INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN PROGRESSIVE EDUCATION & DEVELOPMENT

OPEN ACCESS JOURNAL

Vol 12, Issue 1, (2023) E-ISSN: 2226-6348

Implications Trends of Peer Learning in the STEM Teaching and Learning Process: A Systematic Literature Review (SLR)

Sharifah Intan Natalia binti Syed Abdul Bahari, Mohd Effendi @ Ewan Mohd Matore

Faculty of Education, National University of Malaysia, Selangor, Malaysia

Email: P112294@siswa.ukm.edu.my, effendi@ukm.edu.my

To Link this Article: http://dx.doi.org/10.6007/IJARPED/v12-i1/15664 DOI:10.6007/IJARPED/v12-i1/15664

Published Online: 17 January 2023

Abstract

Peer learning is a student-based learning process, where students help other students in their learning process. This self-study study is important to help students improve their understanding, especially in the context of STEM (Science, Technology, Engineering and Mathematics). Unfortunately, studies related to the implications of peer learning trends are not discussed much, especially in the context of STEM despite having many advantages. Thus, this study aims to analyze the trend of peer learning implications that are most often used through the highlights of previous studies and further develop a conceptual framework in the STEM teaching and learning process. Two databases namely SCOPUS and WOS were used in the screening of articles using Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) which includes selection criteria, search strategy, data collection, selection process and data analysis for the articles obtained. This study uses systematic literature highlights (SLR) in producing a trend analysis of the implications of peer learning among students. SLR survey through the analysis of publication year trends, study country trends and related variable trends through the main phase which is planning, analyzing and reporting are phases in the SLR method. Findings show that the number of studies is increasing starting in 2018 until 2022. This shows that peer learning among students is increasingly considered important to be used as a variable in a study. The trend of country analysis shows that Finland is the country that conducts the most research on the implications of peer learning followed by Turkey and France. A total of 30 articles were identified in this 5-year period through the set criteria. The findings of the study show that the most dominant implication trend in peer learning is increased student involvement followed by improved communication skills and accelerated learning. The conceptual framework formed involves three main elements in this trend of implications, namely increasing student engagement, improving communication skills and accelerating learning. The idea behind this study is to improve the quality of teaching and learning in schools so that it can have a more positive effect in the effort to produce excellent students. Therefore, further research developed in the future is very necessary to examine whether the other two implication trends, namely building networks and gaining new perspectives can be included in the conceptual framework developed. Apart from that,

further research can also be carried out to expand the concept of peer learning to other institutional contexts other than just focusing on schools and a review can be done on the definition of peer learning.
Keywords: Implications, Peer Learning, Increased Student Engagement, Improved Communication Skills, Accelerated Learning.

Introduction

Peer learning is defined as a student-based learning process, which makes students as 'young teachers' who are able to encourage other students, i.e. their peers, to learn together and achieve high academic achievement (Winarno, 1994). According to Sharifah (1983), peers play a role in influencing students' academic achievement.

Peer learning is one of the strategies found in the concept of self-learning that is increasingly practiced during the teaching and learning process at school, which uses the concept of cooperation. Austin (2000), explained that, collaboration has become a trend in the 21st century and is a need in society to think in critical issues. Collaboration can also shift the emphasis from individual efforts to group work to achieve something (Leonard & Leonard, 2001). Peer learning is also a transition or a method that changes from typical teacher-centered or lecture-centered teaching in classrooms to student-centered teaching that is students with students, and students with learning materials.

Since there are not many studies related to the trend of peer learning implications that are discussed in the STEM context, this SLR was conducted with the aim of analysing articles related to the trend of peer learning implications that are most often used by researchers and by using the findings, a conceptual framework was developed based on the analysis conducted. This study is important to carry out so that it can be used as a reference and guide for teachers and researchers regarding the trend of peer learning implications in teaching and learning. The findings of this study can be used as a reference and guide for teachers and researchers regarding the implications of peer learning in teaching and learning.

Research Objective

The systematic review that was carried out achieved the objectives of the study that have been set as follows:

1) Identify research trends in studying the implications of peer learning in the STEM teaching and learning process such as year of publication, country of study, study design and study sample.
2) Studying the trend of peer learning implications in the STEM teaching and learning process that is most often used by researchers through the highlights of past studies.
3) Examining the trend of peer learning implications in the STEM teaching and learning process which is not the choice of past researchers can be used as an option to be carried out in future studies.

Methodology

Systematic Literature Highlights or Systematic Literature Review (SLR) is a study that requires the formation of clear research questions by using systematic and explicit methods in identifying, selecting, evaluating, collecting and analyzing data from relevant past studies (Moher et al., 2009). The study also used the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) flow diagram, which is a checklist used to increase transparency

in systematic reviews. This article covers all aspects of the manuscript, including title, abstract, introduction, methods, results, discussion, and funding. A systematic review report should state the focus of the review and provide a description of the processes used during the search, critical appraisal, data abstraction and data synthesis phases of the review. The focus of the review is provided through the description of review questions and inclusion criteria. This PRISMA diagram includes four stages, namely identification, screening, eligibility stage and the stage of including articles in the SLR study conducted (Liberati et al., 2009). With that, the SLR study carried out includes search strategy, selection criteria, selection process, data collection and data analysis for the articles obtained.

