

Cooperative Learning in Mathematics Education

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Abstract

Cooperative learning is a teaching strategy that encourages students to assist each other in a small group to achieve a common goal. Through cooperative learning methods, each student in the group responsible to share opinion and work together to solve the mathematical problem. The aim of this study is to examine cooperative learning method in Student Teams Achievement Division (STAD) model to assist students to excel in Mathematics. The research methodology used for this study is systematic review on current cooperative learning (CL) in teaching of Mathematics. First, this paper starts with concept of cooperative learning. Next, the STAD model and cooperative learning in Mathematics are also highlighted in the paper. Finally, the findings of 12 studies of cooperative learning methods in the classroom were discussed in this study. It is hoped that this study will be able to shade some light on the implementation of cooperative learning in Mathematics education.

Keywords: Cooperative learning, STAD, Mathematics Education, Teaching Strategy, Group

INTRODUCTION

To ensure effective teaching takes place, an educator should have a deep understanding of the learning processes, recognise the factors that affects the students' motivation and identify the characteristics of students who are developing at different rates (Noraini, 2005). According to Hansen dan Zweng (1984), two important concepts must be considered to create an effective process of teaching and learning of Mathematics. The first concept is to understand that a Mathematics lesson is a fun process and their second concept states that the process of learning should be student-centred (Lambert, Pugalee & Johnson, 2013; Millis, 2012; Polly, McGee, Wang, Van de Walle, Karp & Williams, 2007; Zakaria & Iksan, 2007).

In order to achieve the aim of teaching and learning, the strategy of teaching and learning in classrooms should be changed from teaching Mathematics by explaining to teaching the same subject by making use of various strategies and approaches. Researches have been carried out locally and worldwide to identify the suitable approaches and techniques to be practised in classrooms. As a result, the cooperative learning approach was introduced. Cooperative learning is a student-centred learning style, whereby the students carry out activities in groups. Group members will interact with each other to achieve their

groupmates' and their personal lesson objectives (Felder & Brent, 2007; Li, 2013; McCafferty, Jacobs & Iddings, 2006).

PROBLEM STATEMENT

In this challenging globalized world, the utilization of Mathematics attracts attention. The role of Mathematics is not only limited to counting, but it also involves processing data, simulations, communication and decision making. However, the decline of students' performance in Mathematics is one of the issues that are being discussed widely.

A research by Trends in International Mathematics and Science Study (TIMSS) in 2007 shows that the performance in Mathematics is declining everywhere around the world, including Malaysia. Only a few countries scored more than the average score in TIMSS's scale which is 500, while a majority of the countries scored below 500 (Olson, Martin, Mullis, Foy, Erberber & Preuschoff, 2007). According to Malaysia Education Blueprint 2013-2015 (2013), Malaysia participated in PISA's assessment for the first time in 2009. Malaysia's performance in Mathematics, Reading and Science is categorised in the lowest third from 74 countries. Almost 64% of the students under 15 years old failed to achieve the minimum benchmark in Mathematics which to acquire the basic skills that are needed by students to apply their knowledge in daily lives.

The poor performance in Mathematics is caused by several factors. According to Noraini (2006), one of the main reasons that lead to the poor performance in Mathematics is because the students assume that Mathematics is boring and difficult to master. Moreover, most of the students in Malaysia are passive in the process of learning and the teachers have to plan group activities to encourage discussion among students in the classroom. Chacko (1999) compared the learning of Mathematics between students in America and students in Malaysia. He claimed that Malaysian students learn facts by memorizing and that causes them to fail to think deeply. Learning by memorizing and conventional learning will create students who are good at counting. However, they will not understand the concept of Mathematics and will not be able to apply the concept or skills of Mathematics in solving daily problems. In such, students become passive recipient of knowledge and resort to rote learning (Zakaria, Iksan, 2007).

Therefore, teachers should use effective teaching methods to increase the students' understanding and mastery of Mathematics. Previous researches proved that the application of co-operative learning is not only able to improve the students' performances, but it is also capable of increasing the social and interaction skills (Zakaria, Iksan, 2007) between students and teacher. Apart from that, cooperative learning encourages students to think critically, and at the same time boosts the students' confidence and instills mutual respect in the classroom (Artzt & Newman, 1997; Slavin, 1995). The importance of cooperative learning should not be overlooked. Thus, researches should be carried out to fully utilize cooperative learning in the process of teaching and learning of Mathematics in Malaysia.

