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Review Article

A SYSTEMATIC REVIEW ON THE IMPACT OF PEER TUTORING STRATEGY IN LINEAR ALGEBRA AMONG POLYTECHNIC STUDENTS

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Abstract
Classroom teaching practice becomes more efficient when an understanding of how learners learn is well informed and learning itself will be more successful if students are given the opportunity to clarify their own ideas. Educational development nowadays needs teaching approaches that emphasize more on students' participation, where the focus is on knowledge construction rather than knowledge transformation. The purpose of this systematic review was to examine the impact of peer tutoring strategy in linear algebra among polytechnic students. A literature search was performed using prominent internet databases between 2002 and 2017. Eleven published articles fulfilled the review requirements set for incorporation. The small amount of articles resulting from this search indicates that in recent years peer tutoring strategy has not been investigated to a higher extent in linear algebra classes. Results from the eleven articles disclosed that peer tutoring strategy remains a promising instructional instrument that awaits further exploration in a polytechnic linear algebra classroom. To enhance the knowledge of learners in linear algebra, the research proposes among other things that, allocating more time and particular goals for each peer tutoring strategy session, guiding respondents with preliminary teaching skills and reducing teaching content covered in each session.

Key words: Systematic Review, Peer Tutoring Strategy, Linear Algebra, Polytechnic Education.

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INTRODUCTION

Polytechnic education is an important sub-sector of the entire education system, providing middle-level employees with the necessary workforce in a country's industrial and technological growth. The advancement of polytechnic education is of excellent significance as it can be an instrument for economic diversification in order to reduce unemployment through entrepreneurial growth. Jahun (2017) indicated that the primary aim of polytechnic education is to train learners in technical and vocational fields in order to become self-employed and generate jobs for others after graduation; leading to the awards of Certificates, National Diploma, Higher National Diploma and Advanced Professional Diploma which are relevant to the needs, aspirations and growth of the diversified economy and sectors of a nation. Nowadays, the future of every country depends on the quality of education received by its citizens. The nations that benefit the most are those with a well-educated population that defined the 21st century in the areas of science, technology and social sciences (Umar, 2014).

The challenges of mathematics teaching in the 21st century are to generate experiences that involve learners and promote their own mathematical problem-solving abilities that will enable them to think independently and also make sense of their learned experiences. Nowadays, students are challenged to think critically and work as a team, to be able to use accessible resources to comprehend more thoughts and develop abilities in many academic fields. Helping students to learn how to think mathematically and work in group has been identified as a significant instructional objective as it is used to define purposeful, reasoned, and goal-oriented thinking (Umar, 2014). He emphasized that a greater role in terms of students' working as a team is mostly played by teachers because the students' ability may be directly affected by the approaches employed by the teachers in delivering the mathematics instruction and learning. This means that teaming the students in peers will definitely make the teaching to be effective by promoting and enhancing students' performance in the classroom.

Linear algebra is one of the mathematical branches that forms the basis of modern algebra, and also plays an important role in the development of many mathematical structures like rings and vector spaces. It is among the unavoidable advanced mathematics subjects for which several students encounter at both the polytechnic and university levels. Studies conducted by Adewumi (2013), Muhammad, Abdullah and Osman (2020), Umar (2014) shows that approaches used by teachers in teaching and learning plays a significant role in developing students' ability. Linear algebra teaching is perceived to be challenging for mathematics teachers because of the importance to expose students to the complex and abstract parts of linear algebra as well as to teach students concepts that can be applied effectively in other mathematical topics. It is essential for teachers to recognize and understand how students learn linear algebra due to some controversies on whether the conventional approach pays attention to improving individual student's cognitive and developmental level (Dikovic, 2007). In conventional design content, students use time in the class mainly for transferring information, generally by taking notes and listening to a lecture, and occasionally participating in group work; although they usually work alone outside the class, to apply the general information to higher-level homework tasks and other tasks (Talbert, 2014). A teacher's primary role is to help students in building the process of acquiring knowledge while at the same time ensuring students take an active part in the class on important and difficult topics, either through group discussions or individual opinions. It is previously evident that merely talking and demonstrating would probably not improve students' understanding of such abstract subjects, leading to a recommendation by Dikovic (2007) that students can acquire knowledge by themselves and collaborate with each other through the guidance of a teacher.