Article Search Strategy

Leading databases namely SCOPUS and WOS were used in article searches for SLR conducted. The keywords "peer learning", "peer learning approach", "teaching and learning", "teaching" and "learning" were used to find articles related to peer learning in education. Based on the keywords, the articles displayed on the database are related to the implications of peer learning in the STEM teaching and learning process.

Article Selection Criteria

In order to obtain articles that meet the study criteria, the selection of articles has been determined in terms of the year of publication, language, type of reference material and the field of study of the article as shown in Table 1, which is the criteria for acceptance and rejection of articles. The criteria for the year of publication is within the latest five years, which is from 2018 to 2022. The selection of articles is limited to five years because within five years is the period when the search topic is still hotly discussed and includes the latest issues. Next, all the articles included in this study are articles in English from the selected database. The selected articles are in English because the selected database only publishes articles in English. Meanwhile, the research conducted only uses journal articles and excludes proceedings, conferences, books, research highlights in the selection of reference materials. This is because journal articles are reference materials that have complete and detailed reporting.

Table 1
Article Acceptance and Rejection Criteria

Criteria	**Acceptance**	**Rejection**
Year of Publication	Publication from 2018 to 2022.	Publication before 2018.
Language	English	Malay, Indonesian and other languages.
Types of Reference Materials	Journal article	Theses,proceedings, conferences and books.
Areas of Journal Article Study	In the field of Mathematics and STEM.	Apart from Mathematics and STEM fields.

Article Selection Process

The article selection process for literature highlights was conducted in March 2022. Figure 1 shows the flow diagram of the article selection process adapted from the PRISMA flow

diagram (Tawfik et al., 2019). This study uses articles identified from two databases that are used are 4132 articles. After that, the articles are screened using predetermined criteria before being entered into the qualification stage for more thorough and detailed filtering.
Next, based on the attached article selection process flow diagram, there are four additional criteria for the exclusion of articles before being included in the SLR study conducted. The first is an article that does not have the full text, the second is an article title that does not fit the context of the study, the third is the same article from two databases and the fourth is an article that does not meet the acceptance criteria for the study such as articles that do not have empirical data and are in the form of comments. excluded.
Whereas, for the additional acceptance criteria, the first is an article that has a full text, the second is an article title that fits the context of the study, the third is an article that is researched according to the appropriateness of the study context and no duplication and finally is an article that meets the study acceptance criteria such as an article that have empirical data and not in the form of reviews. Thus, after screening and researching the articles that have been downloaded, there are 30 articles that meet all the selection criteria that have been set and will be included in the SLR study that is being conducted.

