



Peer Tutoring Within Higher Education Applied Science: A Systematic Review

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Abstract. Peer tutoring offers numerous benefits to college students. There are still challenges encountered when implementing peer tutoring. The exploration of peer tutoring as a formal learning strategy in the curriculum of higher education in applied sciences has been insufficient. This review explores the use of peer tutoring within the higher education applied science field. The aim is to identify the benefits and challenges reported in peer-reviewed research studies. Scanning of journal articles between January 2019 and December 2023 from Scopus literature database. Through systematic selection following PRISMA literature review guidelines based on predetermined inclusion and exclusion criteria, eight articles met the set inclusion criteria for the review. Peer tutoring was structured as a formal curricular activity in higher education, potentially enhancing learning, academic performance, friendships, and professional skills. Reported challenges relate to program duration; increasing participant engagement and consistency; and financial support. Aspects of consideration of peer tutoring strategies in higher education in applied sciences for successful peer tutoring implementation are sufficient available time, active student participation, participants' commitment, regular monitoring and evaluation, peer tutoring logistic support, training for tutors, and financial support. Future reviews could expand the range of literature periods, conduct scanning in more than just one literature database, and involve literature from non-English.

Keywords: Applied Science, Higher Education, Peer Tutoring.

1 Introduction

Peer tutoring offers numerous benefits to students in higher education. Students benefit from learning with peers and lecturers [1], resulting in positive outcomes for student learning [1] - [3], found that students experience high levels of motivation to learn when they participate in peer tutoring. The study conducted by [4], revealed that peer instructors enhance confidence in learning skills and provide a crucial evaluation of the skills being practiced. Observations by Polkowski et al. (2020) [5], indicate that understanding of topics is enhanced in classes with peer tutoring.

It's important to note that there are still challenges when implementing peer tutoring. Participation in peer tutoring as a curricular support is voluntary. It depends on the student's interests [6] - [8], and is only suitable for students who wish to benefit from additional academic support [9]. This means that students who need the most support [10] or students with low academic standing [11] may not take advantage of the

opportunities offered by peer tutoring. Other challenges in implementing peer tutoring will be addressed in this study through a systematic literature review.

Systematic literature reviews on peer tutoring mainly focus on its impact and benefits. Abdurrahman et al. (2020) [12] conducted a systematic review to explore the impact of peer tutoring strategies on learning linear algebra among polytechnic students. Aburahma & Mohamed (2017) presented the advantages and disadvantages of peer tutoring in pharmacy schools [13]. Examined the impact of peer tutoring on academic, social, and linguistic outcomes for English language students [14]. Another small group of literature reviews focused on role management in peer tutoring. Gazula et al. (2017) examined the role of peer tutoring in health professions education [15]. Exploring the use of peer tutoring in STEM within higher education is the focus of this systematic review. The aim is to identify reported benefits and challenges from peer-reviewed research studies.

Science, Technology, Engineering, and Mathematics (STEM) careers are classified into two groups: “applied” science (computer science, engineering, and engineering technologies) and “pure” science (biology, chemistry, physics, environmental science, mathematics, and statistics) [16].

The specific research questions were:

1. What are the peer tutoring benefits in the curricular setting in higher education applied science?
2. What are the peer tutoring challenges in the curricular setting in higher education applied science?
3. How can peer tutoring be implemented successfully in the curricular setting in higher education applied science?
4. The findings of our study are valuable for peer tutoring instructional development

2 Method

2.1 Design

This study uses a systematic literature review (SLR) approach. It implements the PRISMA guidelines proposed [17] for conducting SLR. There are four stages based on PRISMA guidelines for conducting SLR: identification, screening, eligibility, and inclusion. Literature review is a valid approach and a necessary step towards structuring the research field [18]. Also added that literature reviews are an integral part of the research conducted. The purpose of literature review according to Carnwell & Daly (2001) is to critically assess and synthesize the current state of knowledge related to the topic being investigated [19].