PEER TUTORING STRATEGY AND ITS EFFECT ON STUDENTS' PERFORMANCE

Peer tutoring is literary referred to as peer-assisted learning, peer education of child-teach-child, mutual instruction, and partner learning. Abaoud (2016), posit that the early peer-tutoring manifestation was associated with children acting as substitute to teachers whose aim was the transfer of information. Topping, Thurston, McGavock and Conlin (2012), Muhammad et al. (2020) have identified a contemporary peer-tutoring perspective as people from similar social groupings whom are not professional teachers that help each other to learn and learning for themselves by teaching. Accordingly, Muhammad et al. (2020), Wolfe (2018) view peer tutoring as an instructional strategy that suggested the pairing of high-performing students with lower-performing once in a class-wide setting with the hope that they work together and function as tutors and tutees under the facilitation of a teacher. In particular, Alzahrani and Leko (2018), Tracey, Natasha and Johanna (2007) quote peer-tutoring as a teaching strategy in which the class is organized in pairs of 5-6 members that may be of different abilities to act as tutor and tutees in the learning process in order to obtain maximum benefits from each other. Meanwhile, Ansuategui and Miravet (2017) view peer-tutoring as bringing together two or more students to act as tutors and tutees in order to enrich their educational experience irrespective of academic ability. According to Ruegg, Sudo, Takeuchi and Yuko (2017), for peer tutoring to occur, there needs to be a difference in knowledge between two individuals, so that the more knowledgeable individual can act as tutor to the less knowledgeable. In this study, peer tutoring relates to a type of teaching in which students are trained to use each other's particular educational approach to enhance their efficiency in a linear algebra classroom. This implies that any non-conforming research has been excluded.

Students with learning difficulties are found almost in every classroom. The possible reasons behind these difficulties varied as demonstrated by students' characteristics which may include problem-solving skills, strategy acquisition and application, memory skills, intellectual development, motivation, and vocabulary development. Different studies on peer tutoring has shown that it can be carried out successfully with tutors of different levels of ability, like peering students with advanced skills and those with learning disabilities (Nawaz & Reman, 2017). Okilwa and Shelby (2010) carried out a longitudinal study in Nigeria with students from Grades 6 through 12 on the effects of peer tutoring on students with disabilities in regards to mathematics performance. The study reported that peer tutoring has positive effect to students with disabilities in special education and general settings. Similarly, a meta-analysis on the effect of peer tutoring was conducted using 938 students of Grades 1-12 by Bowman-Perrot, Davis, Williams, Greenwood and Parker (2013) across 26 single-case research experiments; and peer tutoring was found to have a positive impact on the performance of the students regardless of dosage, grade or disability status.

Peer tutoring was explored to be an effective strategy for engaging students and promoting academic success (Lazarus, 2014; Sofroniou & Poutos, 2016). A study conducted by Oloo (2016) on the outcomes of 65 independent reviews of school tutoring programs found out that students who used peer tutoring perform better in their examination than other students that were taught using the conventional approach. Furthermore, the tutored students developed positive attitudes and gained a greater understanding of the subject matter. Kocak, Bozan and Isik (2009), Vassay (2010) conducted a peer teaching study in college mathematics and concluded that it had a major impact on students' intellectual and moral values such as freedom of expression while sharing ideas, self-confidence and discipline, time management, sense of responsibility as well as mastery of different concepts.

