The Effectiveness of Peer Tutoring in the Teaching of Mathematics

***SIEW-LING GAN**
KIAN-SAM HONG
Universiti Malaysia Sarawak
*(hksam@fcs.unimas.my)

ABSTRACT

Purpose – This study examined the effectiveness of peer tutoring in the teaching of Mathematics in a Malaysian government secondary school. This study also investigated the effects of peer tutoring on interest in learning mathematics, perceptions of instructional methods and mathematics self-efficacy, as well as gender differences for the various variables.

Method – This study utilised the pretest-posttest with control group quasi-experimental research design. Two form four classes were randomly assigned to be taught using peer tutoring, and taught using lectures and exercises. The research instruments used in the study were a pretest, a posttest, and a questionnaire.

Findings – Results showed that students who received peer tutoring had higher gain scores in the mathematics achievement tests compared to those receiving traditional instruction. In addition, female students performed better in the mathematics achievement tests. However, there was no interaction effect between gender and instructional methods used. Students in the peer tutoring groups showed higher interest in learning mathematics and mathematics self-efficacy. They also showed positive perceptions toward peer tutoring. In the peer tutoring group, female students showed higher interest in mathematics than male students. However, gender differences were not evident for mathematics self-efficacy and perceptions toward peer tutoring. Thus, it could be concluded that peer tutoring is a potentially effective instructional method that could be practised in secondary mathematics teaching and learning in Malaysian schools in tandem with other existing instructional methods.

Value – Peer tutoring has not been widely studied in the context of the Malaysian classroom. This paper provides empirical findings

supporting the effectiveness of peer tutoring as an instructional approach in enhancing students' learning of mathematics irrespective of gender. In addition, peer tutoring can also augment students' interest toward learning mathematics and their mathematics self-efficacy.

Keywords: peer tutoring, mathematics, interest to learn mathematics, mathematics self-efficacy, perceptions, gender.

INTRODUCTION

Malaysia has Vision 2020, which aims to produce a new generation of human resource that is productive, innovative, and has critical and creative thinking skills. In order to make this vision a reality, the learning environment in Malaysian schools is being transformed from one that is predominantly memory-based and teacher-based learning environment, to one that emphasises critical and creative thinking and promotes learner-centred learning (Ismail & Alexander, 2005). All schools in Malaysia are in the process of being upgraded to smart schools physically. Yet, in most of these schools, the didactic approach to learning and instruction is ubiquitous within the Malaysian education system (Ismail & Alexander, 2005). The majority of teachers in Malaysia are still not ready to use student-centred approaches, such as peer tutoring in their classroom. If this situation remains, then undoubtedly the nation's Vision 2020 would not be fulfilled.

In Malaysia, the education fraternity is moving from conventional lecturing pedagogy, which focuses on teacher-centred learning of facts acquisition and memory-oriented learning (Ng, Bakar, Roslan, Wong, & Rahman, 2005) to teaching and learning methods which emphasise active student involvement in the learning processes (Ismail & Alexander, 2005). The traditional lecture teaching approach causes students to be unable to construct their own understanding, think creatively, innovatively, and critically since they are not actively participating in the learning process. Additionally, some students are not able to keep pace with the teacher's teaching. Hence, in order to promote active participation of students, teachers should adjust their teaching style to a more learner-centred one. One of the student-centred teaching approaches is the peer tutoring approach (Golding, Facey-Shaw, & Tennant, 2006).

Peer tutoring is "systematic, peer-mediated teaching strategies" (Rohrbeck, Ginsburg-Block, Fantuzzo, & Miller, 2003) that consist of student partnerships, and linking high achieving students with lower achieving students or those with comparable achievement, for structured reading and mathematics study sessions. A significant amount of literature has focused on peer tutoring as a learning strategy to improve learning. However, most of the findings were based on Western contexts. For example, studies conducted by Fuchs, Fuchs, and Karns (2001), Fuchs, Fuchs, Yazdian, and Powell (2002), and Presbitero (2002) showed that peer tutoring classes significantly outperformed control group classes in academic achievements.

Peer tutoring has also been shown to be effective in improving attitudinal and socio-emotional outcomes of students. Topping, Campbell, Douglas, and Smith (2003) reported that a combination of cross-age peer tutoring with mathematics games was successful in increasing self-esteem for both tutors and tutees. Students showed improvements in academic self-efficacy and learning self-efficacy (Topping et al., 2003) and intrinsic interest (Topping, Peter, Stephen, & Whale, 2004) when using peer tutoring. However, as peer tutoring is a teaching approach that is not yet widely used by teachers in Malaysia, the perceptions toward using peer tutoring in mathematics learning has not yet been fully researched in the Malaysian context. It is generally difficult to introduce student-centred instructional strategies, such as peer tutoring, into the Malaysian education system (Ismail & Alexander, 2005) as teachers and students need time to adjust themselves to the new instructional approach. They may or may not accept peer tutoring regardless of its benefits to learning outcomes. In addition, the effectiveness of such instructional methods could also be affected by student factors such as gender.

