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Peer Tutoring Learning Strategies in Mathematics Subjects: Systematic Literature Review

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Abstract: The peer tutoring approach is a student-centered teaching method in which students learn in pairs with teacher supervision. The study discussed in this paper is a systematic literature review related to the effectiveness of peer tutoring approaches which has been published within the last 5 years. A complete text analysis was conducted using 20 research papers stating the impact of the peer mentoring approach for this writing. Among the things obtained from previous studies are the variety of ways to implement peer tutoring approach, the impact on 3 aspects in students which are mathematical achievement, social skills and cognitive skills and the teaching theories used. The findings of the study indicate that most past studies used quantitative research methods with the concept of age peer approach. Then, constructivism theory was the most frequently applied with a sample of high school students. In conclusion, this systematic literature review shows that the peer tutoring approach in mathematics education has many benefits in various aspects and needs to be extended to improve the quality of education.

Keywords: *Mathematics education, peer-assisted learning, peer tutoring, PRISMA, systematic literature review.*

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Introduction

The increase of peer tutoring or peer-assisted learning in recent years has been thoroughly documented in relevant research (Alegre et al., 2019a; Moliner & Alegre, 2020a) including in mathematics education. Interestingly, according to Alegre et al. (2020), peer tutoring in mathematics has similar academic effects in both primary and secondary schools. A growing body of evidence suggests that peer-assisted learning has a favourable impact on academic success (Leung, 2015), mathematics self-concepts (Moliner & Alegre, 2020b), mathematics anxiety (Moliner & Alegre, 2020a), attitude and social behaviours (Song et al., 2018). Peer mentoring is a program to train youths and teenagers to master the skills of helping. These skills can help fellow students who need help mentally, socially, or emotionally, as well as train them to help themselves. Peer tutoring is a form of structured peer learning technique. This peer mentoring program is very important because it is based on the concept that peers are the closest people and they can better understand the problems faced by their other peers. In addition, students are better trained in basic skills which allow them to interact effectively with their other peers. In the context of learning through peer guidance, it is believed to be able to train students' skills to see more broadly how they can solve a mathematical question without the help of a teacher.

Since the findings of previous study stated that most of the students face difficulties in mathematical achievement (Zulnaldi et al., 2020), peer mentors can help to develop planning sessions with learning activities for peer mentoring. Jucoy and Maglipong (2018), for example, found peer tutoring influence on the four steps of problem-solving skills such as understanding the problem, devising a plan, carrying out the plan, and looking back. Furthermore, the features

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integrated into the session plans developed with the learning activities were the cooperative and contextual learning approaches. However, there was a need to determine the significant learning experiences of peer tutors as well as the performance of peer coaching groups and non-peer coaching groups. This technique used the method of anxiety through more experienced peers and peers. Mentoring through peers is more effective than mentoring through more experienced people. This is because peer to peer tutoring has the advantage of an approach between students, and it also occurs in the same class group (Ansuategui & Miravet, 2017). Group discussion is also one of the techniques in the subject of mathematics as it is one of the methods to improve and assist a person in solving mathematical questions. Peer tutoring had a significant positive effect on students' maths learning (Alegre et al., 2020). Peer tutoring has been considered a mandatory program implemented in line with the school curriculum.

The existing systematic review indicates that peer tutoring is utilised in a variety of elementary educational contexts (Alegre et al., 2019b) such as secondary pupils with impairments' reading comprehension performance (Alzaharani & Leko, 2018), health professions education (Gazula et al., 2017), secondary education (7th to 12th grade) (Alegre et al., 2019a) and preclinical medical education (Shenoy & Petersen, 2020). All these are evident in comprehensive review of the literature. Literature reviews and meta-analyses stated that peer tutoring in mathematics was more effective in primary education (ages 7–12 years) than secondary education (ages 13–18 years). The findings of the study found that age practically did not affect the effectiveness of peer coaching. However, most of these reviews did not focus on the theories used, peer tutoring methods, and effects on academic achievement, social skills, and cognitive skills. Additionally, there is a lack of previous SLR comprehensive source using Google Scholar (Alegre et al., 2019a) and not focusing on mathematics education context (Alzaharani & Leko, 2018; Gazula et al., 2017; Shenoy & Petersen, 2020). Therefore, the researchers will examine learning through peer tutoring about mathematics education. Then, they will look at the extent of the effectiveness of peer tutoring from the academic, social, and cognitive aspects of students and whether this peer tutoring is implemented face to face or virtually.

We concentrated our analysis on seven areas of particular relevance, as follows: (1) How are studies on peer tutoring in mathematics subjects distributed by the year of publication, (2) How is research on peer tutoring in mathematics subjects distributed by country, (3) How is the study on peer tutoring in this mathematics subject distributed according to the type of sample, (4) What are the effects of learning through peer tutoring in the mathematics subject from the aspects of academic achievement, social skills, and cognitive skills, (5) What are the theories associated with learning methods through peer tutoring in mathematics subjects, (6) What type of research methodology was implemented in the previous study and lastly, (7) What were the peer tutoring methods implemented in the previous study.

Literature Review

In the current systematic review, the applications of peer tutoring in mathematics instruction are discussed in detail (Alegre et al., 2019b, 2019c). It has been proven that the use of same age coaching over cross-age coaching enhances individual academic performance with very substantial effect sizes. Learning through peer tutoring or better known in terms of educational as 'Peer Assisted Learning Strategies' (PALS) is not a foreign learning strategy today as it is one of the methods that support the way of learning in the 21st century. PALS refers to the construction of knowledge and skills through active help and support among peers who have similar educational status or study for the corresponding subjects (Topping, 2005). The term

'Peer Tutoring' is often used which is a learning strategy that involves individuals from other groups and similar social levels, where more skilled and knowledgeable individuals will educate other individuals (Colvin, 2007). Referring to the term 'peer tutoring' or guidance through peers, it is also defined as a type of collaborative learning aid among peer individuals and this method is believed to help students who are weak in learning through systematic teaching strategies (Chen & Liu, 2011).