2.2 Criteria of Exclusion and Inclusion

Inclusion criteria include (1) Learning activities in classrooms, laboratories, or workshops in higher education. (2) Published in English between January 2019 and December 2023. Analysis is limited to articles that are no more than five years old, this is to the statement from Davis (2013) that acceptable manuscripts are five years old. (3) Learning in peer tutoring settings as a curricular activity [20]. Excludes the following criteria: non-peer-reviewed articles and non-empirical studies. After completing all stages of SLR and selecting the inclusive articles, apply the final exclusion criterion "outside applied science of STEM studies" to compare the number of articles with other areas.

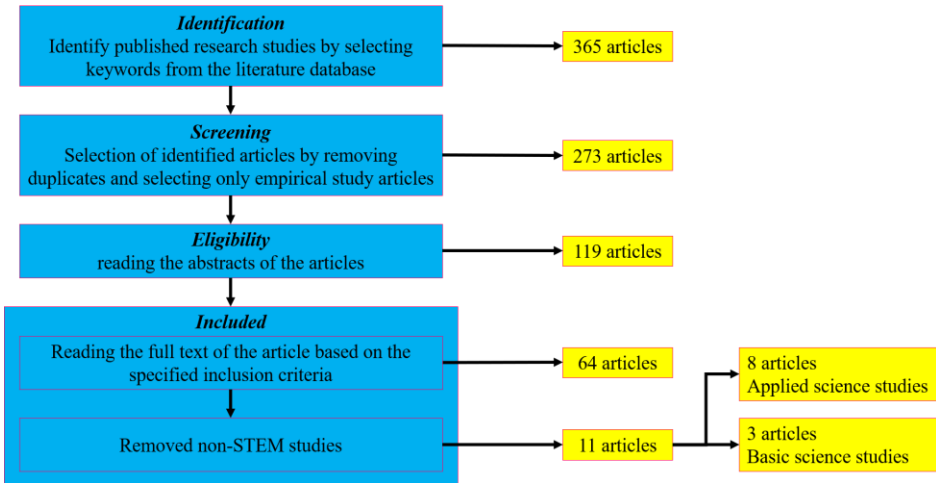


Fig. 1. Stages of Selection of Journal Articles on SLR

2.3 Identification, Screening, Eligibility, and Included

Identify published research studies by selecting keywords from the literature database. Scanning of journal articles at this stage was English language articles between January 2019 and December 2023 through the Scopus literature database using the keyword "peer tutoring". The total number of articles obtained from this first stage was 365 articles. Selection of identified articles by removing duplicates. In addition, SLR selected only empirical study articles, finding 273 research articles. Eligibility of articles by reading the abstracts of the articles found 119 articles. The assessment was carried out by reading the full text of the article based on the specified inclusion criteria. The articles were selected through the four stages above which will be used in the SLR totaling 64 articles. After removing non-STEM studies, 11 articles comprised 8 applied science studies and 3 basic science studies. Figure 1 is the article selection process using the PRISMA guidelines

3 Result and Discussion

3.1 Result

Selected Inclusion Studies

Inclusion articles before removing non-STEM are 64 articles. Table 1 shows the distribution of full-text reading articles by study. The implementation of peer tutoring according to full-text reading articles is predominantly found in the health field in higher education. Out of all the full-text reading of articles 30 articles or 47% are focused on the health field, the second most were in the STEM field with 17% (11 articles), and the last most were in economy and social science each 1,5% (1 article). 17% (11 articles) are selected inclusion articles in this systematic review after removing non-STEM articles. Table 2 shows the article on Peer Tutoring within Higher Education STEM by year.

Tabel 1. Distribution of Full Text Reading by Study

No	Study	Articles	Percent
1.	Health (include medicine, pharmacy, and nursing)	30	47 %
2.	Linguistic	10	16 %
3.	STEM-Applied Science	8	12,5 %
4.	Education and psychology	5	8 %
5.	STEM-Basic Science	3	4,5 %
6.	Multi fields study	3	4,5 %
7.	Soft skill	3	4,5 %
8.	Economy	1	1,5 %
9.	Social science and Humanities	1	1,5 %
	Total	64	100 %