TEACHING AND LEARNING OF POLYTECHNIC LINEAR ALGEBRA

The first advanced mathematics course encountered by students at polytechnic level is linear algebra with the aim of shifting the way students think from the basic school mathematics to advanced mathematical thinking. Applications of its topics can be found in mathematics and other disciplines; for example, eigenvalues and eigenvectors are the building blocks of Quantum Mechanics in physics and are also used to analyze population growth models in biology. Linear algebra requires limited mathematical prerequisites which combines both algebra and geometry; and its applications makes it a necessary component to all technological and scientific courses (Hillel & Sierpinska, 2014; Karakök, 2009; Tucker, 2013). Sequencing the contents of linear algebra can be viewed from two different ways, i.e. the computation-to-abstraction way and the abstraction-to-computation way (Carlson, 1993; Harel, 2017). The first way started from simpler to complex arrangements in such a way that reasoning abilities are developed by the students which makes their understanding of more complex and abstract contents easier and necessary (i.e. from matrix arithmetic, systems of linear equation, vector spaces, and then to linear transformations). The second way of arranging it is starting from complex to simpler (i.e. linear transformations, vector spaces, systems of linear equations, matrices arithmetic) as applications of the former. Hence, in linear algebra classroom, there are several factors that influence student achievement and performance which include differences in students' learning style (Felder & Brent, 2005), approaches to learning and orientation to studying (Brown, 2005), pedagogical implications (Turkmen & Usta, 2007), learner's prior knowledge and misconception or preconceptions (Michael, 2002) and epistemological beliefs (Whitmire, 2003), among others. The study of Felder and Brent (2005) pointed out that the learning styles of the students, their learning approaches and orientation as well as their intellectual development levels have important implications on teaching and learning. An instructional goal should prepare students with skills that are related to different styles of learning because sometimes students tend to adopt different learning approaches due to diversity in backgrounds, weaknesses and strengths, aspirations, desires, motivational levels, sense of responsibility, and techniques used among themselves while studying.

Several studies have been conducted regarding students' understanding of linear algebra. There is an increasing concern that the existing linear algebra course might not completely address the needs of the students, prompting further research and development of curriculum. The study conducted by Dorier and Sierpinska (2001) reported that many students have a limited understanding on the concepts of matrix manipulation, systems of linear equations and linear transformations, making it difficult for students at higher institutions to understand the fundamental concepts of the subject matter. Although students have learnt basic components of linear algebra like addition/subtraction of matrices and systems of linear equations, however, it does not assure successful transition to vector spaces and linear transformation. Carlson (1993) reported that students find it easy to solve systems of linear equation and calculate matrix products, but they become confused and disoriented when solving problems involving subspaces, spanning and linear independence. Although, Harel, Selden and Selden (2006), Bogomolny (2007) posit that linear algebra has some certain peculiarities leading to the obstruction of students' learning and understanding as it has been established in such a way to simplify, unify, and model problems that are on ground rather than solving new ones. Moreover, the study of Hillel and Sierpinska (2014) showed that students can solve many problems of linear algebra without the use of the appropriate theory but through direct manipulation techniques. Even though linear algebra theories are universally applicable to

solve problems, but its algorithms for different tasks are of different varieties, although algorithms of various types operate under different contexts. Hence, students may find it difficult to decide the type of algorithm that is suitable in confronting the given problem. Carlson (1993) stated that among the reason certain topics in linear algebra are difficult to be solved by students is the fact that the difficulty of linear algebra taught differs. Carlson (1993) further explains that the topics that trigger complexities to the students are concepts rather than computational algorithms, and students also require different algorithms to deal with these concepts in different contexts. Hillel and Sierpinska (2014) have a contrary opinion in both teaching and learning of higher level linear algebra which is regarded to be almost a universally frustrating experience. The transition from elementary to advanced mathematics is one of the main reasons students are unable to comprehend linear algebra (Tall, 2013).