Peer tutoring in the context of education is not a new thing; in fact, it has been introduced and often mixed with other learning approaches such as collaborative learning. There are two types of peer tutoring methods that are often introduced: cross-age tutoring and same age tutoring. In the context of cross-age tutoring, it is a learning strategy where students consist of different grade levels and sometimes from different levels of education (Alegre et al., 2020). This means that cross-age tutoring involves tutors from higher levels of education to assist tutees belonging to lower levels of education (Kalkowski, 1995). On the other hand, same-age tutoring is a form of peer tutoring where students belong to the same grade level (Alegre et al., 2020). Same-age tutoring is easier to implement than cross-age tutoring as it is only conducted in one classroom. Several authors have shown that peer tutoring is usually more effective on students from the same academic year (Moeyaert et al., 2021). A study conducted by Alegre et al. (2019b), for example, found that most pupils benefit from same age tutoring in algebra topics with moderate effect size. Nevertheless, interesting findings of research have been discovered also in cross age tutoring. Hänze et al. (2018) conducted a study employing tutors from students in the eighth grade at a secondary school and tutees from students in the third grade at an elementary school. The research found that tutors showed greater knowledge-building rather than knowledge telling behaviour, meanwhile tutees demonstrated greater active behaviour, as well as higher autonomy, competence, and intrinsic motivation.

These peer-guided teaching and learning strategies are generally conceptualized as the learning theory of social constructivism pioneered by Vygotsky where knowledge is constructed originally through social interaction with the individuals concerned (Vygotsky, 1978). Knowledge is gained because of interactions between individuals with other individuals called peer interactions as well as interactions between individuals and the environment (Hofstein & Lunetta, 2004). One of the reasons why learning through peer tutoring is important to implement is to help students to complete tasks that are in the level of zone of proximal development where the task is not able to be completed alone. It requires guidance and help from more competent individuals such as adults or more knowledgeable peers (Vygotsky, 1978). The idea here is that individuals can learn well when they are with other peers through group discussions and through those collaborative efforts with those who are more skilled, students will be able to appreciate new concepts and skills (Shabani et al., 2010).

The application of learning through peer tutoring to some extent brings benefits and advantages to tutors and tutees. The role of a tutor in mentoring other peers is a responsibility that is not easy to perform. It requires skills that should be honed from the beginning as well as guidance from the teacher. Tutors will benefit through peer tutoring where they can enhance the opportunities to learn in guiding tutees where in turn it can create a sense of pride and responsibility for the role held (Maheady, 1998). Not only that, tutors and tutees can also increase their self-confidence through discussion and exchange of opinions during the peer tutoring program. Students can improve themselves better and enhance self-esteem through their involvement in peer tutoring (Maheady, 1998). Apart from that, peer tutoring also facilitates the learning process as students interact with each other using sentences that they can easily understand. Tutors will help tutees by explaining a lesson in their own way without changing concepts where students will be easier to understand and be able to actively engage in the learning process (Laskey & Hetzel, 2011). However, in the study by Song et al. (2018) in rural secondary schools, peer-assisted learning did not raise the tutees' mathematics results; rather, it increased their level of learning tension.

However, peer tutoring-related features such as theories employed, techniques used, and impacts on academic performance, social skills, and cognitive skills are not often well analysed in existing reviews. Furthermore, a prior systematic literature review lacked an all-inclusive source through the use of Google Scholar (Alegre et al., 2019a). Its methodology was not exhaustive because it only accessed the materials that were available via Google Scholar. This suggests that the previous review may have missed some important studies that could have contributed to a more complete understanding of the topic. Overall, a more narrowly focused systematic review that carefully considers the theories employed, peer tutoring techniques, and effects on academic achievement, social skills, and cognitive skills in the context of mathematics education could offer a more nuanced understanding of the efficacy of peer tutoring in this area. Examining the theories that have been used is crucial because this can reveal the fundamental principles that underlie the success of peer tutoring and guide the design of further research and intervention projects. By focusing on a narrower set of factors, such as the theories and methods of peer tutoring, and their impact on specific skills and outcomes, this type of systematic review can provide more nuanced insights and a clearer understanding of the effectiveness of peer tutoring in mathematics education.

Methodology

Research Design

Researching and reviewing the existing literature using certain criteria is one of the important processes to make a research study. Through the 'filter methodology', the workload while reviewing the literature can be reduced and it is the best method to identify research questions

(Gülpınar & Güçlü, 2013; Hidayat et al., 2022). This review study followed the guidelines of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). In this review study, there are three main stages: inclusion and exclusion criteria, data sources and search strategies, and data and analysis programs. These stages will be shown in detail according to the following sections.

Inclusion and Exclusion Criteria

To ensure that the articles reviewed are relevant and meet the criteria and objectives of the study, the inclusion and exclusion criteria should be determined in advance. The selection and exclusion criteria for this review study can be referred to in Table 1.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Must be within the scope of mathematics	Scope other than Mathematics are not allowed
No limit of studying level (can be primary school, secondary school, or higher education)	Other than primary school, secondary school and higher education students
Must use article journals	Books and thesis are not allowed Systematic Literature Reviews are not allowed
Year of study must begin from 2017 until 2021 only	Before 2017
Articles can be in English	Except for English

Data Sources and Search Strategy

A total of six databases were used for the data collection process. Among the databases are ERIC, Science Direct, Proquest, Global Research & Development Service Publishing, IOP Science, Scopus, and Frontier in Psychology. These sources provide access to a wide range of publications, material genres, and topics. For example, scholarly journals and academic papers in every area of social science are available through ProQuest database. Keyword searches include 'Peer Tutoring' and 'Mathematics Education'. To cover all research question, we include any published article in mathematics education and not limit to any countries. Based on these keywords, a total of 63,460 articles were found through the six databases. Because too many articles were found, these articles were filtered by year of publication, article type, availability and other characteristics in Table 1 using filters in those databases before being compared. A total of 29 articles were identified as duplicates. Then the author filtered the remaining articles using other inclusion and exclusion criteria based on title, abstract and thorough reading. A total of 20 articles which were relevant and met the criteria were screened and identified. The authors had adhered to the PRISMA protocol during the search process and the refinement stage. A PRISMA diagram showing the article selection process is shown in Figure 1.