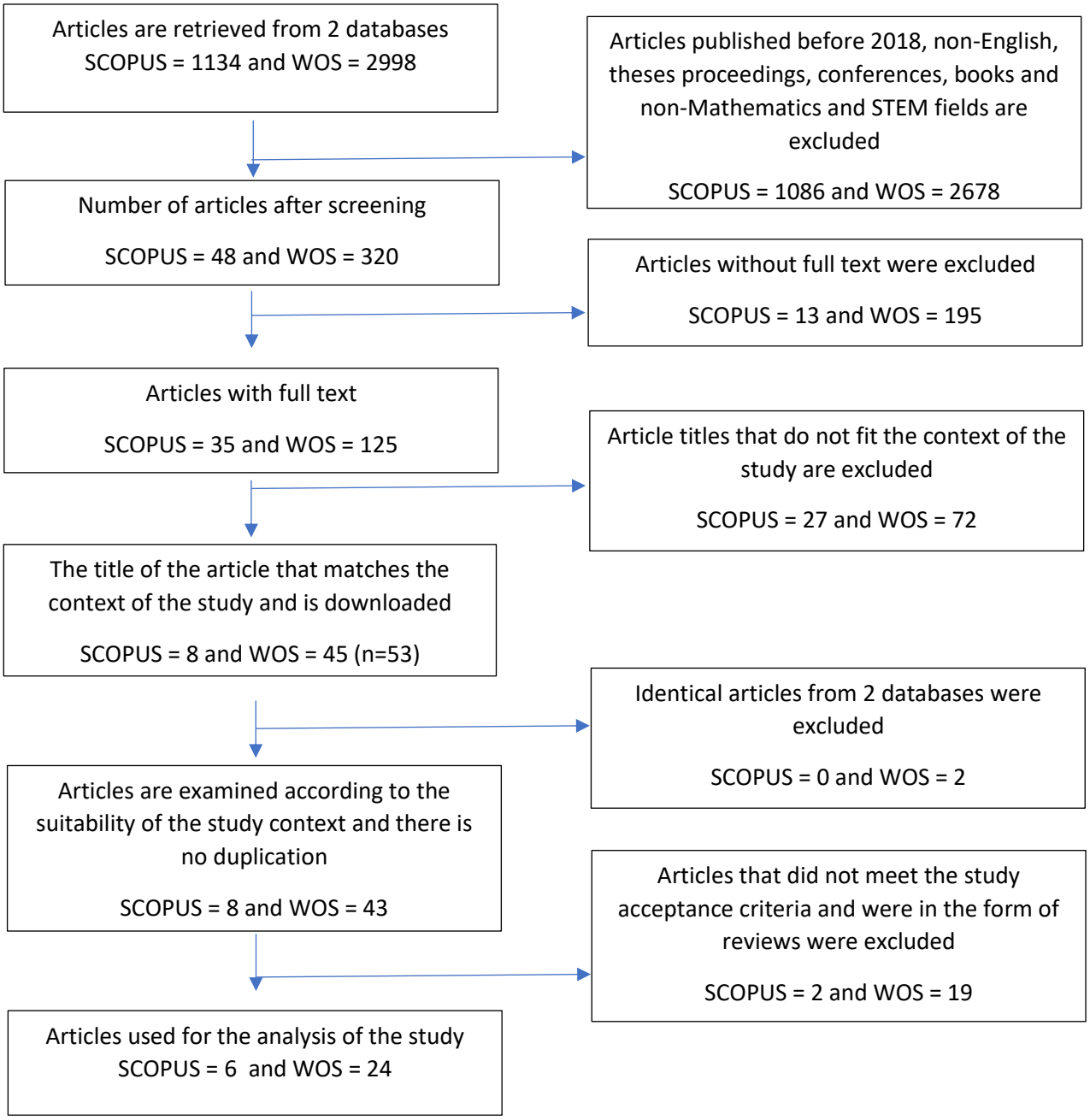

Figure 1: Picture of Article Selection Process Flow Diagram

Data Collection and Data Analysis

Data collection was carried out using 30 articles obtained from two leading databases namely SCOPUS and WOS. Data was collected by extracting the title, author's name, year, purpose of study and type of STEM approach for each past research article into a table built using Microsoft Excel 2016 software. Data analysis was carried out using the table that had been built and categorizing the implications of peer learning by each article. Furthermore, the results of the data analysis carried out will be presented in the form of tables and bar graphs. Table 2 shows the list of previous research articles along with the name and country of the author used in the research conducted. All the selected articles are based on the acceptance and rejection criteria that have been set.

After that, the SLR study conducted was also used to develop a conceptual framework based on previous studies (Kumar, 2012). Based on the data analysis of the SLR study conducted, the most frequent implications of peer learning will be used to form a conceptual framework for this approach. The conceptual framework that was built can be used as a reference and contribute to the literature section of the study in the future.

Table 2
List of Past Research Articles

NO	AUTHOR'S NAME	AUTHOR'S COUNTRY	RESEARCH TOPIC
1.	Gripay et al (2022)	Perancis	Benefits of semiology taught using near-peer tutoring are sustainable
2.	Abal Abas et al (2022)	Malaysia	Modelling Physical Interaction and Understanding Peer Group Learning Dynamics: Graph Analytics Approach Perspective
3.	Oikarinen et al (2022)	Finland	Students' collaboration in technology-enhanced reciprocal peer tutoring as an approach towards learning mathematics
4.	Correge & Michinov (2021)	Perancis	Group Size and Peer Learning: Peer Discussions in Different Group Size Influence Learning in a Biology Exercise Performed on a Tablet With Stylus
5.	Thurston (2021)	China United Kingdom	Assessing the Differential Effects of Peer Tutoring for Tutors and Tutees
6.	Tenhovirta et al (2021)	Finland	Cross-age peer tutoring in a technology-enhanced STEAM project at a lower secondary school
7.	Ben-Dor & Heyd-Metzuyanim (2021)	Israel	Standing on each other's shoulders: A case of coalescence between geometric discourses in peer interaction
8.	Sanchez-Aguilar (2021)	Mexico	Tutors' and Tutees' Behaviors, Attitudes, and Perspectives Regarding EFL Peer Tutoring in Higher Education in Mexico
9.	Olulowo et al (2020)	Nigeria	Using Peer Tutoring to Improve Students' Academic Achievement in Financial Accounting Concepts
10.	Arco-Tirado et al (2020)	Sepanyol	Evidence-based peer-tutoring program to improve students' performance at the university
11.	El-Senousy (2020)	Egypt	How peer assessment could be interactive and effective
12.	Alemu (2020)	Ethiopia	Improving secondary school students physics achievement using reciprocal peer tutoring: A multi-level quasi-experimental study
13.	Liu (2020)	Taiwan	Dialogue-based peer learning of educational topics in a university classroom
14.	Spangenberg & Roberts (2020)	Afrika	Peer tutors' views on their role in motivating learners to learn mathematics

