), knowledge growth (Copur-Gençtürk & Li, 2023), elements of ethno pedagogics (Erkisheva et al., 2014), a framework (Loc et al., 2022), comparing methods (Thippana et al., 2020), a case study (Zohrevand et al., 2010); 4) Practices: preparation count (Akyeampong et al., 2013), ability grouping (Boliver & Capsada-Munsech, 2021), digital game-based math learning (Dai et al., 2023), case studies (Ghic, 2012), co-teaching (King-Sears et al., 2021), An embedded mixed method study (Öztürk, 2021), special teaching methods (Şengül, 2009), Using Math Projects (Stoica, 2015), a mixed-methods investigation (Thomson et al., 2020); 5) lecturing and illumination: content knowledge (Copur-Gençtürk & Tolar, 2022), The school-level standardized testing policy (Im et al., 2020), RMI method (Wang et al., 2011). It can be said that these are basic methods have been researched and applied by teachers and researchers.

Additionally, there are some other studies on math teaching methods, such as: multi-step math skills (Kellems et al., 2016), children's math attitudes (Levine & Pantoja, 2021), Student's Achievement (Pachemska et al., 2014), teachers' self-efficacy beliefs (Perera & John, 2020), teachers' perceived effectiveness (ten Hagen et al., 2022), adult and young students in a same classroom (Zohrevand et al., 2010), teacher motivation and teaching quality (Lazarides & Schiefele, 2021) social relations (Kodzi et al., 2014), teacher beliefs (Tan & Saw Lan, 2011), Cognitive Training Program (Tashtoush et al., 2022b), concepts-rich in math (Tashtoush et al., 2022a), and conceptual and procedural knowledge (Fannakhosrow et al., 2022).

B. METHODOLOGY

This research is conducted based on the following basic aspects: one is to learn about the teaching methods of math in the research; this is done by asking the following questions: (1) how many studies have been done on math; (2) how many studies refer to math teaching and learning; and (3) how much research has been done on math teaching methods and the terms "math teaching method," "math teaching," and "math teaching methods." This study uses data belonging to the Sciencedirect system, Sciencedirect is a high-quality, multi-disciplinary electronic database of Elsevier Publishing House. The journals in Sciencedirect have a high impact factor and are trusted by many researchers. Sciencedirect, in particular, has been very effective in assisting researchers, staff, lecturers, learners, and students with their research, writing articles, scientific works, and teaching and learning work. Besides, the selected data was processed by excel and VOSviewer, a software program for creating and visualizing bibliometric networks called VOSviewer. These networks can be built via citation, bibliographic coupling, co-citation, or co-authorship relationships, and they can contain journals, researchers, or individual articles. But this software was used to visual the keywords relevant to math teaching methods.

C. RESULTS AND DISCUSSIONS

The findings of the study focus on the following key problems: 1) The quantity of academic papers on math teaching techniques; 2) Clusters of linked terms in math teaching methods studies; 3) The kinds of research documents of math teaching methods; 4) Journals that publish articles on math teaching methods; 5) Sectors related in the documents of math teaching methods.

Table 1. The Number of Articles on Math Teaching Methods

Years	MTD		MT''		MTDS''	
	Total	%	Total	%	Total	%
2023	229	1.69	3	1.54		-
2022	1046	7.73	14	7.18		-
2021	1004	7.42	12	6.15		-
2020	969	7.16	12	6.15	1	10.00
2019	898	6.63	13	6.67		-
2018	834	6.16	11	5.64	1	10.00
2017	740	5.47	13	6.67		-
2016	763	5.64	13	6.67		-
2015	840	6.21	15	7.69		-
2014	713	5.27	10	5.13	1	10.00
2013	664	4.91	11	5.64	1	10.00
2012	652	4.82	7	3.59		-
2011	526	3.89	13	6.67	1	10.00
2010	667	4.93	13	6.67	1	10.00
2009	412	3.04	5	2.56	1	10.00
2008	400	2.96	3	1.54		-
2007	312	2.30	2	1.03		-
2006	306	2.26	2	1.03		-
2005	278	2.05	1	0.51		-
2004	263	1.94	5	2.56	1	10.00
2003	217	1.60	7	3.59	1	10.00
2002	238	1.76	3	1.54		-
2001	188	1.39		-		-
2000	184	1.36	1	0.51		-
1999	193	1.43	3	1.54		-
1997	-	-	3	1.54		-
1985	-	-		-	1	10.00

MTD = math teaching method, "MT" = math teaching, "MTDS" = math teaching methods

The Table 1 represents the data about the number of publications of math teaching method, math teaching, and math teaching methods collected from the database of Sciencedirect, over the period of two decades from the years 1985 to 2023. Overall, what stands out from the figure is that there were considerable upward trends of the publications with the keyword "math teaching method", while the articles revealed from the keyword "math teaching" are much smaller and the documents relevant to the keyword "math teaching methods" are ten only. Looking at the details the search of the keyword "math teaching methods" gets only ten documents during the period of time, and each of the ten years has one of the documents mentioned in math teaching methods. The

transfer. Cluster 14 (8 items) dispositions, early intervention, educational games, kindergarten, learning, mathematical thinking, mathematics teaching, secondary school. Cluster 15 (8 items) achievement, beliefs, gender, human capital, identity, narrative, preservice teachers, social capital. Cluster 16 (8 items) applications in subject areas, collaborative learning, discourse, elementary education, improving classroom teaching, interactive learning environments, secondary education, teaching/learning strategies. Cluster 17 (8 items) children, early childhood education, professional development, self-efficacy, teacher collaboration, teacher education, teaching strategies. Cluster 18 (3 items) instructional practices, mindset, teacher beliefs.