Tabel 2. Distribution of Inclusion Articles by Year

Year	2019	2020	2021	2022	2023
Number	4	1	2	3	1
Percent	36%	9%	19%	27%	9%

Characteristic of Studies

As shown in Tab. 3, the application of peer tutoring in all studies is formal in the curricular activity. Two articles were identified from the USA [21], [22], two from the Taiwan [23], [24], one from India [25], Singapore [26], Nigeria [27], and another from Uni Emirate Arab [28]. Three studies used mixed method design [26], [22], [25], three experimental research design [27], [23], [24], one qualitative [21], and another study are comparative quantitative design [28]. In implementing peer tutoring, is based on certain theories. To study the application of peer tutoring, researchers are based on certain theories. Peer tutor lecture series by [26], is based on behavioral strategies influence self regulate learning and [21] used ground practical theory to explore what kind of relational meaning is being socially constructed through communication practices.

Table 3. Characteristics of The Selected Articles

Author, year and place of PT	Supplemental/ Curricular activity	Study design	Participant	Theory used	Study aim
Núñez-Andrés et al. (2022), USA	Curricular: Principles of Environmental Systems	Qualitative and quantitative design	103 students were involved in the survey: Students as tutors are 61 2 nd -year and students as tutors are 42 4 th -year.	None	To introduce and examine peer tutoring to educate architecture students in sustainable design.
Kuo et al. (2022), Taiwan	Curricular: Programming languages	Experiment design	52 2 nd -year students serve as tutors and tutees in pairs and are then randomly assigned to experimental group A (24 students, in 12 groups, demonstration to tutor the tutees in writing codes) and experimental group B (28 students, divided into 14 groups, using a flowchart to evaluate the code and assist the tutees) the peer mentoring group and non-peer mentoring group are further divided by levels	None	<ol style="list-style-type: none"> 1. To examine how an online peer-tutoring format for programming languages affects students' learning achievement and attitudes towards programming languages. 2. To investigate the impact of different teaching skills on learning behaviors and achievements. 3. To explore the differences in learning achievement among peer mentoring groups with distinct teaching skills. 4. To examine the variations in instructional achievement among non-peer mentoring groups with different teaching skills.

Author, year and place of PT	Supplemental/ Curricular activity	Study design	Participant	Theory used	Study aim
Singh (2022), India	Curricular: Applied physic	Qualitative and quantitative design	60 new students are divided into fifteen teams, each with four students.	None	To assess the effectiveness of peer tutoring on new engineering students' engagement in learning.
Choi & Zhi (2021), Singapore	Curricular: Computer-aided design with Autodesk AutoCAD program	Qualitative and quantitative design	A total of 52 responses were returned.	Self-directed learning	To explore the use of Peer-to-Peer learning to enhance students' understanding of computer-aided design (CAD) using the Autodesk AutoCAD program for Interior Design 1 st -year students.
Dong et al. (2019), Taiwan	Curricular: Geographic Information System (GIS)	Experiment design	119 students were separated into two groups. The first group (experimental group) had 47 male and 13 female students, learning GIS using the on-call-tutor system. The second group (control group) had 39 male and 20 female students, learning GIS traditionally.	None	<ol style="list-style-type: none"> 1. To examine how student peer-help behaviors are utilized in the on-call-tutor system and assess the system's benefits for student learning. 2. To investigate how social networks in a heterogeneously grouped class can be expanded with the support of the on-call-tutor system. 3. To analyze the factors that influence the formation of friendships with unfamiliar classmates and examine the relationships among these factors.

Author, year and place of PT	Supplemental/ Curricular activity	Study design	Participant	Theory used	Study aim
Bakare & Orji (2019), Nigeria	Curricular: Electronic and computer fundamentals	Quasi-experimental research design.	107 2 nd -year Bachelor's degree students from two tertiary institutions in Lagos State, comprising 76 males and 31 females.	None	To assess the impact of reciprocal peer tutoring on the academic performance, interest, and retention of 2 nd -year students studying electronic and computer fundamentals at universities in Lagos State.
Agne & Muller (2019), USA	Curricular: STEM subjects	Qualitative design	Participants included 3 tutors (2 male and 1 female) and 4 students (3 female and 1 male).	Grounded Practical Theory (GPT)	To explore how communication practices contribute to shaping relational identities between tutors and students in STEM peer tutoring.
Biju (2019), UEA	Curricular: Problem-solving and algorithms	Comparative quantitative design	To achieve the study objective, the researcher conducted a primary study involving 50 students who are pursuing a college degree in Computer Science.	None	To investigate the impact of peer tutoring versus classroom tutoring solely on the problem-solving and algorithm development skills of college students majoring in Computer Science.