15.	Nshimiyimana & Cartledge (2020)	Afrika	Peer-teaching at the University of Rwanda - a qualitative study based on self-determination theory
16.	Räisänen et al (2020)	Finland	Study-related exhaustion: First-year students' use of self-regulation of learning and peer learning and perceived value of peer support
17.	Rahman et al (2020)	Malaysia	The effect of peer tutoring on the process of learning mathematical proofs
18.	BB Yaman (2019)	Turkey	A multiple case study: What happens in peer tutoring of calculus studies?
19.	Lairamore et al (2019)	Amerika Syarikat	A Peer-Led Interprofessional Simulation Experience Improves Perceptions of Teamwork
20.	Snow et al (2019)	United Kingdom, New Zealand	A discursive question: Supporting student-authored multiple choice questions through peer-learning software in non-STEMM disciplines
21.	Hossain & Sormunen (2019)	Finland	Does informal peer learning stimulate acquisition and development of ICT skills?
22.	Barnard et al (2019)	London UK	Enhancing skills of academic researchers: The development of a participatory threefold peer learning model
23.	Howard (2019)	Turkey	In-Training Advising Sessions for New Peer Advisors: Impacts and Benefits
24.	Alegre et al (2019)	Sepanyol	Peer tutoring in algebra: A study in Middle school
25.	Bell & Lygo-Baker (2019)	United Kingdom	Student-centred learning: a small-scale study of a peer-learning experience in undergraduate translation classes
26.	Matinde (2019)	Afrika	Students' Perceptions on Reciprocal Peer Tutorial Assessment in an Undergraduate Course in Process Metallurgy
27.	Chiu & Hew (2018)	Hong Kong	Factors influencing peer learning and performance in MOOC asynchronous online discussion forum
28.	Ansuategui et al (2018)	Sepanyol	Peer tutoring and academic achievement in mathematics: A meta-analysis
29.	Thurlings & den Brok (2018)	Belanda	Student teachers' and in-service teachers' peer learning: a realist synthesis
30.	Pouezevara et al (2018)	Indonesia	Using Activity Theory to Understand Teacher Peer Learning in Indonesia

Findings and Discussion

First Objective Findings

The main objective of the Systematic Literature Highlight or Systematic Literature Review (SLR) study conducted is to identify research trends in studying the implications of peer learning in the STEM teaching and learning process such as year of publication, country of study, study design and study sample. In addition, this study also developed a conceptual framework. Research results from previous research articles, there are 30 articles that meet

all the criteria that have been set. The selected articles used in this study are studies carried out by the researcher in the last 5 years, which is the study from 2018 until 2022. This is because the study of this trend in the STEM teaching and learning process is always done every year. The trend of peer learning implications focuses on students by creating a meaningful and enjoyable learning experience. Peer learning has several benefits to the world of education, such as developing feedback loops, communication skills, professional development, teamwork, making orientation more efficient and building a stronger self-learning culture.

Country Trends Study

Table 2 shows all the countries involved in the study on the implications of peer learning in the STEM teaching and learning process. Overall, 20 countries have conducted studies on this trend, namely Finland and the United Kingdom recording the highest number of 4 studies, Spain and Africa (3 studies) and Turkey, France and Malaysia (2 studies). While other countries such as China, New Zealand, the United States, Israel, Mexico, Nigeria, Egypt, Ethiopia, Taiwan, Hong Kong, the Netherlands and Indonesia each have only 1 study.

Finland and the United Kingdom are the countries that do the most research on the trend of peer learning implications in the STEM teaching and learning process over the last five years, but on average they only do 1 study per year. Researchers from Spain and Africa are the second most countries that do research in this trend. The country also has an average of 1 study per year. in the production of research articles on this trend.

Other countries such as France, Malaysia and Finland conducted a study on the trend of peer learning implications in the STEM teaching and learning process in 2022. These countries did not conduct a study on the variable in 2018. While other countries such as Indonesia and Hong Kong (2018) do not do this study consistently every year.

The results of the research conducted found that all previous research articles are divided into six implications of peer learning that have been used in the PdPc process. Table 3 shows a list of past research articles according to the identified implications of peer learning. Of the six categories of approaches, increasing engagement is the implication that has the most dominant number of references followed by improving communication skills and accelerating learning.

Study Year Trends

Table 2 also shows the trend of the study year regarding the trend of peer learning implications in the STEM teaching and learning process. The most recent five-year period, including 2022 up to June, has been taken into account. There are nine research articles on the trend of peer learning implications in the STEM teaching and learning process that were published in 2019 and 2020 respectively and these two years are the years in which the most research is done. In 2022, 2021 and 2018, respectively, there are three, five and four articles that tell about the research on the implications of peer learning in the STEM teaching and learning process.