It is noticeable that the information shows the authors and their papers have been published in the Sciedirect database between 1985 and 2023. It can be seen that 13 authors have their own three papers published (audette, luke m. bachman, heather j.; berninger, virginia w.; bicer, ali; blair, clancy; boekaerts, monique; bono, r.; caglayan, gnhan; casey, beth m.; castellon, libni berenice; coles, claire d.; colindres, karla; valesca matute; copur-gencurk, yasemin), there are 94 authors with 02 articles based on the database.

Table 2 Article Titles that Papers on Math Teaching Methods Published

Articles Titles	MTD		MT''		MTDS''	
	Total	%	Total	%	Total	%
Review articles	667	3.7	8	3.48	1	10
Research articles	13,243	72.6	191	83.04	8	80
Encyclopedia	374	2.0	3	1.30	-	-
Book chapters	1,772	9.7	14	6.09	-	-
Conference abstracts	261	1.4	3	1.30	-	-
Book reviews	368	2.0	-	-	-	-
Case reports	10	0.1	-	-	-	-
Conference info	31	0.2	-	-	-	-
Correspondence	23	0.1	-	-	-	-
Data articles	6	0.0	-	-	-	-
Discussion	138	0.8	1	0.43	-	-
Editorials	122	0.7	1	0.43	-	-
Examinations	1	0.0	-	-	-	-
Mini reviews	28	0.2	-	-	-	-
News	58	0.3	-	-	-	-
Practice guidelines	4	0.0	-	-	-	-
Product reviews	24	0.1	-	-	-	-
Short communications	280	1.5	4	1.74	-	-
Other	828	4.5	5	2.17	1	10
Total	18,247	100	230	100	10	100

The above table provides information about the types of documents related to math teaching methods that have been published in the data system, in which, research articles account for the majority (N = 13,243; 72.6%) and the examination contained only one article. If considered in detail, it is the research articles that account for the largest number, followed by book chapters (N = 1,700; 9.7%), review articles, and others with nearly the same numbers and percentages (N = 667; 3.7%; and N = 828; 4.5%). The group of documents with a lower number of publications was encyclopedias (N = 374; 2%), conference abstracts (N = 261; 1.4%), and book reviews (N = 368; 2%). It can be seen that the documents belonging to the review group have a significant number compared to the total number of published documents on math teaching methods. If comparing the number of documents between keywords, there is the same trend as for the keyword "math teaching method," however, there are some types of documents that no longer appear with the keywords of math teaching and math teaching methods, that are Book reviews, Case reports, Conference info, Correspondence, Data articles, Examinations, Mini-reviews, News, Practice guidelines, and Product reviews

Table 3. Journals that Published the most Papers on Math Teaching Methods

Publication Titles	MTD		MT''		MTDS''	
	Total	%	Total	%	Total	%
Teaching and Teacher Education	1,063	13.8	36	20.4	2	20
Procedia - Social and Behavioral Sciences	827	10.7	42	23.8	3	30
Computers & Education	750	9.7	16	9.09	-	-
Early Childhood Research Quarterly	459	6.0	5	2.84	-	-
International Journal of Educational Research	416	5.4	10	5.68	1	10

International Journal of Educational Development	387	5.0	7	3.98		-
The Journal of Mathematical Behavior	350	4.5	5	2.84		-
Economics of Education Review	337	4.4		-		-
Learning and Individual Differences	337	4.4	3	1.70		-
Contemporary Educational Psychology	319	4.1	3	1.70		-
Studies in Educational Evaluation	272	3.5	6	3.41		-
Journal of School Psychology	268	3.5		-		-
Learning and Instruction	266	3.4	8	4.55	1	10
Computers in Human Behavior	214	2.8		-		-
Journal of Applied Developmental Psychology	186	2.4	5	2.84		-
Historia Mathematica	178	2.3		-		-
Children and Youth Services Review	151	2.0		-		-
Linguistics and Education	142	1.8	2	1.14		-
Thinking Skills and Creativity	141	1.8		-		-
Educational Research Review	118	1.5		-		-
System	112	1.5		-		-
IFAC Proceedings Volumes	111	1.4		-		-
Procedia Computer Science	105	1.4		-		-
International Encyclopedia of Education (Fourth Edition), 2023	103	1.3	2	1.14		-
International Encyclopedia of Education (Third Edition), 2010	99	1.3		-		-
Discrete Mathematics			4	2.27		-
Computers in Biology and Medicine			3	1.70		-
Economics of Education Review			3	1.70		-
Information Processing & Management			2	1.14		-
Journal of Economic Behavior & Organization			2	1.14		-
International Journal of Approximate Reasoning			2	1.14		-
Nurse Education Today			2	1.14	1	10
Historia Mathematica			2	1.14		-
Learning , Culture and Social Interaction			2	1.14		-
Trends in Neuroscience and Education			2	1.14		-
Mathematical Modelling in Education and Culture			2	1.14		-
Keeping Mozart in Mind (Second Edition), 2004				-	1	10
Journal of the American Academy of Child Psychiatry				-	1	10
Total	7,711	100	176	100	10	100