Table 4. Peer Tutoring Details Within the Selected Articles

Author	Variety of PT	Intervention	Impetus to initiate of PT	Method to collect data	Setting of PT	Supporting from faculty
Núñez-Andrés et al. (2022)	Peer learning	2 nd -year students work in groups of three members under the tutor of a group of two 4 th -year students 4 weeks activity, explanation program by lecturer; kick of meeting (1 st week); follow up kick of meeting (2 nd week); student works in a team to complete the assignment (3 rd -4 th week)	To enhance active learning with two clearly stated objectives: a) improving tutors' communication abilities; and b) expanding tutees' understanding of sustainable design subjects	Quantitative data collected by survey Qualitative data by student assessment with rubric grading includes student feedback	Classroom Cross-level and unequal status within one institution.	For both 2 nd . and 4 th -year students, the lecturer debriefed the guidelines and content of peer learning and peer tutoring. Weekly meetings lasting 5 to 10 minutes with the professor to discuss progress and resolve internal issues
Kuo et al. (2022)	peer mentoring	Before the online peer tutoring, the tutors in each group received two 30-minute training sessions on recursive programming to enhance their programming ability and understanding of the recursive concept. Peer tutoring in programming	To assist students in troubleshooting and correcting challenging or blind areas in programming content using the smart learning module.	Pre- and post-tests for the programming language attitude questionnaire as well as a questionnaire survey were given out.	Online platform Same level and unequal status within one institution.	Tutor training by faculty staff two 30-minute training sessions weekly

Author	Variety of PT	Intervention	Impetus to initiate of PT	Method to collect data	Setting of PT	Supporting from faculty
Singh (2022)	Peer teaching	<p>languages continued for an additional five weeks after that.</p> <p>Members of each team are carefully chosen for the four responsibilities of Lead, Moderator, Team Member 1, and -2, in that order.</p> <p>Each team must show up on weekends to conduct collaborative peer tutoring to the full unit.</p> <p>Teams are instructed to complete the three-course modules in three weeks.</p> <p>They must present the material according to the rubrics that have already been provided.</p>	To foster an environment in which students in this group collaborate, develop presentations, and teach/present them to their peers.	<p>The survey to collect quantitative data</p> <p>Interviewing participants and collecting qualitative data on the established peer tutoring activity</p>	<p>Classroom</p> <p>Same level and equal status within one institution.</p>	None

Author	Variety of PT	Intervention	Impetus to initiate of PT	Method to collect data	Setting of PT	Supporting from faculty
Choi & Zhi (2021)	Peer criticism	It is a team-based project that will last five weeks. The series includes pre-lecture series activities, a creation stage in which the team generates the assignment themselves, peer evaluation and revision of the work among peers, and moderation by module tutors.	To improve the students' metacognitive awareness of the topic.	Quantitative data was collected by conducting a brief survey among the participating students. Qualitative data was collected from student responses at the end of the year to examine module quality and teaching methods.	Classroom Same level and equal status within one institution.	None
Dong et al. (2019)	Peer coaching	Implemented during the five weeks (one introduction week and four learning with the system weeks) In the lecture sessions, the teacher provided instruction on GIS software and demonstrated practical applications on the computer.	To support peer-assisted activities in diverse classrooms and improve student learning outcomes.	The following information was obtained from the system: 1. Logs for sending preset messages and peer-help activity. 2. Students practice using GIS software. 3. Student attitudes about using our on-call tutoring services.	On-call-tutor Same level and equal status within one institution.	None