This trend shows that the implications of peer learning in the STEM teaching and learning process are becoming more popular and proven through the increasing number of published articles about it every year. Academic researchers are beginning to realize that the peer

learning implication trend has high potential in catalyzing student success in the STEM teaching and learning process.

Findings of the Second Objective

The second objective of this study is to examine the trend of peer learning implications in the STEM teaching and learning process that is most often used by researchers through the highlights of past studies. There are three implication trends identified as the most frequently used which are (a) increasing engagement, (b) improving communication skills and (c) accelerating learning.

Increase Engagement

Student involvement is seen to increase more than self-study. Students are more active and braver to try to answer the questions presented when working together with friends. The findings of the study show that peer learning can increase student engagement, having the most dominant number of references. A total of 13 articles from previous studies such as the study from Oikarinen et al (2022); Rahman et al (2020) stated increased student engagement as the main implication of peer learning. Meanwhile, there are also several articles that link the two implications of peer learning, which is increased student engagement with increased communication. In fact, there are also articles that link the three implications in one study.

Improve Communication Skills

With effective communication, a lot of time can be saved. An active listener that is a good listener is very important so that the information that is delivered and received well will be able to be applied in oneself without leakage occurring. If this does not happen, the communication is said to not be going well and the impact of the communication is not achieving the original purpose and is hindered because the party receiving the information does not pay attention and listen well. this will cause the information obtained to be less clear and misinterpretation of information will occur. The cooperating parties need to choose the type of questions they want to ask because asking questions that are liked and liked by the other party will make the ongoing communication more interesting and the discussion will be more meaningful as both parties who are communicating will understand the information given. and accepted by both sides. There are 11 past research articles that involve improving communication skills.

Accelerate Learning

Building mathematical knowledge together in the classroom will speed up the learning process. Understanding of a lesson content also becomes easy and smooth. Students organize mathematical knowledge together and connect in the construction of social influence. Engle (2014) explains that the discursive mechanism can be better expressed in the interaction component during collaborative mathematics learning activities.

Findings of the Third Objective

The third objective of this study is to examine the trend of peer learning implications in the STEM teaching and learning process which is less of a choice for past researchers and can then be used as a choice for future studies. The two impactful trends are building networks and gaining new perspectives.

Build Networks and Gain New Perspectives

Apart from the three implications of peer learning mentioned above, which are often the focus of researchers in previous studies, there are two more implications that are also studied by researchers but are not the main focus. The implication is to build networks and gain new perspectives.

Table 3

List of Articles According to the Implications of Peer - Learning Trends in the STEM teaching and learning process

No	Name of the Author	The Implications of Peer - Learning Trends in the STEM Teaching and Learning Process				
		Building Networks	Increase Engagement	Improve Communication Skills	Accelerate Learning	Gaining a New Perspective
1.	Oikarinen et al (2022)	*	*			
2.	Gripay et al (2022)			*		*
3.	Abas et al (2022)			*		
4.	Corrégé & Michinov (2021)		*			
5.	Thurston (2021)				*	
6.	Tenhovirta et al (2021)			*		*
7.	Ben-Dor & Heyd-Metzuyanim (2021)			*		
8.	Sanchez-Aguilar (2021)		*			
9.	Olulowo et al (2020)			*		
10.	El-Senousy (2020)			*		
11.	Liu (2020)				*	
12.	Arco-Tirado et al (2020)				*	
13.	Spangenberg & Roberts (2020)			*		*
14.	Rahman et al (2020)		*	*	*	
15.	Räisänen et al (2020)	*				

16.	Nshimiyimana & Cartledge (2020)		*			
17.	Alemu (2020)				*	
18.	Snow et al (2019)	*	*	*		
19.	Yaman (2019)	*		*		
20.	Lairamore et al (2019)		*	*	*	
21.	Hossain & Sormunen (2019)		*			
22.	Barnard et al (2019)		*			
23.	Howard (2019)		*			
24.	Alegre et al (2019)		*			
25.	Bell & Lygo-Baker (2019)		*			
26.	Matinde (2019)				*	*
27.	Chiu & Hew (2018)		*			
28.	Alegre Ansuátegui et al (2018)				*	
29.	Thurlings & den Brok (2018)				*	
30.	Pouezevara et al (2018)				*	
Jumlah artikel Trend Implikasi Peer Learning		4	13	11	10	4

Conceptual Framework

The types of peer learning implications found from past research articles are to increase engagement, improve communication skills, accelerate learning, build networks and gain new perspectives. The results of the study found that there are five types of peer learning implications that have been identified. First of all is to increase involvement which is the implication of peer learning that is most often used by researchers, as many as 13 articles equal to 33%. Meanwhile, improving communication skills has 11 articles equal to 28%, followed by accelerating learning has 10 articles (25%), gaining a new perspective and building a network each has only 4 articles (10%).