The Table 3 provides the information of how many articles of math teaching methods have published by different publication titles. Generally, the titles relevant to education and social sciences have published the most of the articles, especially relevant to keyword of math teach method, while the data of articles of keyword of “math teach methods” are fewer. In the details, the title “Teaching and Teacher Education” have issued the largest numbers of documents of math teaching method with over 1000 items (13.8%). The second largest possibly are Procedia- Social and Behavioral Sciences and Computers & Education with over 800 documents and around 750 articles (9.7%). The third largest of publications are Early Childhood Research Quarterly (N =459; 6%) and International Journal of Educational Research (N = 416; 5.4%). The next group of publications are International Journal of Educational Development, The Journal of Mathematical Behavior, Economics of Education Review, Learning and Individual Differences and Contemporary Educational Psychology, these journals published the numbers between neatly over 300 items and nearly 400 items. And the rest has under 200 items and the fewest is International Encyclopedia of Education (Third Edition), 2010 with 99 articles.

Table 4 . Sectors that Published the most Documents of Math Teaching Methods.

Subject Areas	MTD		MT''		MTDS''	
	Total	%	Total	%	Total	%
Social Sciences	9,411	37.3	172	51.3	8	47.1
Psychology	4,932	19.5	51	15.2	3	17.6
Arts and Humanities	1,885	7.5	49	14.6	3	17.6
Computer Science	1,835	7.3	16	4.8		-
Medicine and Dentistry	1,796	7.1	8	2.4	1	5.9

Mathematics	1,582	6.3	19	5.7		-
Engineering	1,492	5.9	5	1.5		-
Economics, Econometrics and Finance	1,076	4.3	7	2.1		-
Business, Management and Accounting	660	2.6		-		-
Neuroscience	573	2.3	5	1.5	1	5.9
Biochemistry, Genetics and Molecular Biology		0.0	3	0.9		-
Nursing and Health Professions		0.0		-	1	5.9
Total	25,242	100	335	100	17	100

The above table compares the most articles published in the sectors of math teaching methods in the period of over two decades. The table shows the numbers of different sectors having documents of math teaching methods, including Social Sciences, Psychology, Arts and Humanities, Computer Science, Medicine and Dentistry, Mathematics, Engineering, Economics, Econometrics and Finance, Business, Management and Accounting, Neuroscience, Biochemistry, Genetics and Molecular Biology, Nursing, and Health Professions. Overall, it can be seen that Social Sciences is generally the most sector of numbers of publications on math teaching methods with over 37 percent. On the whole, areas such as Nursing, and Health Professions and Biochemistry, Genetics and Molecular Biology are not as popular as Arts and Humanities, Computer Science. In terms of numbers, Social Sciences come top of the list with 9,411 items. Psychology is the next field with published documents with around 5.000 articles.

The Visual

Using a quasi-experimental design, Aqda et al. (2011) assess the effects of traditional instruction vs computer-aided instruction on students' creativity in math courses. The Persian translation of the Torrance Creativity Test and a personal information questionnaire are provided by the authors to show that this approach is more successful than the standard one. Even if this approach might not be suited for all educational circumstances, the results can be used as a guide to select the best strategies. Bros, B. (2009) came to the conclusion that neither teachers nor pre-service teachers are educated about the pedagogical, mathematical, or cognitive fidelity that can improve students' academic performance using virtual math objects and web designers. Additionally, students might have a deeper knowledge of the mathematical formula in the case. Additionally, using a computer network and the Internet, especially through the use of web page links sent via e-mail, students can have a deeper knowledge of the mathematical formula in the case of both knowing and using the formula (Khorasani, M. K. 2012).

The current generation of youngsters, Cunska, A., and Savicka (2012) say differs from the previous one in that they are more open-minded, intuitive, sensitive, and intellectually curious, among other new traits that make them uninterested in conventional teaching approaches. The authors claim that interactive teaching methods and ICT tools can aid in students' active learning procedures as well as the growth of skills for self-evaluation, teamwork, and tolerance for divergent opinions. By assisting teachers and students in understanding their responsibilities and cooperating to fulfill the learning tasks for math sessions, these strategies provide an engaging learning environment.

To make it simpler for professors and students to answer arithmetic issues including mathematical formulae, charts, graphs, etc., Makowski et al. (2018) recommend adopting an e-learning platform for remote education. This is particularly helpful for instructing and assessing college students with impairments. The authors divide a typical math exercise into a number of straightforward sub-exercises. This makes it possible for arithmetic problems to be solved interactively and for the accuracy of exercise outcomes to be continuously assessed. These methods are more valuable because they were created and evaluated by students and adults with vision impairments. They found that, despite the difficulty of the mathematical calculations, alternate structure descriptions are more easily understood. This is due to the fact that detailed presentations make the mathematical formulas easy to understand. A platform for computer-aided interactive mathematics training that is adapted to the needs of the blind has also been created, constructed, and put into use. It can be used for on-site, online, and distant learning. There are several challenges that can be solved while instructing students with impairments with the aid of the suggested method.

The Questioning

The performance of primary school students who struggled with verbal math problem-solving was examined by Babakhani, N. (2011) to determine how teaching cognitive and meta-cognitive methods (self-instruction procedure) affected the results (VMPS). From the experimental and control groups of 60 kids with VMPS difficulties, 30 girls and 30 boys received strategies instruction for 16 weeks spread over two months during the

school day. The author notes that the self-instructional procedure's teaching of cognitive and metacognitive procedures significantly enhanced the experimental group's performance in both genders ($F=44.86$, $P<0.0001$). Boys and girls did not differ significantly in their use of the strategies or the effectiveness of education ($F=1.22$, $P>0.05$).