Author	Variety of PT	Intervention	Impetus to initiate of PT	Method to collect data	Setting of PT	Supporting from faculty
		<p>During practice sessions, students used GIS software to follow textbook instructions.</p> <p>Throughout the trial session, students in the experimental group had access to an on-call tutor system for forming friendships, asking for help, and receiving it.</p> <p>In contrast, students in the control group were only able to obtain support during face-to-face instructions.</p>		Created a questionnaire based on the technology acceptance model.		
Bakare & Orji (2019)	Reciprocal peer tutoring	The experimental group received five reciprocal peer tutoring sessions, whereas the other group received five direct teaching (face-to-face) sessions. The treatment	To improve academic performance, interest, and retention of student learning	Electronic and Computer Fundamentals Achievement Test (ECFAT), Electronic and Computer Data were collected using the Fundamentals Interest	Classroom Same level and equal status within one institution.	None

Author	Variety of PT	Intervention	Impetus to initiate of PT	Method to collect data	Setting of PT	Supporting from faculty
Agne & Muller (2019)	None mentioned	lasted four weeks. This treatment consisted of reciprocal peer tutoring sessions. Each session lasted for 2 hours. None discoursed	None listed	Inventory (ECFIH) test and a survey via statement. The researchers created statements. Action Implicative Discourse Analysis (AIDA)	Classroom Same level and unequal status within one institution.	None
Biju (2019)	Peer Mentoring	Working in pairs was encouraged in the classroom during problem-solving sessions. Each pair consists of a tutor and a tutee. Tutors were chosen by the speaker and trained to assist and function as peer tutors. They were given the materials necessary for tutoring.	Improving students' academic achievement throughout all levels of education	Pre- and post-test	Classroom Same level and equal status within one institution.	Train, support the tutors with the material required, and guide the session.

Table 5. Results of The Selected Studies

Author	Academic Benefit	Generic Benefit	Challenges encountered	Limitation of study	Recommendations
Núñez-Andrés et al. (2022)	<p>Improved their knowledge of sustainable design.</p> <p>Increased drive and self-confidence in the field of sustainable design.</p> <p>Allowed 4th-year students to focus on professional skills such as technical communication, project management, team management, dispute resolution, etc.</p>	Students' performance and learning experiences improve significantly.	Although there are usually differences owing to the peculiarity of working with students with two distinct course levels, the activity's most difficult feature has been duration.	None listed	<p>Introduced peer learning through peer tutoring methods should be repeated in subsequent classes with a longer time of study.</p> <p>Provide each learner with an identification code so that you can track their progress and correlations.</p>
Kuo et al. (2022)	<p>Both groups showed considerable improvement in learning outcomes while using an online peer-tutoring platform for programming languages.</p> <p>The demonstration method is preferable in online peer tutoring since tutees can mimic the tutors' coding and so gain a better understanding and absorption.</p> <p>Academic achievement in a non-peer mentoring group shows no</p>	None	None listed	<p>The distribution of students' levels of competence in the class should be standardized.</p> <p>The function of peer tutoring and teaching given in this study enables peers with a high level to assist students with a lower level in</p>	<p>Due to the research system's complexity, it may be necessary to design more thorough instructional functions for the teaching and discussion activities of the peer teaching system.</p>

Author	Academic Benefit	Generic Benefit	Challenges encountered	Limitation of study	Recommendations
	<p>significant difference in teaching skills when the tutor and tutee levels are lower.</p> <p>The significant rise in the learning state demonstrates that an online peer-tutoring platform for programming languages can successfully improve students' programming concepts and abilities.</p>			<p>learning programming languages using peer tutoring in an online system.</p>	
Singh (2022)	<p>Enforcing the considerable benefits of peer tutoring to improve learning and knowledge retention.</p> <p>When constructing the course, use a well-thought-out plan and arranged content to improve student learning.</p> <p>Peer tutoring practice can play a key role in increasing student learning through a well-planned and coordinated course design.</p>	Collaborative and active learning	<p>Members' active engagement can be increased by educating them on the advantages of participation and providing incentives to leaders.</p> <p>Furthermore, financial assistance for devices such as phones and smart tablets with continuous network connectivity is available.</p>	<p>This study's findings are restricted to participants from a single course and institution; therefore, they cannot be broadly generalized.</p> <p>This is a pilot project, thus the data gathered to confirm the worth of peer tutoring will</p>	<p>In the future, participants could be drawn from a variety of courses, class levels (freshmen, sophomores, juniors, and seniors), and other schools.</p> <p>The author wants to gather more information to thoroughly investigate the arguments and give more definite findings.</p>