Efforts have been made to restructure the teaching and learning of linear algebra such as the culture of teachers and classrooms as well as incorporation of technology. Issues about teacher's perspectives on beliefs seems to be of great concern in the design of linear algebra learning as well as issues about the role of teacher should also be of paramount importance due to the change from teacher-centered to student-centered learning. To help students understand this change in learning, a teacher should also be ready for so many issues, such as building up the theory of students, misconceptions of students, the role of representations and how students move from misunderstanding to understanding (Husnul-Khuluq, 2015). It is important that teacher recognizes the limited knowledge of the students and uses this as a basis for their learning. Reforming the cultures of teaching may have an effect on the atmosphere of the classroom, as students may not be used to the new situation as revealed in the study of Castro and Godino (2014) that majority of the teachers maintain traditional beliefs in an algebraic classroom. However, Dikovic (2007), Husnul-Khuluq (2015), Putri, Dolk and Zulkardi (2015) argued that students can adapt easily to a new knowledge if only their teachers can facilitate good social interaction between and among students, and also becomes autonomous in their learning. A study conducted by Rowland (2009) on the way higher institution lecturers' belief about teaching linear algebra prompted to make changes to her teaching style, rejecting an exposition and note-taking paradigm; and making her to employ an interactive teaching approach so as to prioritize testing of conjectures and sense-making in the class sessions.

The era of increasing demand necessitates re-examination of strategies that will maximize and facilitate students' participation in learning linear algebra. Many students at higher institutions level found out that linear algebra is difficult and challenging because it is probably the first advanced mathematics course they encounter; hence, making instructors of mathematics to provide an environment that is friendly to the students and assist them to overcome these challenges. Abdelkarim and Abuiyada (2016), Geoffrey (2017) posit that one way of achieving this is through offering students the opportunity to collaboratively work in groups and learn or study together. In this process, students are grouped together in two or more as a team and are trained to work on a specific academic task to prompt, track and assess one another, while working collaboratively towards group objectives. Topping et al. (2012) perceive peer learning as knowledge and skills acquisition by encouraging active assistance and matching between students of equal status. This includes students from similar social backgrounds that are not qualified teachers, but are supporting each other to learn and teaching themselves under a teacher's facilitation. Hence, enhancing the students' involvement in learning linear algebra can be accomplished via student-assisted instruction which was established and advocated by both Vygotsky and Piaget. Studies conducted by Curry (2016), Geoffrey (2017), Karakök (2009), Wass (2012) explained that Vygosky's and Piaget's idea of social interaction, which includes peer-to-peer interaction motivates students and at the same time leads to the social construction of knowledge. The sociocultural theory of Vygotsky focuses on the social process as a learning mechanism in which the development of higher mental ability is believe to be resulted from social interaction. This means that people naturally learn from each other and work cooperatively in their everyday lives. Vygotskian perceptions have influenced many different areas of education, including peer collaboration and his concept of the Proximal Development Zone provides a theoretical framework for peer tutoring (Siyepu, 2013).

METHODS

This article used the meta-analysis technique suggested by Borenstein, Hedges, Higgins and Rothstein (2009), Kitchenham and Charters (2007) whereby several operations were suggested in a review that included the following main measures: search for literatures as well as inclusion and exclusion criteria based on title, abstracts and full paper review among others.

LITERATURE SEARCH, INCLUSION AND EXCLUSION CRITERIA

A meta-analysis was conducted to determine the impact of peer tutoring strategy in linear algebra among polytechnic students. Google Scholar search engine and prominent online databases including JSTOR, SAGE Journals, Scopus, ScienceDirect, SpringerLink, Taylor & Francis Online, and Web of Science were used to locate articles for this study. The researchers searched separately and in conjunction with polytechnic education for appropriate research under the keywords "peer tutoring strategy", "peer-assisted teaching", "linear algebra teaching". The way the inclusion criteria were performed included learners of comparable levels alternating roles of tutors and tutees through the use of a conforming definition of peer tutoring approach articulated within the research to fulfill the defined goal. On the other side, peer-reviewed papers published in English between 2002 and 2017 are the inclusion criteria used for this study; narrative and non-peer-reviewed articles, non-conformity with the definition of peer tutoring approach, among others, are regarded as some of the exclusion criteria (refer to Fig. 1 below).