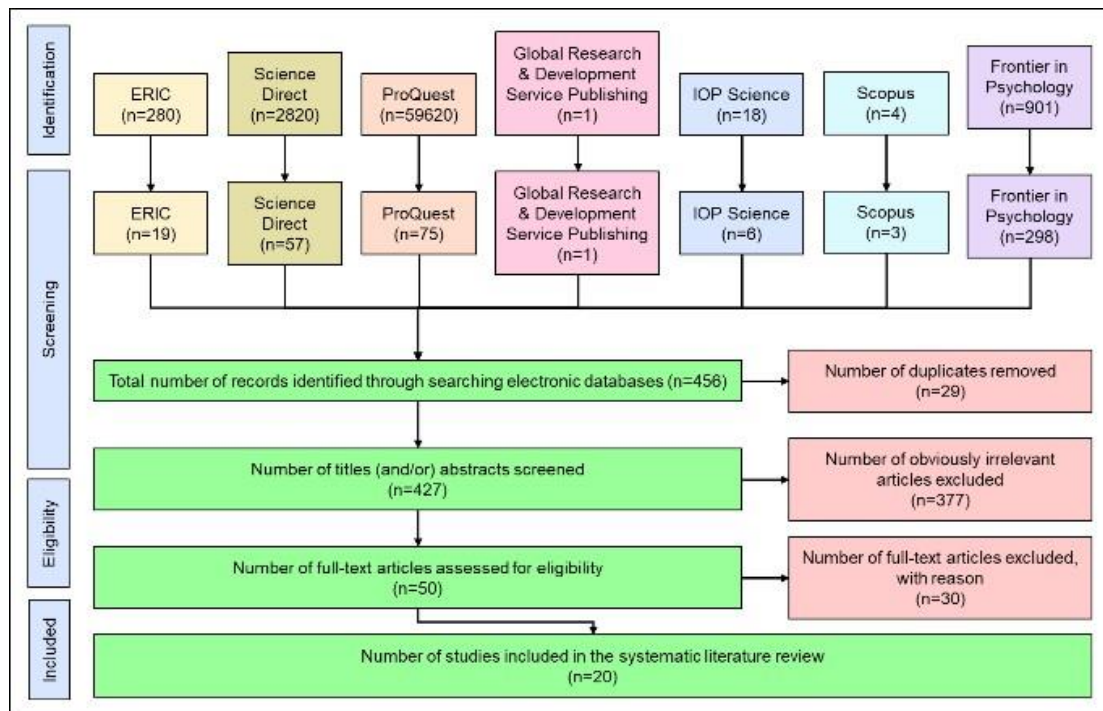


Figure 1. Article selection process based on PRISMA

Data Analysis

Once the articles which were relevant and met the criteria had been screened and identified, an analysis was conducted. The analysis conducted is divided into two types: descriptive analysis and thematic analysis. The descriptive analysis conducted focused on the following aspects: year of publication, country of issuer, sample type (primary school, secondary school, or higher education), learning theory, and research design used. This descriptive analysis aimed to provide a big picture of the distribution of the implementation of research regarding the learning through peer tutoring in the subject of mathematics. Moreover, the thematic analysis conducted was guided by recommendations from Braun and Clarke (2006) and Caulfield (2019). The approach used was an inductive approach, in which the authors will determine themes based on information gleaned from the articles. Thematic analysis was used because this methodology provided a very complete picture of a topic, helped comparisons between articles and

brought research findings or research themes which were not expected (Braun & Clarke, 2006). The following are details of the thematic analysis steps which had been carried out.

Reading to get a general idea. The articles which were relevant and met the criteria were read in general by the authors to get the general idea conveyed by the authors of the articles. *Coding.* In this process, the authors analyzed sections of the study findings in each of the selected articles. Important and informative word phrases were underlined and given short keywords (or 'codes') that represent the meaning in the word phrase. *Theme Production.* The code generated in the second step will be collected and labelled with a theme. 'Theme' refers to a more general 'code' and covers a wider field. *Theme review.* Afterwards, the authors had a thorough discussion of the theme that had been chosen. This was done to get a more appropriate theme and more precise meaning. Changes were made when deemed necessary by the authors. *Naming and definition of themes.* After discussion, the most appropriate theme was selected, and the definition of the theme was given based on the article or academic writing as well as the context of our analysis. *Report writing.* Finally, a report was prepared. The report covered the methodology, research findings, research analysis (by theme) and conclusions.

Findings

A total of 20 articles were chosen for this systematic literature review based on 7 research questions inquired. Table 2 is a summarization and comparison of the chosen articles which include the distribution of articles in terms of publication year, country and sample type, the effects of peer tutoring of mathematics in terms of academic achievement, social skill, and cognitive skill, applied theories, design methodology and type of peer tutoring implemented.