LITERATURE REVIEW

The Concepts of Cooperative Learning

Cooperative Learning (CL) is defined as a learning process that requires students to work and learn together. They are expected to be responsible not only towards their own learning, but also towards the learning of their friends. The practice of cooperative learning gives acknowledgements or rewards to make sure the students have fun learning. In addition, cooperative learning motivates students. This is similar to the idea of the behaviorism theory which agrees that rewards and certificates given by a teacher motivates the students to learn (Cohen, 1994; Johnson, Johnson and Anderson, 1976; Slavin, 1990). According to Juriah Long (2010), cooperative learning changes the conventional approach by stimulating the students' thinking ability and higher order thinking skills. Juriah also added that cooperative learning requires students to voice out their opinion and generate ideas to obtain ideas relevant to the topic that is being learnt. This approach is also effective in creating students who learn actively and it indirectly increases the students' confidence and the effectiveness of the learning process.

STAD Model

Students Team Achievement Division (STAD) is a technique in cooperative learning that was introduced by Slavin (1990). Slavin conducted a research and went through intensive training using this approach in John Hopkins University. STAD is a continuous teaching structure which covers the beginning of the lesson until the very end of the lesson. According to Slavin, STAD is one of CL's models which is suitable for teaching and learning Mathematics because this model is perfect for subjects in which the questions will produce only one correct answer.

Most of the researches involving this approach (Conring, 2009; Esmonde, 2009; Mohammed Shafiuddin, 2010; Sin, 2006; Slavin, Madden & Leavey, 1984) indicate that STAD is able to improve students' performance and it leaves a positive impact on the students' learning. Apart from that, the structure of the activities that utilizes this approach is brief, direct and easily understood. Wahyuni and Abadi (2014) found out that STAD is more effective compared to Think Pair Share (TPS) in terms of tertiary students' competence, mathematical communicative ability and mathematical thinking.

Cooperative learning's STAD model is an approach that prioritizes interaction among group members and their willingness to help each other to achieve their group's and their own learning objectives. The STAD model is not the same with the regular class activities. It requires the students to be responsible upon their achievement and assessments are done individually. Apart from that, the STAD model gives students the opportunity cooperates with other students. Students will depend on each other in a positive way and they will be able master the lesson taught.

Cooperative Learning in Mathematics

Lasvani and Khandan (2011) stated that suitable teaching techniques should be restudied to create an effective Mathematics teaching and learning session. Malaysia's Ministry of Education (2002) stressed that teaching and learning activities planned by educators must encourage

students' involvement, stimulate the students' thinking, consider their learning style and the multiple intelligence among the students. The technique of teaching Mathematics in a wider context together with the affective objectives are one of the ways to focus on the relationship between aim, attitude and learning (Sundre, Barry, Gynnild & Ostgard, 2012). Ifamuyiwaa and Akinsola (2008), on the other hand stated that Mathematical knowledge is not only limited to encourage students to count logically and accurately, and to sort out facts systematically, but, it should also be able to help students to think to solve their problems. Thus, Cooperative learning is recognized as an effective method of teaching Mathematics by fulfilling the criteria mentioned above (Koh, Choy, Lai, Khaw & Seah, 2008).

Besides that, another vital aspect for a student to compete in today's world is their ability to think and solve problems. Studies indicate that the application of cooperative learning increases students' skills in solving complex Mathematical problems which involves dynamic interaction between cognitive and metacognitive (Dees, 1991; Qin; 1993). This method is also a simple learning approach which is able to create a collaborative learning environment which involves learning in groups and each group member contribute to achieve their target together (Ifamuyiwaa & Akinsola, 2008; Meor Ibrahim Kamaruddin & Nurul Amira Ahmad, 2010; Slavin, 1990). Learning in groups and interaction among students during a Mathematics lesson were recommended long time ago by Ahmadi (2000) ; Artzt dan Newmann (1997); National Council for Teachers of Mathematics (1989); Noraini (2006), Robertson, Davidson and Dees (1994).