Author	Academic Benefit	Generic Benefit	Challenges encountered	Limitation of study	Recommendations
Choi & Zhi (2021)	Appropriate for freshmen to get technical knowledge. More inspired and motivated in their technical understanding acquisition.	Increased effectiveness and efficiency in teaching and learning, resulting in additional benefits.	The initial time cost of researching and discovering appropriate resources for learning available for self-directed learning.	require more study in the future. None listed	This improved teaching style is easily adaptable to both technical and non-technical subjects, and it works with varying class sizes. The teaching team expected it to be integrated with other modules of the instruction in the future.
Dong et al. (2019)	Students who used our system participated in more peer-to-peer activities and performed better academically than students who did not use it. Students enlarged their social network and interacted with their classmates to communicate, seek or provide social support, and get relevant knowledge for learning reasons. The system's usefulness for learning had a substantial impact on students' desire to develop	None	There were also occasions where students abused the system, such as posting queries unrelated to the instructional process and subject. The instructors assisted others, and their progress would have been impeded compared to their peers who did not assist.	Other peer-help activity characteristics were not considered, but they are likely to have an impact on the data and its interpretation.	Some mechanisms to avoid such abuse in the system must be implemented in the future. Some other variables are likely to influence the data, and its analysis must be addressed. In future research, it is required to interview those "local bridges" to determine their impact on linking students and supporting peer support activities.

Author	Academic Benefit	Generic Benefit	Challenges encountered	Limitation of study	Recommendations
Bakare & Orji (2019)	<p>connections within the social network, regardless of their acquaintance with their peers, and communicate with them.</p> <p>Reciprocal peer tutoring improves students' academic progress. It is more successful than direct education at piquing students' interest and enhancing recall of electronic and computer foundations.</p> <p>This discovery may be attributed to students' active participation in how they learn through work as tutors and preparing and presenting lessons using technologies such as electronic devices and online environments.</p> <p>The male and female students in the experiment group had better mean achievement than the male and female students in the control group.</p>	On average enhances students' academic achievement.	None listed	None listed	<p>Lecturers in electronic and computer foundations should constantly use reciprocal peer tutoring to teach their students.</p> <p>Curriculum planners and developers should include reciprocal peer tutoring in the technical and vocational education curriculum.</p> <p>Students should be allowed to utilize some technologies such as electronic apparatus for lectures during reciprocal peer tutoring.</p> <p>Workshops and seminars on the best ways to use reciprocal peer tutoring in the classroom should be organized.</p> <p>Students should always be able to actively participate and converse openly with their lecturers and classmates in class.</p>

Author	Academic Benefit	Generic Benefit	Challenges encountered	Limitation of study	Recommendations
Agne & Muller (2019)	<p>Interactions in tutoring sessions occur between partners interacting within and on the outskirts of the shared community of practice; these interactions achieve more than information exchange.</p> <p>These interactions do discursive work to co-construct relational identities, which are especially important when participants' institutional identities are unclear and potentially conflicting, facilitating relationships and meanings that participate in (and probably advance beyond) the disciplinary communities of practice represented by the sessions of tutoring.</p>	None	None listed	<p>For example, while we argue that encouragement to talk, understanding checks, and meta-disciplinary discussion help tutors and students negotiate a relational identity, these are not the only options.</p> <p>This study also did not look into concerns of gender or cultural disparities, which could be essential in comprehending these tutoring sessions.</p> <p>Audio recordings were the sole data</p>	<p>Future research could look into how tutors and tutees negotiate the value and productivity of tutoring sessions.</p> <p>Critical discourse analysis (CDA) may be useful in identifying gendered, cultural, and power disparities in light of discussions.</p> <p>Future research may focus on how this educational medium acts as an interactional resource to improve the learning process through eye contact and gestures.</p>

Author	Academic Benefit	Generic Benefit	Challenges encountered	Limitation of study	Recommendations
Biju (2019)	Peer tutoring is more effective than working alone in a classroom among higher education students studying computer science. The tutor has also profited from peer tutoring sessions, as seen by improvements in skill among all peer tutors.	Enhance students' learning ability and academic achievement.	None listed	acquired for this investigation. None listed	It's also worth noting that peer learning cannot replace the teacher. The professor will still be obliged to teach, and students will require the professor's instruction. Peer learning, like other instructional approaches, is helpful when used for a specific goal, such as solving a specific problem in a class, and it must be carefully organized, supervised, and assessed.