Table 2. Summary of Article

Author/year	Country	Sample	The effect of peer tutoring in Mathematics			Theory applied	Research methodology	Peer tutoring approach type
			Academic achievement	Social skill	Cognitive skill			
Zeneli et al. (2018)	United Kingdom	550 students aged 9 to 19 years	Academic achievement increased but not significant	No significant effect towards social skill stated	No significant effect towards cognitive skill stated	Social dependency theory	Quantitative	Cross-age tutoring
Yaman (2019)	Turkey	8 out of 50 first year engineering students	No significant effect towards academic achievement stated	Interaction among students provide positive impacts towards students' achievements	No significant effect towards cognitive skill stated	Socio-culture and constructivism theory	Quantitative	Same-age tutoring
Deshler et al. (2019)	United States of America	Developmental mathematics students	Students show higher achievements level	Students' persistence increased slightly Students more committed to finish their studies	No significant effect towards cognitive skill stated	Not mentioned	Mixed method	Same-age tutoring
Song et al. (2018)	China	2 rural Chinese middle school	Tutor has higher Mathematics achievement while tutees have no significant increment	Tutor experiences positive changes while tutee experiences negative changes	No significant effect towards cognitive skill stated	Not mentioned	Quantitative	Not mentioned
Thurston et al. (2020)	United Kingdom	487 students aged 10 to 12 from 20 elementary schools in 3 different districts	Students' Mathematics achievement increased	No significant effect towards social skill stated	No significant effect towards cognitive skill stated	Social dependency theory	Quantitative	Same-age tutoring
Alegre et al. (2019a)	Spain	380 grades 7th and 8th high school students	Majority of the students improve their academic achievement in algebra	No significant effect towards social skill stated	No significant effect towards cognitive skill stated	Not mentioned	Quantitative	Same-age tutoring

Table 2. Continued

Author/year	Country	Sample	The effect of peer tutoring in Mathematics			Theory applied	Research methodology	Peer tutoring approach type
			Academic achievement	Social skill	Cognitive skill			
Putranto and Marsigit (2018a)	Indonesia	Junior high school year 7 slow learners from inclusive classes	Inclusive classes students have overall development	No significant effect towards social skill stated	No significant effect towards cognitive skill stated	Realistic Mathematics Education approach	Quantitative	Same-age tutoring
Nawaz and Rehman (2017)	Pakistan	200 high school students in Haripur district	Students' achievement increasing significantly	No significant effect towards social skill stated	Students understand their level in processing knowledge	Constructivism theory	Quantitative	Same-age tutoring
Berso and Lorente (2020)	Philippines	5 classes of grade 9 students of Bantayan National High School, Tabaco City	Understanding level in quadratic equations topic increased for both tutor and tutee	Tutee more comfortable asking questions. Social skills, interpersonal skills, communication skills and confidence level of students increased.	Tutors understand the learning better	Not mentioned	Descriptive and comparative design	Same-age tutoring
Putranto and Marsigit (2018b)	Indonesia	31 slow learners in Grade 5 Junior High school from 3 different inclusive classes	No significant effect towards academic achievement stated	No significant effect towards social skill stated	Developed problem solving skills abilities, mathematics attitudes, mathematics literacy and conceptual understanding	Realistic Mathematics Education approach	Quantitative	Same-age tutoring
Johnston (2021)	Australia	Second year undergraduate students numerical methods subject in Applied Mathematics course	To increase students' understanding of the content of the lessons learned.	Improving students' language skills and self-confidence is increasing.	No significant effect was noted on cognitive skills.	Not mentioned	Quantitative	Same-age tutoring

Table 2. Continued

Author/year	Country	Sample	The effect of peer tutoring in Mathematics			Theory applied	Research methodology	Peer tutoring approach type
			Academic achievement	Social skill	Cognitive skill			
Chu et al. (2017)	Taiwan	Pupils from three fourth grade classes of primary schools in Taiwan	Improving the level of student learning achievement	No significant effect was noted on social skills.	Increasing the cognitive load of students where students also show a caring attitude as the role of tutor and tutee	Theory of cognitive load.	Quantitative	Cross-age tutoring
Alegre et al. (2020)	Spain	First, fourth, seventh, and ninth grades student	Both secondary school students and primary school students gain similar benefits in academics.	No significant effect was noted on social skills.	No significant effect was noted on cognitive skills.	Not mentioned	Quantitative	Cross-age tutoring
Campbell (2019)	South Africa	Secondary school students	No significant effect was noted on academic achievement.	The social aspect gives high motivation to the tutee where the tutee shows interest in discussions with the tutor face to face.	Students' cognitive can be built through assignments completed with the tutor.	Constructivist theory	Study design	Cross-age tutoring
Moliner and Alegre (2020a)	Spain	376 students aged 12 to 15 years	Most students had a positive impact on the implementation of peer tutoring and were able to reduce anxiety over mathematics subjects.	No significant effect was noted on social skills.	No significant effect was noted on cognitive skills.	self -concept	Quantitative	Same-age tutoring
Moliner and Alegre (2020b)	Spain	420 students in grades 7-9 from 12 to 15 years.	Provide benefits and effects on the self-concept of mathematics in students.	Effective interaction in peer tutoring benefits tutors and tutees.	No significant effect was noted on cognitive skills.	Self -concept	Combined methods	Same-age tutoring

Table 2. Continued

Author/year	Country	Sample	The effect of peer tutoring in Mathematics			Theory applied	Research methodology	Peer tutoring approach type
			Academic achievement	Social skill	Cognitive skill			
Rosdianwinata et al. (2019)	Indonesia	Higher education students aged 18 to 21 years	Students' achievement in understanding mathematics through peer tutoring is better than the understanding of students who learn on their own.	Peer tutoring trains students to collaborate, build and maintain communication with tutors to gain improvement in learning	No significant effect stated on cognitive skills	Not mentioned	Quantitative	Same-age tutoring
Roberts and Spangenberg (2020)	South Africa	Grade 12 students in private schools in South Africa	Increase the level of student motivation through tutorials conducted during tutoring.	Tutors understand the role of encouraging tutees to be responsible for assignments, tutee's self-confidence in mathematics subjects also increased.	No significant effect was noted on cognitive skills	Not mentioned	Qualitative	Cross-age tutoring
Ansuategui and Miravet (2017)	Spain	Grade 2 students of Castellon de la Plana (Spain)	Students successfully complete assignments faster and gain better understanding	Students dare to explain the problem to a friend as well as remove feelings of embarrassment.	Students demonstrate positive behaviours and cognitive competencies throughout the program	Self-concept	Combined methods	Same-age tutoring
Baiduri (2017)	Indonesia	Grade 5 students of Sekolah Rendah Pertama Kujang, Indonesia	Students find that through peer tutoring, it is easy to understand the concept and able to complete the task given by the teacher.	Students dare to ask questions and actively engage in discussions.	No significant effect was noted on cognitive skills.	Constructivist theory	Qualitative	Same-age tutoring