The STAD is a commonly used Cooperative learning approach to promote effective learning of Mathematics. Previous studies proved that the STAD model is one of the effective Cooperative learning approaches used to improve students' academic performance in Mathematics. This approach also leaves a positive impact towards the perception of learning and students' attitude (Esmonde, 2009; Johnson & Johnson, 2008; Lee, 1999; Slavin, 1990; Whicker et al, 1997; Williams, 1988). On the contrary, the conventional or traditional approach that has been used so far could not affect the students' achievement because the skills and the knowledge of each student differ (Conring, 2009; Noraini, 2005). Previous researches imply that cooperative learning through the STAD model is an effective approach to increase the students' cognitive and affective abilities especially in Mathematics.

METHODOLOGY

The systematic review method was used in this study. The main focus of this study is to obtain the necessary information regarding the use cooperative learning in Mathematics by utilizing the STAD model. The sources of references of this study include theses from the libraries, electronic theses and electronic journals obtained from various sources like Springer Link, ProQuest, Elsevier and Google Scholar. The sources of references were published between 2006 and 2016. The keywords searched are "cooperative learning", "mathematical education" and "STAD model". 36 articles were found. However, only 12 articles were selected as the 12 articles extremely relevant to this research. Among the 12 articles, four of them are related cooperative learning in Mathematics, whereas nine of the articles focus more on the main idea of the research itself which is cooperative learning in Mathematics by utilizing the STAD model. The data collected through the researches are divided into four focuses, which are 1) The

Increase of Students' Performance in Mathematics, 2) Positive Attitude towards Mathematics, 3) Increase the students' confidence in Mathematics and 4) Positive Attitude among Students.

RESULTS AND FINDINGS

Research Pertaining Cooperative Learning

Cooperative learning is one of the techniques that managed to attract many researchers' attention locally and globally. The effectiveness of the practice of cooperative learning is the main research focus of researchers. Plenty of researches were conducted in Western countries because they had been implementing the cooperative learning technique in their education system for quite a while now. However, in Malaysia, the research on cooperative learning is not that popular considering that this technique is not widely used in this nation. The research on cooperative learning has been carried out since 1990s in Malaysia (Nor Azizah & Chong, 2000). Despite this, some efforts were made to study the implementation and accomplishments of cooperative learning in our country. This study analyzed the results of 12 researches carried out in Malaysia and overseas which focused on the effects of the implementation cooperative learning from 2006 until 2016.

Table 1 shows that the results of six previous researches agree that cooperative learning could improve students' performance in Mathematics. Sin (2006) conducted a research on 60 Form 1 students by using cooperative learning's STAD model in teaching Mathematics. The research proved that the students perform better when they are taught using the cooperative learning approach compared to the conventional learning approach.

Tarim dan Akdeniz (2008) conducted a research on seven Year 4 classes, whereby two classes were taught using the cooperative model's Team Assisted Individualization (TAI), another two classes were taught using the cooperative model's STAD method and the remaining three classes were taught using the conventional method. It is found that there is an improvement in the students' performance in Mathematics in the experimental group compared to the students in the controlled group. The research conducted by Teoh, Toh and Nor Azilah (2010) which focuses on the integration of cooperative learning strategy, mastery learning and interactive multimedia proved that there is an improvement in the academic performance in the topic Matrix.

Zakaria, Chin and Daud (2010) conducted a research on two form 1 classes in Miri, Sarawak. The findings of the research suggest that the cooperative learning technique improves the students' performance in Mathematics. The research carried out by Awofala, Fatade and Ola-Oluwa (2012) which utilized the combination the STAD and TGT approaches found out that there is a significant difference in the Nigerian secondary school students' performance in Mathematics. Wong (2014) proved that cooperative model's STAD succeeded in improving Form 2 students' mastery of the chapter 'Direct Numbers'.