The SLR study conducted was also used to develop a conceptual framework based on the implications of peer learning. Figure 2 shows the conceptual framework that has been developed through the results of the analysis of the SLR study conducted.

Figure 2: Conceptual Framework Implications of Peer Learning

For the discussion section, the findings of the SLR study show that increased student involvement in the PDPC process is often used by researchers as the main implication of peer learning. This point is in line with some studies by past researchers such as (Hossain & Sormunen, 2019; Barnard et al., 2019; Arco-Tirado et al., 2020; Chiu & Hew, 2018; Corrégé & Michinov, 2021). Snow et al (2019) explained that peer learning encourages student involvement in completing assignments is higher and obtains deeper learning than just answering questions and allows students to compose, evaluate and comment on questions and answers with friends. Peer learning increases enthusiasm, self-efficacy and readiness among students in addition to improving leadership skills (Lairamore et al., 2019). Students showed an increase in positive perceptions of teamwork and collaborative practices. In addition, peer learning increases the level of positive attitudes as well as the values and beliefs of students regarding collaboration between professionals. Encouraging involvement is an implication of peer learning that is found to have the most impact in the teaching and learning process.

Based on the study of Spangenberg & Roberts (2020), many students were found to be unmotivated to learn Mathematics due to lack of attention, feeling that Mathematics is not relevant to learn as well as low self-confidence and often feel dissatisfied. However, peer learning is able to provide opportunities for students to engage with other individuals and can encourage them to become more attentive to the tasks carried out at their own pace in this one-on-one relationship.
The results of a study conducted by Ben-Dor & Heyd-Metzuyanim (2021) show the shift in ability during peer interaction. During problem-solving activities, students move from configural procedures to deductive procedures. The study of Rahman et al (2020) stated that

peer learning improves students' ability to create mathematical proofs and understand conceptual mathematics.

A study conducted by Thurston et al (2021) found that there is strong evidence that peer learning, as a form of cooperative learning, has a positive effect on tutor and tutee outcomes. The advantage was greater and more pronounced on the comprehension test. Peer learning accelerates learning compared to normal teaching methods. Yaman (2019) reported that, students who regularly meet and study together will investigate the mentoring nature of other friends and this is an element in building a network.
The relationship between one partner and another will create a larger network. Peer learning which is a method of learning with friends, that is, friends who are skilled give guidance to students who are less skilled. This sharing of knowledge in pairs indirectly encourages interaction between students and active learning will take place and then be able to strengthen their own learning by teaching others. Furthermore, when students share the same discourse or reference source, understanding will be clearer. This matter is seen as building a network during the teaching and learning process. In previous studies it was also stated that gaining a new perspective is also an implication of peer learning.
Based on the previous studies reviewed, the implications of peer learning address student achievement gaps. The study of Oikarinen et al (2022) is an example of a study that gives special emphasis to this writing. A study conducted by Matinde (2019) stated that peer learning plays an important role in the teaching and learning of engineering science. However, its effectiveness as a platform to provide personal and academic support is continuously challenged by other factors, but this study uses peer learning peer assessment as a specific teaching strategy. Peer learning can highlight the delicate balance between the obvious benefits of this study.

In addition, referring to Figure 3, the conceptual framework that has been developed involves increasing engagement, improving communication skills and accelerating learning except building networks and gaining new perspectives. The exclusion of these two implications in the conceptual framework developed is due to the fact that both are only discussed in 3 articles and are only cursory and not studied in depth. This point shows that this implication is less discussed and has less impact in the learning process by peer learning. Nevertheless, revision and research should be done on the part of the conceptual framework that is built for future studies.

Limitations of the Study

The study conducted has several limitations. The first limitation, the Systematic Literature Highlight or Systematic Literature Review (SLR) study was conducted using only two databases namely SCOPUS and WOS. It is possible that there are still articles with the specified selection criteria existing in other databases.

The second limitation is the use of a data set or a small number of articles, causing some articles not to be included in the SLR study conducted. This happens when there is the same type of peer learning but labeled using different names or keywords.
The third limitation is the selection criteria of articles involving full text. By entering full text criteria for the searched article means articles that do not have full text will be excluded. Articles that do not have full text are articles that require the researcher to purchase the

article from the database used. The limitation of the selection criteria for full-text articles caused a few articles related to SLR studies that were conducted to be excluded because the researcher did not have the full text or a complete text to refer to and analyse.

The fourth limitation is the conceptual framework of the proposal developed based on the SLR study is a contribution that can be used as a reference only but not as a guideline in the teaching and learning process. Therefore, the research that will be conducted requires a sufficient number of researchers, reference materials, infrastructure and finance.