The Peer-Tutoring Studies Distributed in Terms of Publication Year

The research papers implemented in this systematic literature review were published in the recent 5 years (2017 – 2021) (Figure 2). Five research papers were published in 2017 (e.g., Moliner & Alegre, 2020a), three were published in 2018 (e.g., Putranto & Marsigit, 2018b). In 2019, six research papers were published (e.g., Yaman, 2019). Six more papers were published in 2020 (e.g., Johnston, 2021). Based on the findings, the study on peer tutoring has been very consistent in the past five years (2017–2021). However, the number of such studies is not high. This indicates that peer-tutoring in mathematics education is not a prominent topic.

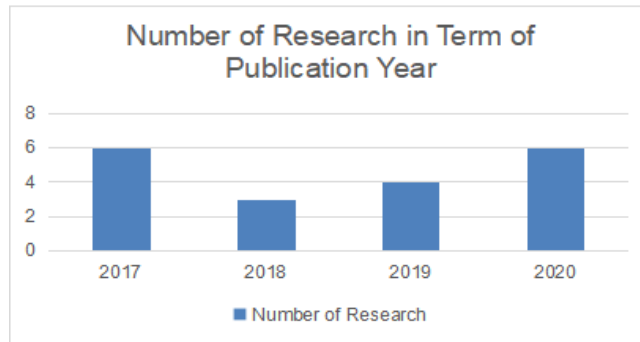


Figure 2. Year publication in the reviewed articles

The Peer-Tutoring Studies Distributed in Terms of Country

In the spotlight of this systematic literature, peer-tutoring learning research by country in the past five years have been distributed among 11 countries. Among those countries, studies in Spain and Indonesia in peer-tutoring learning in mathematics education were highest, with 5 and 4 studies respectively. Other studies were conducted in South Africa, United States, Australia, China, Pakistan, Philippines, Taiwan, Turkey, and United Kingdom. The study papers utilised were not subjected to any continent or country. Overall, the selected study papers were published from South Africa (e.g., Campbell, 2019), United States (Deshler et al., 2019), Australia (Johnston, 2021), China (Song et al., 2018), Indonesia (e.g., Baiduri, 2017), Pakistan (Nawaz & Rehman, 2017), Philippines (Berso & Lorente, 2020), Spain (e.g., Alegre et al., 2020), Taiwan (Chu et al., 2017), Turkey (Yaman, 2019) and United Kingdom (e.g., Zeneli et al., 2018). It was also found that the distribution of the studies by continent was mostly done in the Asian and European continents (Figure 3). Studies on the African, Oceania and American continents, on the other hand, were very limited, in comparison. The chart below shows the classification of total studies based on continents.

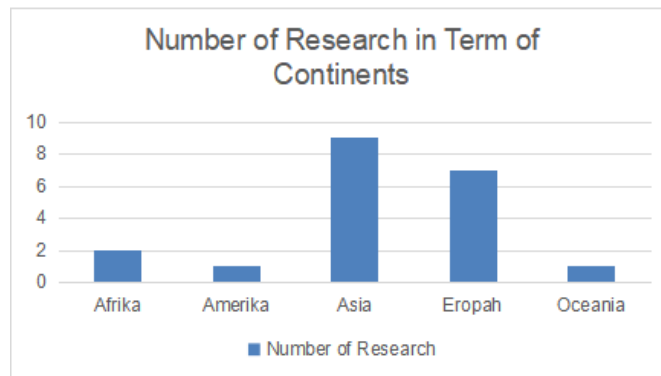


Figure 3. Distribution of published articles by geographical distribution

Studies on Peer Tutoring According to Sample Type

According to the analysis, most of the studies related to peer tutoring learning covered in this systematic literature review were conducted in secondary schools (Figure 4). Only a few studies with the same theme were conducted in primary schools or institutions of higher learning. Meanwhile, one article discussed the comparison between peer tutoring learning in Mathematics education in primary and secondary schools. Based on the selected research papers, 3 types of population samples were studied: primary school students, secondary school students and higher education students. Of all the research papers used, only one (1) used a sample of primary and secondary school students simultaneously (Alegre et al., 2020). 4 studies used samples from primary schools (e.g., Chu et al., 2017), 11 used samples from secondary schools (e.g., Nawaz & Rehman, 2017) and 4 used samples of higher education students (e.g., Deshler et al., 2019).

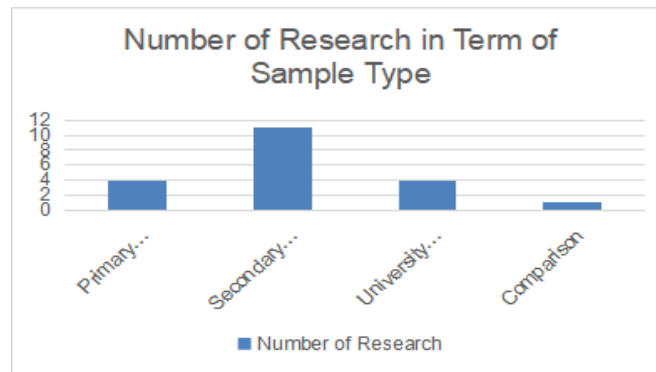


Figure 4. Research Samples

The Effect of Peer Tutoring on Academic Achievement, Social and Cognitive Skills

The fourth research question discusses the effect of learning through peer tutoring in the subject of mathematics where the impact is considered from three main aspects namely in terms of academic achievement, social skills, and cognitive skills of students. Figure 5 indicates number of article in term of learning outcome.