Table 1: Findings on Improvement Performance in Cooperative Learning Mathematics

No.	Title	Reference	Author	Year	Focus
1	STAD model cooperative learning for form 1 student In the Topic "negative numbers".	Thesis, Faculty Science, Open University Malaysia.	Sin Chow Lai	2006	Improving academic performance and Positive attitude towards Mathematics
2	The effects of cooperative learning on Turkish elementary students' mathematics achievement and attitude towards mathematics using TAI and STAD methods	Journal Educational Studies in Mathematics	Tarim and Akdeniz	2008	Improving academic performance
3	Effect of an interactive courseware in the learning of matrices	Journal of Educational Technology & Society	Teoh, Toh and Nor Azilah,	2010	Improving academic performance
4	The Effects of Cooperative Learning on Students' Mathematics Achievement and Attitude towards Mathematics.	Journal of Social Sciences	Zakaria, Chin and Daud	2010	Improving academic performance and Positive attitude towards Mathematics
5	Achievement in cooperative versus individualistic goal-structured Junior Secondary School Mathematics Classrooms in Nigeria.	International Journal of Mathematics Trends and Technology	Awofala, Fatade and Ola-Oluwa	2012	Improving academic performance
6	Effects of Cooperative Learning (STAD) On Learning Mathematics in Secondary School Students	Thesis, Sultan Idris Education University	Wong	2014	Improving academic performance

The results of the four researches illustrated in Table 2 show that students tend to display a more positive attitude when they learn Mathematics through cooperative learning. The

research conducted by Sin (2006) proved that cooperative learning's STAD helped to improve the Form 1 students' performance in the topic Negative Numbers. 90% of the students in the experiment group prefer cooperative learning's STAD because it is fun and 87% of them realized that they are able to solve mathematical problems involving negative number more easily after they were taught using cooperative learning's STAD model.

Zaitun (2001) as cited in Effandi Zakaria and Zanaton Iksan (2009) studied the effects of cooperative learning using the STAD model. The results indicate that there is a positive attitude towards Mathematics, whereby most students have a positive perception towards the STAD model. The findings of Zakaria, Chin and Daud (2010) research showed that cooperative learning could instill a positive attitude among students towards the learning of Mathematics. This is due to the fact that students could help each other during group activities to solve mathematical problems. This indirectly changes the students' attitude towards learning Mathematics. The research conducted by Zainun, Zainaton and Norziah (2013) identified the effects of cooperative learning by using the STAD model on the attitude of students toward the learning of Mathematics. Overall, 95% of students had a positive perspective in learning through cooperative learning's STAD model.

Table 2: Findings Cooperative Learning about Positive Attitude towards Mathematics Students.

No.	Title	Reference	Author	Year	Focus
1	STAD model cooperative learning for form 1 student In the Topic "negative number".	Thesis, Faculty Science, Open University Malaysia.	Sin Chow Lai	2006	Positive attitude towards Mathematics and Improving academic performance
2	Promoting cooperative learning in science and mathematics education: A Malaysian perspective	Eurasia Journal of Mathematics, Science & Technology Education	Zaitun as cited in Effandi Zakaria and Zanaton Iksan	2009	Positive attitude towards Mathematics
3	The Effects of Cooperative Learning on Students' Mathematics Achievement and Attitude towards Mathematics.	Journal of Social Sciences	Zakaria, Chin and Daud	2010	Improving academic performance Positive attitude towards Mathematics

4	The Effects of Cooperative Learning Model STAD On Attitude towards Mathematics	Journal of Mathematics Education	Zainun, Zainaton and Norziah	2013	Positive attitude towards Mathematics
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Table 3 shows four research findings which indicate that cooperative learning in Mathematics could produce students with positive attitude. Findings from the research done by Curtis (2006) on cooperative learning shows that the anxiety of students towards learning Mathematics decreased because they got along with this teaching technique. Cooperative learning could be implemented in pre-schools to teach Mathematics (Artut, 2009). Artut found that children tend to cooperate, share, and listen to the teachers' instructions better after they were introduced to cooperative learning. They are also found to be more responsible.

Oluwasanmi (2012) proved through his research that in cooperative learning, students are more motivated to learn. They also tend to possess a higher self-esteem and they are less worried in learning Mathematics. Moreover, the findings of the Prabowo and Sunaryo (2015) research show that the practice of cooperative learning's STAD model in Curriculum Analysis and Mathematics Learning Material (I) course using STAD, improves students' participation in the lesson and they tend to be more active in group activities.

Table 3: Findings Cooperative Learning about Positive Attitude Among Students.