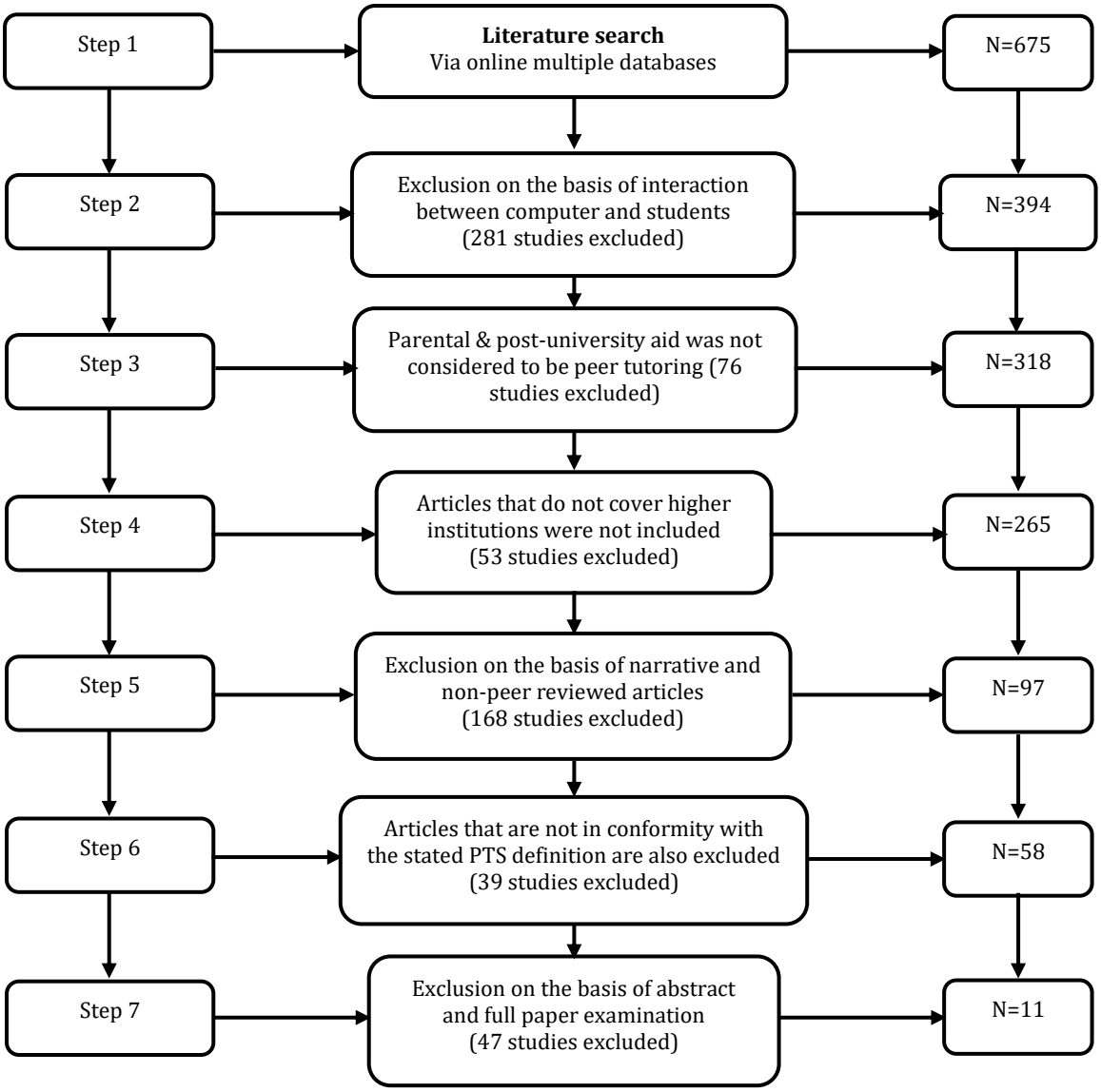

Fig. 1: Steps of the research articles selection process

RESULTS

Most of the studies discovered with the keywords "peer tutoring strategy", "peer-assisted learning", and "reciprocal peer tutoring" did not address peer tutoring strategies among high institution students in a linear algebra classroom; and as such resulted in their exclusion from meta-analysis. The first selection criteria was that we regarded only studies in which the interaction between tutors and tutees was direct; meaning that all study that regarded computer-student interaction was excluded leading to the exclusion of 281 studies. The second criterion is that parental or post-university aid was not considered peer tutoring because, in the context of this study, it violates the concept of the word "peer", which leads to the exclusion of 76 studies. Third criteria was that there was also no inclusion of papers that did not cover higher institutions leading to the exclusion of 53 research. Fourth criteria was that both narrative reviews and non-peer reviewed articles were removed resulting in 168 studies being excluded. Fifth criteria was non-conformity with the definition of the peer tutoring strategy for this study leading to 39 studies being excluded. Sixth criteria was that abstract and full papers were then examined in order to meet the criteria for inclusion whereby 47 studies are excluded. Finally, eleven (11) studies were identified to be used for this research based on the terms used in the search for the review articles (see Fig. 1). These remaining studies are four (4) quantitative, three (3) qualitative and four (4) mixed methods studies. The small number of articles arising from this search indicates that in recent years, peer tutoring strategy in linear algebra classrooms has not been investigated to a greater extent.

The review and integration of research literature begins with the identification of the literature, the results of the analyzed articles have been tabulated with the author's specification and the year in the first column, the objectives in the second column, the third column as framework, methodology in the fourth column and findings in the fifth column as shown in Table 1 below.

Table 1: Summary of the distribution of the eleven (11) articles that are meta-analyzed

Researcher/Year	Objective	Framework	Method	Findings