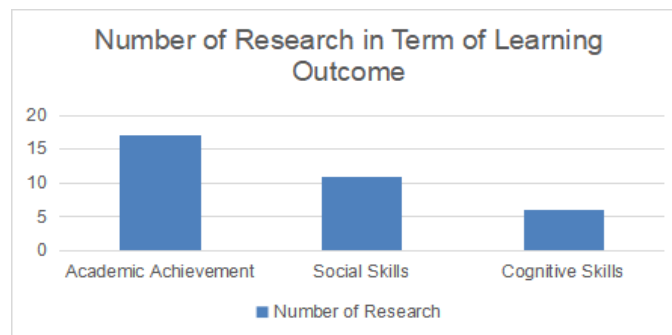


Figure 5. Learning Outcome

A total of seventeen articles discussed the impact of the implementation of peer tutoring from the aspect of student academic achievement (e.g., Berso & Lorente, 2020). In general, most of the articles discussed the impact of academic achievement of tutors and tutees in implementing peer tutoring and the findings showed a positive impact of academic achievement as well as benefit through the program. Through selected articles, eleven articles discussed the impact of the implementation of peer tutoring from the aspect of students' social skills (e.g., Campbell, 2019). The impact in terms of social skills of these students such as increased interaction, increased self-confidence of students and courage of tutors and tutees can be seen through the implementation of peer guidance. The students' interaction and discussion with each other to some extents were able to promote their cognitive thinking and build their understanding in the subject of mathematics. From the aspect of cognitive skills, six articles discussed the effects of peer tutoring on students' cognitive skills (e.g., Berso & Lorente, 2020). All six articles showed a positive effect from this aspect. The effect of cognitive skills can be seen in terms of students' mastery of a topic and their ability to complete assignments with tutors. *Theories Associated with Peer Tutoring*

The fifth research question discussed theories associated with learning methods through peer guidance. A total of six types of theories were linked, namely constructivism theory ($n = 4$), self-concept theory ($n = 3$), social dependence theory ($n = 2$), theory through realistic mathematics education approach ($n = 2$), cognitive load theory ($n = 1$) and sociocultural theory ($n = 1$). 8 articles did not mention any theories related to peer guidance. Constructivism theory is the theory with the highest number associated by authors (e.g., Nawaz & Rehman, 2017). Constructivism is an understanding that students actively construct their own knowledge or concepts based on existing knowledge and experience. One article stated that the researcher focused on the interaction between students with mathematical communication and he created a framework based on the constructivism theory and the concept of 'Zone of Proximal Development' which was important in creating learning through peer tutoring (Yaman, 2019).

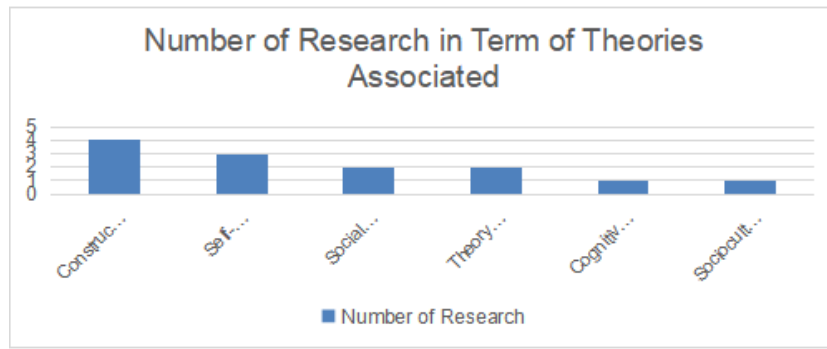


Figure 6. Theory used

Based on the conclusions, constructivism theory and self-concept theory were the two theories most widely associated with peer tutoring learning. Both theories provided a general idea of where knowledge will be constructed by the students themselves. Thus, it can be proven that peer guidance learning is related to the construction of knowledge by the students themselves.

Nevertheless, there are also articles linking peer tutoring learning to social theory, showing that although knowledge construction by students themselves occurs in peer tutoring learning, external involvement (in the case of this learning strategy, tutors) plays an important role as well.

Type of Research Methodology Implemented in Previous Studies

The sixth research question discussed the type of methodology used in the previous study to study the application of peer tutoring in Mathematics subject. Based on the research papers, five types of methods used by researchers were quantitative (n=13), mixed method (n=3), qualitative (n=2), descriptive and comparative design (n=1) and design-based research (n=1).

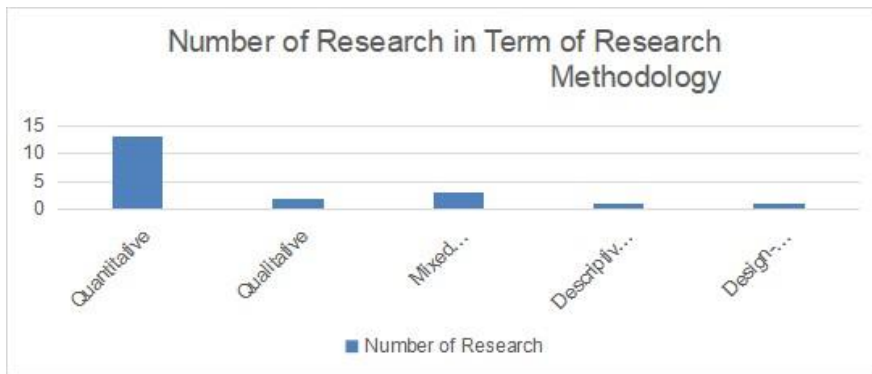


Figure 7. Research methodology

Type of Peer Tutoring Approach Implemented in Previous Studies

Two peer tutoring approaches were implemented in the previous studies: the same age approach and cross age approach (Figure 8). 14 research papers implemented the same-age approach (e.g., Thurston et al., 2020). Another 5 research papers implemented a cross-age tutoring (e.g., Chu et al., 2017) and another research (Song et al., 2018) did not mention the type of approach implemented in the study.