In a 2013 study, Hunter and McCurry looked at the challenges undergraduate nursing students encounter when studying math as well as the methods used to teach math and problem-solving skills. The authors claim that it has been challenging for nurse educators to build students' mathematics competency and problem-solving skills. To address this issue, numerous educational strategies have been used, with varying degrees of success. The need for more innovative pedagogical methods to teach mathematics to student nurses is another issue that needs to be addressed. These four main issues are student learning challenges, traditional pedagogies, curriculum strategies, technology integration as pedagogy, and the need for more creative pedagogical approaches. To help children acquire the theoretical foundations as well as practical hands-on methods to problem solving and arithmetic competency, nurse educators in particular play a significant role. It is recommended that you utilize an integrated technology strategy since it will improve student performance, comprehension, and overall satisfaction with their education.

Results from two clustered Randomized Controlled Trials (RCTs), in which a Singaporean-inspired "mastery" approach to teaching mathematics was implemented in a number of England's primary and secondary schools, are presented by Jerrim and Vignoles (2016). They point out that two aspects in particular have attracted policymakers' attention are curriculum design and East Asian teaching strategies. The study came to the conclusion that there is evidence of a modest, positive treatment effect that comes at a relatively low per-pupil cost and possibly will have more high-performing East Asian economies dominate the top of the Programme for International Student Assessment (PISA) rankings. In particular, East Asian teaching methods actually represent an improvement over the status quo in England. It has prompted speculation about the viability of incorporating similar techniques onto.

Problem Solving

Lvarez et al. (2020) developed theoretical design concepts for projects for common college mathematics courses that address applicability to teaching secondary mathematics. Despite the fact that teaching mathematics is a form of applied mathematics, they stated that resources for curricula in mathematics major courses typically disregard applications to teaching. A range of teaching-related materials produced by these writers are also used in four mandatory undergraduate mathematics courses. Three major concepts were used to develop the exercises that teach aspiring teachers how to comprehend and apply mathematics in a way that is crucial to their future careers. The paper also includes suggestions for instructors who wish to develop or make use of similar software. The process of developing these tasks serves as a reminder of the value of certain components related to the roles of individuals in the activities, the deliberate focus on challenging school mathematics curriculum, and the use of active engagement approaches.

Copur-Gencturk & Li (2023) make a contribution to the field by evaluating responses from 290 instructors from 48 states and showing how different conceptualizations of teachers' subject knowledge may have affected the dimensionality of these dimensions in earlier studies. The authors held the opinion that teachers need possess specific examples of content-specific knowledge and skills in order to effectively teach a certain subject. They recognized that one important factor in preparing the teaching workforce is the type of knowledge required to teach a subject matter. According to the study's findings, pedagogical content knowledge, subject knowledge pertinent to teaching mathematics (which has two distinct components), and content-specific noticing skills all have a role in teachers' ability to teach mathematics. Additionally, it aids in the better understanding by primary school mathematics teachers of the distinction between subject-specific noticing and subject-specific knowledge as well as pedagogical topic knowledge. Also underline how actual findings about the dimensionality of the construct are impacted by the conception of content knowledge.

According to Erkisheva et al. (2014), ethno pedagogies are one of the resources being developed for math instruction. It's because ethnic pedagogies, which has been created and transmitted from one generation to the next, is a synthesis of pedagogical educational experiences that have been built over centuries and have a strong connection to national educational traditions.

Loc et al. (2022) propose activity theory and show how it may be applied to teach Geometry 10's straight-line equations in a plane using three stages. Phase 1: Motivation and goal orientation, where teachers use scenarios to entice students to participate in the class; Phase 2: Knowledge creation, when students participate in a range of learning activities to build the knowledge they need to acquire; and Phase 3: Assessment and evaluation. Giving students a ton of exercises to do during Phase 3: Practice and Consolidation helps students reinforce their knowledge and aids teachers in identifying and resolving students' misunderstandings. Researchers found that the activity theory approach is more effective than the conventional teaching approach and that students in the experimental class who were taught using activity theory had better learning outcomes than students in the control class who were taught using the conventional teaching approach. In the experimental class, the number of weak students decreased in comparison to the conventional approach, but the number of good students

increased. Further study is required to ascertain how to influence a wide range of students with diverse math skill levels in order to increase the efficacy of teaching utilizing the activity theory approach.

In order to compare techniques with family factors and circumstances influencing math ability, number discussion was measured for 97 parent-child pairs during in-lab and at-home play sessions in a study by Thippana et al. (2020). They discovered that the amount of time parents spent engaging in math-related activities during home observations was related to parent reports of math activities and parent number conversations at home and in the lab. We found that parents of males and parents with higher educational levels talked about numbers more during non-math-related activities than parents of girls and parents with lower levels of education. However, during math-related activities, no such racial or gender differences in number talk were seen. These findings highlight the importance of considering the contextual variables and constraints that restrict children's opportunities to learn math, especially when creating interventions to encourage math learning in family households.

Zohrevand et al. (2010) used a case study in mathematics education at the Islamic Azad University to highlight various important and successful features of the quality of mathematics education and learning as well as problems with teaching arithmetic to students with different requirements (IAU). The authors identified a number of variables, including student age (adult and younger students), employment (students with jobs and those without), prior educational programs, and others. Teaching and learning can be improved by having a better understanding of the diversity among students and their opinions on math education.