Peer Tutoring Details within Studies

The variety of peer tutoring in higher education is diverse [29]. As identified in Tab. 4, Various peer tutoring methods include peer learning, peer mentoring, peer teaching, peer criticism, peer coaching, and reciprocal peer tutoring. One study did not mention the peer tutoring setting. The researcher's encouragement to apply peer tutoring strategies in learning is to enrich active learning [22]; help students fix difficulties [24]; create an environment where students in these groups work together [25]; increase students' metacognitive awareness [26]; improve interest and retention in learning [27] and improve academic achievement [26], [28], [23]. Table 4 also identifies that the role setting of peer tutoring is in format same level and equal status within one institution [27], [28], [26], [23], [25] same level and unequal status within one institution [21], [24] and cross-level and unequal status within one institution [22]. All studies implemented a peer tutoring strategy in the classroom except for Kuo et al. (2022) in an online platform and [23] in the format of an on-call tutor. There are only three studies that reported faculty involvement in peer tutoring. In Núñez-Andrés et al. (2022), faculty supporting takes the form of explained program and content and review by weekly meeting. Faculty organizes training for tutors [28], [24] and support material required [28]. To collect data researchers, use methods survey [27], [26], [24], [22], [25], test include pre-or post-test or both [27], [28], [23], [24], interview [25], assessment by rubric grading [22] qualitative data from software system [23] through video recordings which were analyzed using action-implicative discourse analysis [21].

Result of Studies

As seen in Tab. 5, Applying peer tutoring strategies to formal learning in curricular activities had the following benefits: improved understanding and experience work through professional skills (Núñez-Andrés et al., 2022); increased motivation [26], [22] improve learning achievement [27], [28], [23], [24], enhance abilities [24], enhance learning and knowledge retention and improve the student learning (Singh, 2022); influenced students' willingness to form friendships [23] and active participation in the learning process [27]. Even though she did not directly report the benefits of peer tutoring, Agne identified that peer tutoring interactions are partner interactions that facilitate relationships and meanings that contribute to the disciplinary communities of practice the tutoring sessions represent [21]. Table 5 shows that not all studies report challenges from peer tutoring in its application to higher education applied science. The activity's most challenging aspect of cross-level and unequal-status peer tutoring has been the duration [22]. Singh (2022) highlights active participation that must be increased and financial support for gadgets as challenges encountered [25]. Another challenge is the initial implementation costs [25], misuse of the system by peer tutoring participants and tutors are slower down than non-tutors [23].

3.2 Discussion

Peer tutoring has been widespread in various fields of higher education. Health, linguistic, and applied science. Health, linguistics, and applied science fields are the three top using the peer tutoring strategy (Tab. 1). This systematic review focuses on exploring the use of peer tutoring within the field of applied science in Higher Education, aiming to identify the benefits and challenges reported.

Suitability Between Impetus and Benefits

The reported benefits of peer tutoring as a formal strategy in higher education applied science settings (RQ1) are improved understanding and experience work through professional skills [22], increased motivation [26], [22], improve learning achievement [27], [28], [23], [24], enhance abilities [24], enhance learning and knowledge retention and improve the student learning [25] influenced students' willingness to form friendships [23] and active participation in the learning process [27]. These benefits have been shown to justify the push to implement peer tutoring (Tab. 4 and Tab. 5). Núñez-Andrés et al. (2022) used peer tutoring strategies to increase tutees' knowledge and strengthen tutors' communication skills of sustainable design topics [22]. The academic benefits obtained align with the impetus of implementing peer tutoring, namely improved tutee understanding and motivation, and allowed tutors to work through professional skills including communication skills. Likewise with other studies in the selected inclusion research except for Agne & Muller (2019), because they did not include information about the initiation of peer tutoring, the study's focus was examining partner interactions [21].