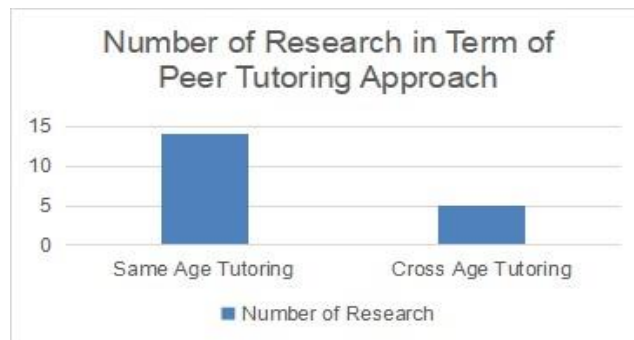


Figure 8. Types of peer tutoring approach

Discussion

The first research question focused on the distribution of publication years of the 20 academic papers studied, which focused on peer tutoring in mathematics education. From the findings, it was found that research on peer tutoring was consistent throughout the last four years (2017-2020). The number of academic papers published about peer tutoring in mathematics education published were six papers in 2019 and another six papers in 2020. Our observations are consistent with earlier findings by Greene et al. (2018) who noted that although peer tutoring has been shown to be an effective intervention for both academic, the studies on the subject are still inadequate. The fact that the number of researches on this topic was consistent showed that the issue of peer tutoring in mathematics education might not be a topic of interest for most researchers. Despite this, researchers should carry out more research regarding peer tutoring in mathematics education or Peer Assisted Learning Strategies (PALS) in mathematics education in the future, as it is a student-centred learning strategy which is much more prioritised in this 21st century.

For the second research question, attention had been given to the distribution of the publishing country of the academic papers. It was found that the majority of papers were published in 11 countries and among them, Spain was the country with the most published papers. The country which came at second was Indonesia and its researchers published many papers on peer tutoring in mathematics education. Spain and Indonesia had more papers published than other countries. This might be because the two countries had done research regarding peer tutoring in mathematics education, but the results were not unsatisfactory. For example, in an article published in Indonesia in 2017, the researcher stated that the outcome of mathematics education was undesirable. This is in line with the findings of Song et al. (2018) and Zeneli et al. (2018) which indicated the improvement of students' academic achievement in mathematics was not significant. It was stated that peer tutoring might be a way to overcome this predicament. As a result, the concept of peer tutoring was introduced, and research showed that the model of peer tutoring may improve the mathematics result of both the tutor and tutee.

The third research question discussed the type of sample used in the research on peer tutoring in mathematics education. The finding shows that the percentage of researchers which used secondary school students as the target population was the highest at 55.5% from the 19 studies (one of the academic papers did not mention the target population of the research). This study confirms past studies which indicated that peer tutoring was more prevalent among students in secondary schools (Alegre et al., 2019b). One of the reasons for such a condition might be that peer tutoring programmes in mathematics in secondary schools were easier to be conducted and the effectiveness of the programmes could be seen more easily. Additionally, the communication during peer tutoring among secondary school tutors and tutees was believed to be more effective. From previous research conducted in 2019 which focused on secondary school students, it was shown that tutees understood the topics and activities given better because they asked their peer tutor about what they should do without hesitation, and thus tutors could teach them straight away (Deshler et al., 2019).

Next, the research shows that most researchers focused on the effect of peer tutoring on academic achievement of the students. The effect of peer tutoring from all three aspects concerned were academic achievement, social ability, and cognitive ability of students (e.g., Ansuategui & Miravet, 2017). This indicated that academic achievement was regarded as the most important effect that should be investigated in research on the effectiveness of peer tutoring. The researcher stated that academic achievement was the effect most frequently investigated by researchers on the issue of peer tutoring, and it was the only investigated variable in most research (Alegre et al., 2019c). As an overview, most research showed that peer tutoring brought positive effect on both the tutor and tutee; however, attention must be given on the method of peer tutoring used. Overall, almost all the articles indicated that the effect was positive, which support previous work (Moliner & Alegre, 2020a; Ullah et al., 2018). Peer tutoring learning can be said to have a positive impact on students' academic achievement in mathematics and social skills. However, more research needs to be done to support the effectiveness of peer tutoring learning strategies in having a positive impact on students' cognitive skills in mathematics. There are also differences in a small number of articles.

The findings also showed the effect of peer tutoring from the aspect of social skills. The effect of peer tutoring on social skills was very significant. Similar output has been found in research conducted by Moliner and Alegre (2022). Researchers gave attention to the social skills of the students besides academic papers because in peer tutoring, both the tutor and tutee, regardless of same age tutoring or cross age tutoring, would need to communicate and interact with each other. Alegre et al. (2019c) stated that research on peer tutoring should not focus solely on its effect on academic achievement, but also other aspects, as peer tutoring was believed to be able to improve the ability of students in other aspects such as empathy, communication, and unity. From the academic papers studied in this systematic literature review, it was shown that the effect of peer tutoring in improving the social ability of students could be observed through the improvement of communication skills and the self-confidence of the students. In most cases, peer tutoring was carried out in a classroom where students were needed to work together in pairs or in groups. This meant that they would get to know each other better and indirectly this would boost their self-confidence and thus bring positive effects to both the tutors and tutees (Alegre et al., 2019a).