Hannah, Stewart and Thomas (2011) Karakök (2009) Bogomolny (2007) Dikovic (2007) Stewart and Thomas (2010)	To improve students' procedural and conceptual understanding as well as thinking in linear algebra through instructional method that better identify some of the difficulties they experienced	• Three worlds of mathematics • Actor-oriented transfer (AOT) • APOS theory • Social and individual learning	• Classroom voting through multiple choice questions and true/false questions • In-depth interviews • Ethnography • Observations • Pre-and-post quiz • Examination results (grades) • Questionnaire	• Students have learned new techniques and have been able to model and evaluate a situations that was challenging, interesting and real in linear algebra classroom • There are difficulties concerning student understanding in the procedural approach rather than a conceptual one, and an apparent lack of representational versatility
Geoffrey (2017) Abdelkarim and Abuiyada (2016) Curry (2016) Huang (2015) Wass (2012) Rowe (2002)	• To identify the effectiveness of peer teaching on students mathematics academic achievement • To promote learning by enhancing the level of higher order cognitive talk among collaborative groups engaged on mathematical task	• Constructivist theory • Vygotsky's sociocultural theory and his Zone of Proximal Development (ZPD) model • Medcalf's peer tutoring model	• Quasi experimental method • Questionnaires • Semi-structured interview • Observation • Document analysis • Reflective journals • Researcher's diary entries • Personal correspondence with the participants	• Learners' higher level thinking skills were improved after the implementation of the collaborative metacognitive community • Learners preferred to work in groups during the knowledge construction process • Vygotsky's ZPD model can help teachers to focus on individual students rather than thinking about students as a homogenous group

Table 1 summarizes the distribution of the articles that are meta-analyzed on the impact of peer tutoring strategy in linear algebra classrooms among polytechnic students; and it was found that there exist a positive impact. The above table also showed that issues of multiple choice, mathematics achievement tests, questionnaires and surveys were used to capture quantitative data; whereas semi-structured interviews, classroom-based behavior, observations and ethnography were used to capture qualitative information. Furthermore, it was pointed out that the results had to be used carefully because some prior meta-analyzes had set requirements for evaluating only those studies that took place in a real classroom/school environment (Kulik, 2003); although leaning through peer tutoring strategy can take place anywhere as it is nowadays not restricted to the formal education system (Sandberg, Maris & Geus, 2011).