Practices

In especially for the poorest students, the quality of learning in reading and mathematics is assured by teacher preparation, according to Akyeampong et al. (2013). Initial teacher education, which led to false confidence and standardized instructor-driven methods that failed to engage pupils, had the greatest impact on newly qualified teachers. While reading instruction was disconnected from meaning, mathematical exercises were not related to understanding concepts. They suggest that teacher education be restructured to focus on classroom practice with students' learning at its core.

In 2021, Boliver, V., and Capsada-Munsech, Q., conducted research on how ability grouping influences the enjoyment of math and English among UK primary school kids. Ability-homogeneous classrooms, according to proponents of grouping children for instructional reasons based on measured ability, increase the accomplishment of high-ability students without diminishing that of students who are perceived to have lesser ability. In contrast, opponents of ability grouping claim that low-ability children in ability-homogeneous classrooms perform much worse than high-ability students, with high-ability students performing at best just somewhat better. One justification offered by individuals who oppose ability grouping is that those who receive the label of low-ability suffer psychological harm as a result of this practice, which results in a self-fulfilling prophecy of poor achievement. Most earlier studies have looked at the claimed psychological impacts of ability grouping on students' "academic self-concepts," which refers to students' perceptions of their skills with reference to particular subjects or academic work in general. The authors examine whether enjoyment of arithmetic, English, and education as a whole changes between the ages of 7 and 11 depending on the ability group that the students were assigned to at age 7. The findings show that ability grouping, at least in terms of students' enjoyment of math

Dai et al. (2023) utilized a mixed-methods approach to examine how students employed learning supports when learning math through video games. They see digital game-based math learning environments (math DGBLE) as potential resources for students to advance their conceptual understanding and mathematical reasoning, two aspects that are given top priority in today's mathematics curriculum. Two learning tools that the authors developed for a math DGBLE are Task Planner and Math Story. Six clusters of learning-support-use behaviors, including conceptual knowledge development, skills development and application of mathematical problem decomposition, metacognitive mathematical connections, metacognitive regulation, information selection using cognitive aids, and sustained motivation for necessary aversive practices, were extracted using an unsupervised machine learning technique (i.e., the Gaussian Mixture Model). As the study showed, the designed in-game learning supports facilitate individual meaningful and mindful math problem-solving experiences, it is possible to use a mixed-methods research design that combines machine learning with multiple case studies to guide the creation of adaptive and efficient DGBL.

Teachers have struggled to make math engaging for students by providing them with problems and real-world examples that highlight its relevance. The use of case studies in mathematics instruction is what Ghic (2012) does. Contrarily, technology enables students to experience the value of mathematics in daily life rather than just learning about it. An aids students in developing a positive mindset and, in particular, the skills needed to improve this unwanted outcome. The authors came to the conclusion that real-world case studies provide context for theoretical notions. The student is therefore interested in what can be done with a certain topic.

According to King-Sears et al. (2021), a meta analysis, co-teaching boosts academic achievement for children with disabilities (SWD). They compare the academic achievements of SWD kids in co-taught classes to those of SWD children in special education environments. Although the findings indicate that SWD can achieve

academic success in co-taught classes, more research is necessary to ascertain how SWD differ in co-taught versus special education settings and how instruction differs in each. Two of the reasons that are linked to the results that are presented are the lack of understanding about instructional strategies and the comparability of students put in co-taught or special education settings. Future researchers are advised to follow the recommendations and are cautioned against implementing SWD widely in either setting before making sure that effective teaching strategies are in place and that students are receiving carefully individualized instruction as specified in their Individualized Education Plans.

M. ztürk (2021) designed an embedded mixed approach to (1) examine the effect of the IMPROVE method, a metacognitive training method, on the academic accomplishment of middle school pupils regarding algebraic expressions, and (2) examine the teaching process of algebraic expressions with IMPROVE. The results of the study showed a significant difference between the students' total accomplishment scores for algebraic expressions and their achievement scores for questions requiring advanced cognitive abilities, favoring the experimental group. When comparisons based on cognitive field levels are made, it has been found that there is a statistically significant difference in favor of the group that received education based on metacognition for questions at the synthesis level. The qualitative results also demonstrated how this teaching method enhanced the students' many emotive characteristics, enhanced their conceptual learning, and captured their interest. Additionally, it has been discovered that students who receive education based on metacognition value their education and feel that this method of instruction ought to continue for future sessions.

S. Engül (2009) investigated how particular teaching strategies affected the performance of teacher candidates. that carrying out the goals of education is something teachers have to do. In a teaching-learning context, teachers' responsibilities are changing and becoming more important. Teachers should have the necessary training in order to accomplish this goal because they are responsible for guiding future generations and have a huge impact on shaping the future. In lesson two on special teaching approaches, fourth-year primary arithmetic students are evaluated on how well they function as teachers throughout the application period.

Stoica, A. (2015) asserts that the "Maths Project," which is incorporated into regular classroom activities, can take the role of the conventional mathematics curriculum, which entails teaching students the theory first before assigning them exercises and problems to answer. The solutions to these challenges and exercises are generally algorithmic, and they rarely relate to actual actions. According to the author, this approach integrates instruction, learning, and evaluation. The study's findings, which included a significant difference in test scores between the experimental and control groups even after adjusting for pre-testing variables, confirmed the experimental hypothesis that the "Maths Project determinates better child learning than other classic approaches."