Aspect Consider to Peer Tutoring Implementation

Aspects of consideration of the use of peer tutoring strategies in higher education in applied sciences will answer how can peer tutoring be implemented successfully in the curricular setting in higher education applied science (RQ3). These aspects relate to reported challenges and supporting faculty. The reported challenges of peer tutoring as a formal strategy in higher education applied science settings (RQ2) are peer tutoring duration [22]. Increasing active participation and financial support [25], initial implementation costs [26], and misuse of the system by peer tutoring participants and tutors are slower down than non-tutors [23]. The reported faculty support takes the form of explained program and content and review through weekly meetings [22], organizing training for tutors [28], [24], and support material required [28].

First aspect is duration, some students suggested that they needed more preparation time and added that resources should be available, during assignments [26]. The application of peer tutoring to learning requires students to make certain preparations such as theoretical and content knowledge [30], [31], learning materials [32], and pedagogical techniques [33], [34]. This is a consideration of whether the available time is sufficient to carry out peer tutoring or not. *Second*, for increasing active student participation within a peer tutoring setting, Singh (2022) suggests providing clarity on the benefits of participation. Related with Cheng et al. (2022) there needs to be clarity of roles and attention to emotions at a lower level [35]. Another consideration, the gender composition of the couple or group also needs to be considered because women

experience more anxiety, feel less confident, are perceived as less self-confident, and rate their performance worse (as tutors) [35]. *Third*, participants' commitment not to misuse the system and *fourth*, tutors are slower down than non-tutors. For these requires regular monitoring and evaluation to ensure. After the peer tutoring program is running, regular monitoring and evaluation is required [37]. Peer tutors and course lecturers meet weekly to work together, exchange teaching strategies and educational materials, and share information regarding student learning difficulties and cases of low achievement levels [38]. Related to Núñez-Andrés et al. (2022) that reported faculty support takes the form of explained program and content and review through weekly meetings. *Fifth*, peer tutoring logistic support. The fifth rule in the seven golden rules for peer tutoring is support the tutors [39]. The availability of supporting teaching materials is important. One of the difficulties in peer tutoring is due to the limited availability of supporting teaching materials [40]. Peer tutoring sessions were structured and sequenced in the Working notebooks to facilitate the student tutors' implementation and follow-up on tasks [41]. *Sixth*, training for tutors. The third rule in the seven golden rules for peer tutoring is to train the tutors (Falchikov, 2001a). Students selected as peer tutors are trained to assist and work as peer tutors (Biju, 2019). tutors in each group are trained on the content to improve their abilities [42], [24]. *Seventh* or final aspect is financial support. Faculty support is very necessary for this aspect. It's not just financial involvement, faculty can support by providing material and learning resources; contact low-performance learners and matching with tutors; carry monitoring program; and reimbursed hourly for tutors' services [43].

4 Conclusion

Peer tutoring offers numerous benefits to students in higher education. This systematic review focuses on exploring the use of peer tutoring within the field of applied science in Higher Education, aiming to identify the benefits and challenges reported. The reported benefits of peer tutoring as formal learning in higher education applied science settings are improved understanding and experience working with professionals, increased motivation, improved learning achievement, enhanced learning and knowledge retention, improved student learning, influenced students' willingness to form friendships and active participation in the learning process. The reported challenges of peer tutoring as formal learning in higher education applied science settings are peer tutoring duration, increasing active participation and financial support, initial implementation costs, and misuse of the system by peer tutoring participants and tutors are slower down than non-tutors. Aspects of consideration of the implementation of peer tutoring strategies in higher education in applied sciences for peer tutoring implementation successfully are sufficient available time, active student participation, participants' commitment, regular monitoring and evaluation, peer tutoring logistic support, training for tutors, and financial support.

This study only uses one literature database for the identification process in the first stage of SLR. This research only uses one literature database for the identification process in the first stage of SLR. More than one literature database and expanding the

period range of literature inclusion criteria can identify more empirical articles to bring to the SLR stage. Research published in non-English languages may have been missed as this review only included studies published in English.

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