Conclusion

The results of the analysis conducted show that increasing engagement has the most dominant number of references followed by improving communication skills and accelerating learning. However, building networks and gaining new perspectives were excluded from the conceptual framework as there were only four articles in the previous study. Both implications cannot be denied through the number of articles. This may be due to both being included in different categories. This SLR study conducted can be improved so that the research findings obtained are more accurate and detailed. Empirical studies need to be conducted to confirm the validity of the conceptual framework formed by using experimental methods to compare the three implications of peer learning that are often used by previous researchers. Furthermore, systematic research and examination needs to be conducted to examine whether the learning community or there are other implications that are not explored through the SLR study conducted. This is because if there are other implications, the conceptual framework developed needs to be changed and refined, based on the latest research findings. With that, based on the improvements carried out, the results of the study in the future will be more robust. Therefore, in future studies, researchers need to use more general keywords to include all categories of articles related to the study to be conducted.

Educational theory is a set of principles and knowledge to explain different phenomena, which occur in the teaching and learning process. Educational theory is very important to make predictions, guide students, prevent problematic situations, and then correct those problems. So with this, it can be concluded that theories can explain how learning occurs and how knowledge emerges and can develop various assumptions that are important to be used as support in research on aspects related to education.

Peers can be a positive influence because most of their time is spent at school together. Positive peers will always be active in beneficial activities in their free time. In addition, peers are also among the individuals who are able to help and influence a student to achieve success. One of the main reasons is because these people have the same level of thinking because they are the same age. This means, if they understand a subject, especially a subject in the STEM field, it is easy for them to convey that information to their friends compared to a presentation from a teacher.

Peer learning is one of the strategies found in the concept of self-learning. In general, self-directed learning is defined as a student-centered learning process. Peer learning strategies have a positive effect on a student's achievement and at the same time can increase intrinsic learning motivation. This learning strategy can eliminate the negative nature in the mind of students. When students often study together, there will be comfort among them because

the students are in the same age range. In addition, the feeling of embarrassment or fear of being laughed at by other friends can be minimized. The feeling of wanting to help fellow students will cause students to become closer. The opportunity to learn together with peers does not stop only in the classroom as they are often seen together with friends outside of school hours. This situation will encourage students to learn continuously especially in the STEM teaching and learning process. More interest and understanding will be obtained by students because they will continue to study with their peers anytime and anywhere.

References

Abas, A. Z., Norizan, M. N., Abidin, Z. Z., Abdul Rahman, A. F. N., Rahmalan, H., Tharbe, A. I. H., & Sobri, A. S. (2022). Modeling Physical Interaction and Understanding Peer Group Learning Dynamics: Graph Analytics Approach Perspective. *Mathematics*, *10*(9), 1430.

Ansuategui, A. F. J., Miravet, M. L., Lorenzo, G., & Maroto, A. (2018). Peer tutoring and academic achievement in mathematics: A meta-analysis. *EURASIA Journal of Mathematics, Science and Technology Education*, 2018 Volume 14 Issue 1, pp. 337-354

Alegre, F., Moliner, L., Maroto, A., & Lorenzo-Valentin, G. (2019). Peer tutoring in algebra: A study in Middle school. *The Journal of Educational Research*, *112*(6), 693-699.

Alemu, M. (2020). Improving secondary school students physics achievement using reciprocal peer tutoring: A multi-level quasi-experimental study. *EURASIA Journal of Mathematics, Science and Technology Education*, *16*(4), em1832.

Arco-Tirado, J. L., Fernandez-Martin, F. D., & Hervas-Torres, M. (2020). Evidence-based peer-tutoring program to improve students' performance at the university. *Studies in Higher Education*, *45*(11), 2190-2202.

Barnard, S., Mallaband, B., & Leder Mackley, K. (2019). Enhancing skills of academic researchers:The development of a participatory threefold peer learning model. *Innovations in Education and Teaching International*, *56*(2), 173-183.

Bell, L., & Lygo-Baker, S. (2019). Student-centred learning: a small-scale study of a peer-learning experience in undergraduate translation classes. *The Language Learning Journal*, *47*(3), 299-312.

Ben-Dor, N., & Heyd-Metzuyanim, E. (2021). Standing on each other's shoulders: A case of coalescence between geometric discourses in peer interaction. *The Journal of Mathematical Behavior*, *64*, 100900.

Chiu, T. K., & Hew, T. K. (2018). Factors influencing peer learning and performance in MOOC asynchronous online discussion forum. *Australasian Journal of Educational Technology*, *34*(4).

Correge, J. B., & Michinov, N. (2021). Group Size and Peer Learning: Peer Discussions in Different Group Size Influence Learning in a Biology Exercise Performed on a Tablet with Stylus. In *Frontiers in Education* (Vol. 6, p. 733663).

El-Senousy, H. (2020). How peer assessment could be interactive and effective. *South African Journal of Education*, *40*(2), 1-14.