DISCUSSION

The aim of this systematic review was to examine the effect of peer tutoring strategy (PTS) among polytechnic students in linear algebra classroom and also to investigate how PTS could be effectively applied within tertiary institution environments. An investigation of the students' understanding in linear algebra was earlier conducted and it was found to be low because of the continued poor performance in their semester examinations which is attributed to method of teaching which appeared to be mostly conventional lecturing method (Maduabum & Odili, 2011; Muhammad et al., 2020; Owolabi, 2013).

The result of the systematic review showed that student performs better in LA when taught with PTS than when taught using conventional method. The outcomes of this study are in line with that of Alzahrani and Leko (2018), Bowman-Perrot et al. (2013), Nawaz and Reman (2017), who made a meta-analysis of the academic impact of peer tutoring and found that the performance of students in peer tutoring intervention increased academically. The finding is consistent with study conducted by Lazarus (2014), Muhammad et al. (2020), Okilwa and Shelby (2010), Oloo (2016), Sofroniou and Poutos (2016), who conducted peer tutoring research as an approach to enhancing academic performance, and found that peer tutors can help low-level students understand and build on the content already implemented in a traditional classroom setting through in depth explanation of the concepts and using the relevant communication skills. Accordingly, Kocak et al. (2009) and Vassay (2010) reported that when students are motivated to explore and study linear algebra concepts in groups, they appear to be more attentive in the classroom, leading to a deeper understanding of mathematics rather than memorizing relevant information and proofs. In addition, the results also support the findings of Tracey et al. (2007), who set out to investigate the effects of cross-cultural peer teaching in South Africa. They found that students had a better understanding of algebra topics during the peer-teaching sessions and that both peer-tutors and peer-tutees benefited mutually from the peer teaching interactions. Furthermore, the results of this study are in line with those of Ansuategui and Miravet (2017), Wolfe (2018), whom examined the effectiveness of collaborative work among higher level students and found that teamwork is an influential factor in promoting their learning.

USES AND BENEFITS GAINED FROM PEER TUTORING STRATEGY

Krych, March, Bryan, Peake, Paulina and Carmichael (2005), Bentley and Hill (2009), Youdas, Krause, Hellyr, Hollman, and Rindflesch (2007), Bennett, O'Flynn, and Kelly (2014), Scott and Jelsma (2014) and Asghar (2010) pointed out that different researchers and lectures have embraced the use of peer tutoring strategy as a mainstream teaching-learning activity as well as a supplementary strategy among institutions of higher learning. Stimulus for using peer tutoring strategy in a linear algebra classroom can vary from exploring applications, promoting professionalism, identifying connections between what has been taught and learned, and transferring learning between tutors and tutees (Abdelkarim

& Abuiyada, 2016; Dikovic, 2007; Harel, 2017; Husnul-Khuluq, 2015). Some researchers sought to use peer tutoring strategy in combating increased numbers of students as well as decreased in educational resources, while others used the approach to improve student practice and develop non-technical abilities (Bentley & Hill, 2009; Scott & Jelsma, 2014; Kassab, Abu-Hijleh, Al-Shboul, & Hamdy, 2005) in a linear algebra settings (Dikovic, 2007; Harel, 2017). This study also discovered that peer tutoring strategy helped to achieve metacognitive regulation, which is a collection of self-regulatory abilities to coordinate self-learning actively. Metacognition is seen as crucial to the development of readiness and skills for academic life and career development (Bridgestock, 2009; Ursache, Blair & Rave 2012).