In order to examine how rookie teachers' mathematical efficacy trajectories altered over the course of their teacher preparation and their first two years of work, Thomson et al. (2020) employed a mixed-methods approach. Alumni of an esteemed American university's elementary STEM program made up the participants (N = 245). Overall, quantitative findings showed that participant efficacy increased over their teacher training program and decreased during their first years of teaching. For particular groups, efficacy trajectories—patterns of either increasing or decreasing efficacy over time—were also discovered. Utilizing qualitative data, it was possible to pinpoint the timing and root reasons of changes in teaching effectiveness.

Arithmetic knowledge and skills are extremely abstract, therefore they are frequently developed through practice. This is because the cognitive qualities of primary school pupils are quite particular, and since math knowledge and skills are frequently formed through practice and practice. In order to encourage students' independence, the practice strategy works well. The following are examples of practice activities: completing tasks or assignments given by teachers so that students can discover or acquire new knowledge and skills on their own; practicing applying knowledge in doing calculations and solving math problems to consolidate knowledge and form skills; collecting data and creating simple statistical tables; moving from solving practical problems to solving math problems that they have set themselves; and solving exercises.

Lecturing and Illumination

Im et al. (2020) investigate the direct and indirect links between math proficiency in primary grades and standardized testing practices at the school level. Data from the nationally representative Early Childhood Longitudinal Study-Kindergarten Cohort in the United States were used to create the sample, which included 6774 children spread among 925 primary schools. The advantages of frequent testing policies in Grade 1 do not carry over to Grade 3, despite students making short-term gains in that grade, according to the results of a multilevel comprehensive structural mediation study. On the other hand, procedural instructional techniques were discovered to attenuate a detrimental link between Grade 3 math achievement and policies regarding school-level standardized testing (e.g., drills). The results have consequences for primary-grade teachers, educational policymakers, and students regarding the validity of standardized tests.

Copur-Gençturk & Tolar (2022) gathered the viewpoints of 290 instructors from 48 US states to advance the topic. This was accomplished by showing how different conceptualizations of teachers' subject-matter competence may have affected the dimensionality of these dimensions in earlier investigations. Additionally, it aids in the better understanding by primary school mathematics teachers of the distinction between subject-

specific noticing and subject-specific knowledge as well as pedagogical topic knowledge. According to the findings, there are three separate elements of instructors' ability for teaching mathematics: subject knowledge (with two distinct components), pedagogical content knowledge, and content-specific noticing abilities. The results also demonstrate the multifaceted nature of teachers' subject-area expertise in teaching mathematics. The outcomes also show how conceptualizing content knowledge affects empirical discoveries about the dimensionality of the construct.

Mathematics is fundamentally a tool for thinking, by which we mean a specific way of thinking, according to Wang et al. (2011). The invasion and dissemination of the mathematical style of thinking is the main means by which the mathematical sciences achieve their goal. For mathematics to advance, it is important to promote the use of mathematics as a tool. By examining the theoretical and practical applications of the RMI thinking approach in the teaching of mathematics, the authors accelerated the process of creating mathematical thinking and raised the capacity for applied mathematics. As a result, improving teaching standards is essential.

Other Factors

Using a video prompting intervention package, Kellems et al. (2016) assess the efficacy of teaching multi-step math skills to nine persons with disabilities in a transition program for students ages 18 to 21 after high school. The percentage of steps correctly completed served as the dependent variable. The video prompting intervention served as the independent variable and required students to perform various multi-step arithmetic calculations, including (a) figuring out a tip (15%), (b) figuring out item unit pricing, and (c) modifying a recipe for more or less people. The percentage of steps correctly completed was shown to have a functional link with the video prompting interventions and prompting package, according to the authors. After receiving the video prompting intervention, 8 out of the 9 adults immediately displayed considerable improvements.

According to Levine and Pantoja's study from 2021, both adolescents and adults have been widely investigated in terms of how different math attitudes relate to math achievement. Math anxiety, math self-concept, mindset, and math-gender stereotype were all examined as they related to early math learning. By the beginning of primary school, these attitudes start to develop and are linked to math proficiency. The authors contend that early math success is crucial for the beginning formation of either favorable or unfavorable attitudes toward math, which may set off a negative or favorable loop that can either support or hinder math learning. Additionally, during early to mid-elementary school, gender disparities in math attitudes (favoring boys) start to show. Understanding how early attitudes toward arithmetic link to one another and whether particular attitudes constellation is frequent is an important future direction. As important socializers, parents and teachers, they also take into account these different forms of math attitudes: generic (math gender stereotypes and mindsets), self-relevant (math anxiety), and child -specific (expectations and value of math for their child or student). The review emphasizes a connection between important socializers' attitudes toward math and related actions and their kids' attitudes toward math and arithmetic achievement. The Early Math Achievement-Attitude model is suggested by the authors (EMAA). Increasing our knowledge of how key socializers with various math attitude constellations interact with kids regarding arithmetic is an essential future direction. Finally, we address intervention strategies that show promise for enhancing young children's math achievement and attitudes based on the examination of these subjects as well as intervention research.

Pachemska et al. (2014) conducted study on ICT-based approaches for modernizing math instruction in primary schools. The empirical findings from the completed research indicate that the Macedonian educational system should introduce and practice using ICT for math instruction with the theoretical basis of the terms: math instruction, teaching techniques, ICT instruction... and the gained results.