The theory applied most frequently in the academic papers studied was the constructivism theory, followed by self-concept theory, social dependency theory, theory of realistic mathematics approach and cognitive load theory. Meanwhile, eight of the academic papers did not mention clearly the theory applied in their research. These findings agree with earlier empirical research (Campbell, 2019; Oloyede et al., 2019). The constructivism theory was applied more frequently as it did bring significant effects in mathematics education (Lerman, 1989). Social dependency theory was applied as the interaction between the tutor and tutee brought effect to their mathematics achievement (Thurston et al., 2020). Meanwhile, the theory of realistic mathematics approach and cognitive load theory also brought significant positive effects to the academic achievement of students from inclusive classes (Putranto & Marsigit, 2018a) and problem-solving skills in mathematics (Phan et al., 2017).

A majority of the academic papers studied used the quantitative approach as the research methodology. Both qualitative approach and mixed-mode approaches were used in three papers each. On the other hand, the descriptive approach, comparison approach and design-based approach were only used in one paper each. To evaluate the academic achievement of students, the quantitative approach was more suitable (Hidayat et al., 2020) to be used while the affective elements were best evaluated using the qualitative approach. Some researchers used a mixed-mode approach as they were interested in the effect of peer tutoring on both the cognitive domain and the affective domain of the students (Deshler et al., 2019; Moliner & Alegre, 2020a). The other two research methods were less used as they required longer time and complicated evaluation from the researchers.

For the aspect of type of peer tutoring (same age tutoring or cross age tutoring), it was found that same age tutoring was done in 70% of the research, while cross age tutoring was conducted in 25% of the research. From previous meta-analysis (Ansategui & Miravet, 2017; Leung, 2015), the frequency of research on same age tutoring and cross age tutoring was not consistent. This was because there were research papers which showed that the difference in age between the tutor and tutee did not affect the result of the research. It is believed that same age tutoring was done more frequently because it was easier to be conducted in one single class and the students knew each other well. As a contrast, tutors and tutees needed more time to get to know and connect with each other in cross age tutoring. However, there was a difference between same-aged tutors and cross-aged tutors. Tutors who were older than tutees tended to have higher achievement, skills, and better attributes than tutors who were of the same age as tutees.

Conclusion

This study adds to the body of knowledge by demonstrating earlier research on 'cross-age and same age peer tutoring' in mathematics education settings from the academic, social, and cognitive perspectives. Peer tutoring learning method is not a new form of learning, but it is a learning strategy that leads to the 21st century way of learning. This kind of learning strategies is important in improving students' academic performance, sharpening social skills, and helping them in terms of students' cognitive development. The learning environment through peer tutoring also makes students active in learning as they are more comfortable to communicate and free to give their own opinions. In addition, through this peer tutoring strategy, tutors and tutees can determine for themselves what they want to learn, their freedom to set their own goals, determine the time allocation required and choose the appropriate method for their learning strategies. Teachers also need to constantly monitor the progress of students and guide tutors to ensure that they can get the same benefits in the future.

Recommendation

Through the study of articles conducted, it was found that there were two types of peer tutoring conducted, namely peers of cross ages and peers of same age. These two types of relationships did not show clear differences in outcomes for peer tutoring learning through the articles that were reviewed. Thus, a proposed new issue that can be conducted for future studies is to examine the effectiveness of peer tutoring learning between two types of relationships namely peers of different ages with peers of the same age. It may be possible to see the effectiveness better in the peer tutoring conducted. The results of the study found that most of the effects of learning through peer tutoring in the subject of mathematics on students' cognitive skills showed no significant effect. In addition, the personality and behaviour of tutors during peer tutoring learning were also given less emphasis through previous studies. Therefore, a proposed new issue for future studies is to examine further the impact on students' cognitive skills through peer tutoring learning. Since cognitive skills need to be emphasized in mathematics learning, it is possible that this peer tutoring can hone students' cognitive skills. As such, future researchers need to be more involved in cognitive effects in their studies to see and make connections to their academic achievement.

Further research is needed to measure the level of effectiveness of peer coaching among these students in a broader sample scale due to lack of random sample selection, allocation of random participants, short duration, weak instruments, and many other elements needed to measure the impact of stronger research (Zeneli et al., 2018). Some study results stated that mathematics achievement for tutors increased while the tutee achievement was not significant (Song et al., 2018). Exploration of new strategies to encourage students to use higher levels of mathematical reasoning skills under peer tutoring should be linked in future studies. Thus, future studies on this issue suggest that the use of quality teaching aids as well as the personality of tutors need to be further studied. The language used by tutors and

tutees also needs to be investigated in advance to ensure a mutually beneficial naturalistic learning environment among peers. For future research on this peer tutoring learning method, researchers need to emphasize the results of peer tutoring from the aspect of students' cognitive skills as this peer tutoring leading to discussion and communication between peers is often conducted. It is hoped that through this peer tutoring strategy, it will also be able to attract students' interest in learning mathematics.

Limitation

A handful of peer tutoring studies in the mathematics subject found that the results of the study did not yield encouraging results. This is because some of the articles we explored had a limited sample distribution compared to other studies. The time frames are restricted to only five years for the review. When considerably new data is available, a most recent article is appropriate and valuable. It's possible that our analysis of data left out a number of items about which we are ignorant. A further restriction is connected to the key word utilized. Peer tutoring is a search term we use to locate articles. As a result, there might not be an article that serves as a reference for a thorough literature evaluation on peer tutoring in mathematics education.

Authorship Contribution Statement

Hidayat: Conceptualization, analysis, writing, securing funding. Nasir: Editing/reviewing, supervision, securing funding. Fadzli: Analysis, design. Rusli: Editing/reviewing, writing. Kamaruzzaman: Editing/reviewing. Sheng: Analysis, writing. Mohammad: Designs, writing. Shukeri: Editing, writing

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