No.	Title	Reference	Author	Year	Focus
1	Improving student's attitudes: A study of a mathematics curriculum innovation	Tesis PhD, Kansas State University	Curtis	2006	Show a positive attitude among students Boosting students' confidence in Mathematics
2	Experimental evaluation of the effects of cooperative learning on kindergarten children's mathematics ability	International Journal of Educational Research	Artut	2009	Show a positive attitude among students
3	Achievement, anxiety, self-concept and motivation	Tesis Sarjana, University of	Oluwasanmi	2012	Show a positive attitude among

	among college algebra students within a cooperative learning structure	New Mexico			students
4	Improving Active Participant of Student on Curriculum Analysis and Mathematics Learning Material (I) Courses Using Cooperative Learning Model Type Students Team-Achievement Division (STAD).	Journal Mathematics Education AlphaMath,	Prabowo and Sunaryo	2015	Actively involved (positive attitude) in the group

As showed in Table 4, a previous research concluded that the students' confidence increases with the implementation of cooperative learning in classrooms. Curtis (2006) found that cooperative learning boosts the students' confidence in Mathematics because they are more confident in solving mathematical problems.

Table 4: Findings Cooperative Learning of Increasing Confidence Students in Mathematics.

No.	Title	Reference	Author	Year	Focus
1	Improving student's attitudes: A study of a mathematics curriculum innovation	Tesis PhD, Kansas State University	Curtis	2006	Boosting students' confidence in Mathematics Show a positive attitude among students

In conclusion, the previous researches support that the utilization cooperative learning leaves a more positive impact in terms of affectivity and the performance of students compared to the application of traditional learning. Researches to date consistently prove that cooperative learning is capable of improving academic performance, creating a more conducive learning environment and improving students' self-esteem. Moreover, cooperative learning also improves students' self-confidence and soft skills.

DISCUSSION

The previous researches discussed above do not show any obvious advantages for the implementation of continuous traditional learning. Cooperative learning's STAD model improves students' cooperation with the teacher. It also consistently improves the students

performance and problem-solving ability. It is hoped that the exposure to cooperative learning not only assists students to solve complex mathematical problems, but also helps them in their challenging daily lives.

However, it should be noted that Mathematics teachers would go through plenty of challenges in implementing cooperative learning in classrooms. For instance, teachers should prepare more teaching materials. They also require more time to adapt themselves to the new technique. Moreover, some teachers might not have the necessary skills to conduct group activities. According to Zakaria and Ikhsan (2007), these problems could be solved by carrying out intensive courses for in-service teachers. Apart from that, it is hoped that the Ministry of Education will plan and provide cooperative learning modules to reduce the teachers' burden and aid creative teachers who are willing to use this method in the process of teaching and learning Mathematics.

Previous researches also clearly prove that cooperative learning leaves a positive impact in terms of affectivity and students' performance compared to the conventional method. The finding of these researches should be benefitted in the teaching and learning in Malaysia. Generally, students in Malaysia are more conservative. They find it difficult to voice out their opinion and interact actively in their class. It is hoped that with the practice of cooperative learning, students' cognition could be improved besides transforming Mathematics as a subject that catches the interest of students.

The results of studied related to cooperative learning should be spread to all schools in Malaysia to encourage Mathematics teachers to utilize this teaching approach. An effort that could be done to increase the quality of the Mathematics teachers' lessons is by conducting staff developmental programs which focus on the criteria that must be fulfilled by the teachers' lessons. The analysis of the researches should be studied before conducting the program. These programs should emphasize on hands-on activities and tutorials. Even though, cooperative learning could not overcome all the problems faced in the teaching and learning of Mathematics, it could not be denied that cooperative learning is a great alternative to the traditional learning method.

CONCLUSION

Cooperative learning is not a new technique in teaching and learning according to the previous researches. Cooperative learning is proved to benefit the students, especially in the mastery of a skill in Mathematics. Cooperative learning is a proven learning technique which is capable of leaving positive impacts among teachers and students to improve the students' academic performance in Mathematics. Cooperative learning should be practised by Mathematics teachers in schools and it should be accepted as a major learning technique in Mathematics to produce students who are excellent in academics. It could also benefit students in their challenging daily lives.

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