Results of multilevel structural equation modeling showed that teachers' self-efficacy beliefs for teaching math were positively correlated with teachers' job satisfaction, class levels of math achievement, and interaction quality. Perera & John (2020) gathered data from over 6000 4th grade students and 450 teachers. Both individual views of the quality of interactions and individual levels of math self-concept were positively correlated with math achievement at the level of the individual student. Math achievement, however, was found to have a negative correlation with residualized interindividual assessments of interaction quality. These were the outcomes of putting out and testing an integrative model of the relationships between teachers' job happiness and students' math achievement, both directly and indirectly through the quality of their interactions as a crucial aspect of the quality of classroom operations. According to the ecology of the classroom, other relational and motivational indicators of math accomplishment at the student level are also included. These include personal assessments of the effectiveness of student-teacher interactions and math self-concept.

In order to account for innate differences in students' interests, cognitive abilities, school grades, and family backgrounds, ten Hagen et al. (2022) investigated the relationships between teachers' perceived student-specific and domain-specific teaching effectiveness in math and reading, student-reported interest-supportive instruction, and students' subject-specific interest in these domains. N = 449 for arithmetic and N = 568 for reading; grades 3-6; data from 48 math and 55 reading teachers and their elementary school students were analyzed. Domain-specific multilevel path analyses showed significant within-classroom relationships between teachers' perceptions of their ability to teach specific students and student reports of interest-supportive instruction and

subject interest, but no significant between-classroom relationships were found. The perceived efficacy of instructors' instruction in arithmetic, but not reading, was positively predicted by prior differences in students' subject-specific interest within classes. In both disciplines, a teacher's perception of the effectiveness of a particular student's learning was correlated with how probable it was that student would find the teacher's instruction compelling, which in turn predicted an improvement in the student's interest in arithmetic and reading. Different findings across levels of study (between- vs. within-class) and disciplines (math vs. reading) highlight the significance of looking at correlations between student- and subject-specific outcomes and teacher perceptions of their teaching abilities.

According to Lazarides & Schiefele, (2021), in mathematics classes, teacher-reported cognitive activation, classroom management, and emotional support were all positively correlated with teacher-reported self-efficacy in instruction. Positive correlations were found between teacher reported educational interest and both student and teacher reported emotional support. It is proposed that future studies concentrate more on the distinctive relationships between various teachers' motivational traits and pertinent aspects of teaching quality. These conclusions are based on data collected from 84 mathematics teachers (61.2% female) and their students (1718 students; 48.5% girls), as well as from earlier studies on teacher motivation, which looked at the relationships between mathematics teachers' interest and self-efficacy and other pertinent aspects of teaching quality as perceived by both teachers and students.

In 70 schools across six Kenyan districts, Kodzi et al. (2014) looked at how differences in important facets of social relationships among instructors, between teachers and students, and between principals, teachers, and parents and kids affect sixth-graders' arithmetic proficiency. While accounting for baseline factors at the school, classroom, and student levels, we modeled math achievement as a function of social perception and support measures. They discovered that regardless of topic expertise and background traits, pupils performed better under the instruction of teachers who consistently check students' homework and keep them engaged in math sessions. Math performance was inversely correlated with teacher absence and lack of interest. The absence of parents from the classroom also had a negative impact on students' grades. Math achievement at the school level benefited from the principal's degree of participation as seen by his or her effective teacher supervision and warm parent contacts. While student misbehavior and absence had a detrimental impact on grades, schools whose parents provided material and financial support had superior scores.

The attitudes and beliefs of upper secondary Math and Science teachers (MST) whose students are the first and second cohorts to learn Mathematics and Science in English are examined in Tan & Saw Lan's (2011) study. The results demonstrate how MST attitudes and beliefs influence teaching practices through teacher interviews and classroom observations. Additionally, the data demonstrates how the interaction between exam policy, instructor perceptions, and their beliefs promotes the use of translation and a focus on keywords during instruction. These methods benefit students who are academically and linguistically talented but have a negative effect on their ability to master new material and express themselves in new languages. Additionally, these techniques might enhance students' short-term information understanding while limiting the growth of their oral and written communication skills.

DISCUSSION

In terms of Visual, the student's math learning results are assessed as the ability to do the math, and the ability to do all kinds of math problems is a key criterion for assessing the student's math learning level. Therefore, teaching math is important, especially the visual method. The visual is a teaching method in which teachers organize instructions for students to directly operate on teaching media and tools, thereby helping students to form the necessary knowledge and skills of mathematics. This method is based on specific images, drawings, objects, and surrounding reality to form knowledge for learners. This method is often used at many stages in the teaching process, such as knowledge acquisition, problem-solving, learning practice, and knowledge review. This method helps teachers understand the importance of teaching methods and the need to use visual methods in teaching and learning mathematics. It also makes it easier for students to acquire knowledge through specific images or models that represent mathematical symbols, concepts, rules, and properties. Typical studies on visualization methods (Aqda et al., 2011), (Bos, 2009), (Cunsa & Savicka, 2012), (Khorasani, 2012), (Maćkowski et al., 2018) all show that the effectiveness and impact of this method not only for learners but also can help teachers' teaching more effective, meeting the diverse needs of students' understanding and understanding of math learner. Intuition is a method and a means to assist learners in achieving mastery of abstract mathematical knowledge and developing thinking capacity. Therefore, teachers must choose the appropriate form, content, and expression of the visual method to avoid confusion in the process of helping learners exploit pictures, models, or diagrams of problems or systems of prompting questions, so that learners can find a way to solve problems and apply math knowledge in a vivid and practical way.