Febra, N. F., Zulkefly, N. R., Sofian, M. I., & Hasif, M. H. (2022). STEM Achievement in the Middle Smart and Talented Pupils Through Peer Interaction and Learning Strategies. E-Proceeding Insan Junior Researchers International Conference 2021(iJURECON 2021). https://oarep.usim.edu.my/jspui/handle/123456789/15676

Gripay, B., André, T., De Laval, M., Peneau, B., Secourgeon, A., Lerolle, N., & Biere, L. (2022). Benefits of semiology taught using near-peer tutoring are sustainable. *BMC medical education*, *22*(1), 1-7.

Hossain, M. A., & Sormunen, E. (2019). Does informal peer learning stimulate acquisition and development of ICT skills?. *Education for Information*, *35*(2), 129-148.

Howard, S. L. (2019). In-Training advising sessions for new peer advisors: Impacts and benefits. *Studies in Self-Access Learning Journal, 10(*2), 156-164.

Kamal, N. M. M., Hussin, Z., & Sulaiman, A. M. (2022). Heutagogic Approach: Student Perception Towards Peer Assessment. *International Journal of Education and Pedagogy*, *4*(1), 114-129.

Lairamore, C., Reed, C. C., Damon, Z., Rowe, V., Baker, J., Griffith, K., & VanHoose, L. (2019). A peer-led interprofessional simulation experience improves perceptions of teamwork. *Clinical Simulation in Nursing*, *34*, 22-29.

Liu, S. H. (2020). Dialogue-based peer learning of educational topics in a university classroom. *Learning and Teaching*, *13*(2), 41-61.

Matinde, E. (2019). Students' perceptions on reciprocal peer tutorial assessment in an undergraduate course in process metallurgy. *Education Sciences*, *9*(1), 27.

Mumen, N. A., & Khairuddin, K. F. (2022). The Importance of Peer Support Systems Against Social Aspects of Special Education Pupils Learning in Inclusive Classes. *Malaysian Journal of Social Sciences and Humanities (MJSSH)*, *7*(6), e001583.

Nshimiyimana, A., & Cartledge, P. T. (2020). Peer-teaching at the University of Rwanda-a qualitative study based on self-determination theory. *BMC medical education*, *20*(1), 1-12.

Oikarinen, R. M., Oikarinen, J. K., Havu-Nuutinen, S., & Pöntinen, S. (2022). Students' collaboration in technology-enhanced reciprocal peer tutoring as an approach towards learning mathematics. *Education and Information Technologies*, 1-30.

Olulowo, T. G., Ige, O. A., & Ugwoke, E. O. (2020). Using peer tutoring to improve students' academic achievement in financial accounting concepts. *Education Research International* 2020 (12), 1-10.

Pouezevara, S., Sentosa, F., & Asrianti, T. (2018). Using Activity Theory to Understand Teacher Peer Learning in Indonesia. *Cultivating Dynamic Educators: Case Studies in Teacher Behavior Change in Africa and Asia*, 205-248.

Rahman, N. A. A., Razak, F. A., & Dzul-Kifli, S. C. (2020). The effect of peer tutoring on the process of learning mathematical proofs. *Advances in Mathematics: Scientific Journal*, *9*, 7375-7384.

Raisanen, M., Postareff, L., Mattsson, M., & Lindblom-Ylänne, S. (2020). Study-related exhaustion:First-year students' use of self-regulation of learning and peer learning and perceived value of peer support. *Active Learning in Higher Education*, *21*(3), 173-188.

Sanchez-Aguilar, J. (2021). Tutors' and Tutees' Behaviors, Attitudes, and Perspectives Regarding EFL Peer Tutoring in Higher Education in Mexico. *Profile Issues in TeachersProfessional Development*, *23*(2), 167-182.

Snow, S., Wilde, A., Denny, P., & Schraefel, M. C. (2019). A discursive question: Supporting student-authored multiple choice questions through peer-learning software in non-STEMM disciplines. *British Journal of Educational Technology*, *50*(4), 1815-1830.

Spangenberg, E. D., & Roberts, A. K. (2020). Peer tutors' views on their role in motivating learners to learn mathematics. *Pythagoras*, *41*(1), 1-13.

Tenhovirta, S., Korhonen, T., Seitamaa-Hakkarainen, P., & Hakkarainen, K. (2021). Cross-age peer tutoring in a technology-enhanced STEAM project at a lower secondary school. *International Journal of Technology and Design Education*, 1-23.

Thurlings, M., & den Brok, P. (2018). Student teachers' and in-service teachers' peer learning: a realist synthesis. *Educational Research and Evaluation*, *24*(1-2), 13-50.

Thurston, A., Cockerill, M., & Chiang, T. H. (2021). Assessing the differential effects of peer tutoring for tutors and tutees. *Education Sciences*, *11*(3), 97.

Yaman, B. B. (2019). A multiple case study: What happens in peer tutoring of calculus studies? *International Journal of Education in Mathematics, Science and Technology* (IJEMST), 7(1), 53-72.