A research undertaken by Gazula, McKenna, Cooper and Paliadelis (2017) classifies the advantages obtained in discipline-specific and generic advantages from using peer tutoring strategy. The discipline-specific and generic advantages included discipline understanding and abilities specifically needed by the curriculum, while generic characteristics denote transferable peer-related abilities. Gazula et al. (2017) synthesizes these transferable skills as enhanced communication, enhanced teaching skills, independent learning and problem solving, as well as collaborative learning and working. The discipline-specific advantages include enhanced understanding and retention of topics, improved grades of courses, inculcation of self-directed learners, and enhanced knowledge skills (Krych et al., 2005; Bentley & Hill, 2009; Youdas, et al., 2007; Asghar 2010; Scott & Jelsma, 2014). It was emphasized that it was not officially incorporated into higher education curricula despite countless documented advantages of peer tutoring strategy.

CHALLENGES ENCOUNTERED AND RECOMMENDATIONS

Sometimes when asked to learn and teach new knowledge among their peers, students are anxious and overwhelmed. This is because they lack previous teaching experiences, insufficient time before teaching it to peers in order to master the content, and lack of timely feedback to correct errors. Some peer tutors have been reported to give their peer students more marks due to lack of experience or bias (Kassab, et al., 2005). There have also been reports of group dynamics and individual learning differences (Bridgestock, 2009; Kassab, et al., 2005), providing negative feedback (Asghar, 2010; Youdas, et al., 2007) as well as fear and anxiety among college students to adopt PTS (Kassab, et al., 2005). These included allocating more time and specific goals for each PTS session, guiding respondents with preliminary teaching skills and reducing the teaching content covered in each session (Bentley & Hill, 2009; Kassab, et al., 2005; Krych et al., 2005). Other suggestions included consideration of interactive teaching styles to match the skills of learners and their development. The studies also recognize that unique preparation for tutors is essential to the effective learning experience of students.

CONCLUSION

Most of the polytechnic curriculum depends heavily on mathematics; and the success of the students depends strongly on their ability to connect mathematics with the technical and vocational fields (Darlington & Bowyer, 2016; Loch & Lamborn, 2016). Linear algebra is one of the unavoidable advanced courses in mathematics that many students encountered at both polytechnic and university levels; therefore, one of the most essential thing that would support and improve students learning in it is the appropriate use of teaching method. Teaching and learning of polytechnic linear algebra should be encouraged with a constructive way of finding solution to problems rather than over dependence on the usual conventional approach which sometimes lead to learning through memorization without understanding the subject matter. Most of the conventional teaching and learning in colleges emphasize on the development of knowledge rather than thinking skills (Chuen, 2006); although the review shows the importance of PTS in educating students is to cope with the rapidly changing world. For students to be able to develop their skills, they need to elaborate, defend, and extend their positions, opinions, and beliefs so as to become active learners rather than passive recipients of information, making them taking responsibility for their own learning.

The aim of this systematic review was to incorporate and draw general conclusions from the results of various independent research works assessing the effect of PTS in linear algebra among polytechnic learners. This review has explored the use of PTS in linear algebra classroom within tertiary education setting. In order to guarantee that students have a positive teaching experience from PTS in linear algebra, careful planning and preparation for tutoring roles is crucial. Although students still remain the active participants in a linear algebra classrooms, academic facilitation by their teachers is useful to guarantee continuous assistance and monitoring, particularly if the participants are new to this instructional approach. This demonstrates that PTS remains a promising instructional medium in the polytechnic linear algebra waiting for more exploration.

LIMITATIONS

This review included only studies that are published in English, thus excluding studies published in other languages. Despite the strict methodology employed during the inclusion criteria, some constraints are anticipated to be taken into account by researchers. This will help interpret this study's results with caution and also within the limitations framework. The research studies that are meta-analyzed in this study are obtained from some internet databases by using a few main search terms, resulting in the non-extraction of many research papers that may be applicable to this study. Students' lack of teaching skills was also acknowledge as one of this study's constraints. Furthermore, there is no good description of how the main information about peer tutoring strategy was effected in some of the included studies in the linear algebra classroom; thus restricting a comprehensive representation of PTS. There is a strong prevalence of lack of consistency in terminologies used to describe PTS found in this systematic review.

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