The Questioning method in mathematics instruction uses a series of questions to steer students' thought processes and prompt their responses rather than explicitly imparting all of the information to gain the required information and abilities. This approach is appropriate for the demands of teaching innovation because it does not demonstrate the knowledge that is already in the classroom. Instead, teachers encourage students to seek out

knowledge on their own by asking them questions, which helps them think critically and express themselves. Learning methods are developed to support in long-term memory retention, improved comprehension, increased confidence, and learning. When employing this technique, teachers must be mindful of creating and utilizing a system of questions that suggest the outcomes of offering related information or solutions to learners' learning activities. Additionally, it's important to systematize the questions by making them: 1) appropriate for particular subjects, requirements, and teaching content; 2) each question should have a specific purpose related to the lesson's goals; 3) ask a variety of questions and rely on prior knowledge to predict potential responses.

This Problem-Based approach can involve the following steps: raise the problem at the beginning of the lecture; evaluate the relationship between the known and the desired; Propose and put into practice a problem-solving strategy that includes gathering and organizing facts, mobilizing knowledge, drawing conclusions utilizing cognitive processes and techniques, developing solutions, selecting the best answers, and coming to a conclusion. After an issue has been resolved, fresh information that is extremely helpful for future use may emerge from the outcomes. However, if we simply stop at the discovered solution, then this valuable information only exists in the form of the unique knowledge and experience that each student has gained by participating in problem-solving activities. Consequently, they vary depending on the pupil. It is the responsibility of the teacher to provide and communicate that knowledge to the class so that it becomes general knowledge that all pupils may utilize later. This is stated explicitly as a theorem, formula, rule, procedure, etc. The teacher is said to have completed the institutionalization step at that point. To put it another way, institutionalization is the process of converting individual knowledge into collective knowledge.

Several prerequisites for utilizing the practice method. It's important to spell out the lesson's goals explicitly, as well as the fundamental concepts and abilities that need to be practiced, and to give enough time for exercises practice with certain material. Determine what needs more practice - prepared practice exercises so that all pupils can actively practice in each subject. Provide each pupil with enough practicing space. To avoid replacing or performing all of the student's work during the practice, it is important to observe, check, and correct any faults that may occur. You should also set up circumstances with educational aims to encourage students to be active and self-disciplined.

The Lecturing and Illumination is a kind of method in which the instructor explains the information in words and then supports the explanation with visuals to help the students comprehend the lesson's material. Because mathematics contains many very abstract concepts that are challenging to learn about on your own, this method is essential in the process of teaching math at many school levels, including elementary and high schools. To help pupils comprehend material and develop concepts at that time, teachers must employ this approach of explanation. When utilizing the method, there are a few key criteria. This technique is frequently applied in practice and review classes to identify issues with inefficient teaching techniques. The teacher should employ this strategy when pupils do not fully or properly understand the material. Give a precise definition of why a knowledge unit or other object needs to be explained. The instructor either presents a point that conflicts with the students' recently acquired knowledge and asks them to express their opinions on the subject or tries to explain it succinctly in a way that is easy to understand (e.g., a wrong solution, an explanation that contradicts the existing rule, etc.). Thus, the teacher will know if the student understands the knowledge correctly or not, thereby finding a way to explain it appropriately.

It can be said that besides the main trends, math teaching methods and activities are also influenced by many different factors, which may come from the environment outside the classroom, but there are also factors that come from within the classroom. Understanding these factors not only enables quality teaching and math learners to enjoy quality and effective learning sessions, but it can also help overcome problems that may affect the quality of teaching. and learning math, or even help come up with solutions to improve teaching as well as the driving factors themselves. For example, teacher motivation or student attitudes.

D. CONCLUSION AND FUTURE WORKS

The terms math, teaching, and methods are found in many documents; there are documents that only deal with math problems and mathematical forms that have been studied and popularized in the general education system and schools in particular. Next are the materials on math teaching, math learning, and math learning methods, which are more limited in number, on the one hand, because of problems not only in the scope of mathematics or mathematics at all levels of study, on the other hand. The problem is interdisciplinary or pedagogical in nature and does not refer entirely to field knowledge. With the math teaching method, the number is lower because most of it is pedagogical in nature, with the main requirement being how to do pedagogical activities to understand and practice math or math problems.

Teaching methods are very important, if well researched and prepared, the published data and quality on math teaching methods will contribute to innovation in teacher training and retraining at all levels of education. Thereby, it will improve professional and professional capacity, update methodological developments, thereby helping to improve learners' activities, creativity and problem-solving ability, self-monitoring and self-monitoring. evaluate the learning outcomes of learners, integrate many methods to create effective math teaching and apply math in practice. No method is absolute, because what may work well for one learner may

not work for another, so not only depends on one method, but the teacher needs not only to be proficient in many teaching methods, but more importantly, mastering the application of appropriate methods or a combination of methods to create the highest efficiency of the teaching process, ensuring the appropriateness for each learner, group of learners and even the needs of students with specialized demand.

The first limitation of this study is the lack of literature on math teaching methods in other languages. This limits aspects of research in many different languages and prevents us from getting a full picture of math teaching methods. The materials we used for this study were all published in English.

Authorship Contribution Statement

Dr. Hai designed the study, Dr Thang Ngoc Hoang and Hoa Thi Thanh Dang contributed to the design and implementation of the research, to the analysis of the results, Dr. Thang The Nguyen, and wrote the manuscript, reviewed the final manuscript and revised the manuscript as the reviewers commented.

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