Problem Statement

Malaysia introduced the smart schools initiative to create schools that adopt a learner-centred approach (Onn, 1998 as cited in Ismail & Alexander, 2005) with students working cooperatively and collaboratively with each other on their classroom tasks and assignments with some guidance from teachers (Ismail & Alexander, 2005). In actuality, all schools in Malaysia have been or are in the process of being upgraded to smart schools physically, yet in most

schools, the teaching and learning approaches used are still mainly of transmission mode from teachers to students. The Majority of the teachers in Malaysia are still not ready to use student-centred approaches, such as peer tutoring in their classroom.

Peer tutoring is not a well-known instructional strategy among Malaysian teachers and students. Malaysian schools have not fully embraced this instruction strategy in the process of teaching and learning. A possible reason is the lack of local context studies that showed peer tutoring as a useful instructional strategy to improve and enhance academic performance of students in Malaysia.

Purposes of the Study

Thus, the purpose of this study was to determine whether peer tutoring has positive effects on mathematics achievement among students in Malaysian secondary schools. Furthermore, this research also intended to investigate differences in mathematics achievement between female and male students in secondary schools, as well as the interaction between the instructional methods (peer tutoring and traditional instruction) and gender on mathematics achievement. Additionally, the effects of peer tutoring and gender on students' interest in learning mathematics, students' perceptions of the instructional methods, and students' mathematics self-efficacy were also investigated.

Research Questions

This study investigated the following research questions:

1. Are there any differences in mathematics achievement between the groups of students taught using peer tutoring and traditional instruction method for the topic of 'straight line'?
2. Are there any differences in students' mathematics achievement based on gender?
3. Are there any interaction effects between instructional methods (peer tutoring and traditional instruction method) and gender on mathematics achievement?
4. Are there any differences in students' interest in mathematics between the groups of students taught using peer tutoring and traditional instruction method?
5. Are there any differences in students' interest in mathematics based on gender in the peer tutoring group?

6. Are there any differences in mathematics self-efficacy between students taught using peer tutoring and traditional instruction?
7. Are there any differences in students' mathematics self-efficacy based on gender in the peer tutoring group?
8. Are there any differences in students' perceptions of the instructional methods between students taught using peer tutoring and traditional instructional?
9. Are there any differences in students' perceptions of peer tutoring based on gender?

LITERATURE REVIEW

Peer Tutoring

Peer tutoring has received increasing attention from educators and researchers in recent years. According to Topping (1996), peer tutoring is an existing instructional method traceable to at least as far back as the ancient Greeks. Peer tutoring comprises systematic, peer-mediated teaching strategies (Rohrbeck et al., 2003) in which students work with others who are at their own grade level during peer tutoring sessions (Robinson, Schofield, & Steers-Wentzell, 2005). However, multiple definitions of peer tutoring exist, and they are not all consistent (Northwest Regional Educational Laboratory, 2001). Peer tutors can be one who is an expert, same-aged classmate, or same-aged low achiever. Hence, there is a variety of instructional approaches, developed by educators or researchers based on the concept of peer interaction which could improve students' performance in various academic areas or in behavioural management. Classwide peer tutoring (CWPT), reciprocal peer tutoring (RPT), peer-assisted learning strategies (PALS), and cross-age tutoring are examples of peer tutoring instructional strategies.

According to Boud, Cohen, and Sampson (2001), students learn by explaining their ideas to others and by participating in activities which they can learn from their peers. The specific characteristic of peer tutoring is one of the students will become the tutor while another one will become the student. Hence, peer tutoring can be considered as an interaction between two students in which the tutor helps the tutee in learning skills or content material (Bettenhausen, 2002).

Peer Tutoring and Mathematics Achievement

Peer tutoring has been increasingly utilised in educational settings, especially in Western countries. There is strong evidence that peer tutoring is effective for students in learning school-related materials (Fuchs, Fuchs, Bentz, Phillips, & Hamlett, 1994) and can also lead to greater achievement gains than traditional instruction (Fuchs, Fuchs, Mathes, & Simmons, 1997).

In a study that evaluated the effectiveness of using PALS to enhance mathematical development of kindergarten students, Fuchs et al. (2001) used 168 kindergarten students in five schools in a metropolitan public school district in the American Southeast as participants. Twenty classes were randomly assigned to PALS (treatment group) and non-PALS (control group). Fuchs et al. (2001) found that PALS students showed an improvement in the standardised test of math readiness (scores and the improvements exceeded that of the control group students).

Presbitero (2002), in a study designed to investigate the effectiveness of peer tutoring in improving mathematics achievement of second year high school students, summarised that students who receive peer tutoring performed better than students who did not received peer tutoring. The result also showed that the experimental group performed better for comprehension, computation, and analysis skills. Fuchs et al. (2002) examined the effects of PALS on first-grade children's mathematical development, and reported that (a) first-grade teachers implemented PALS with high fidelity, (b) PALS teachers were satisfied with their teaching experiences and felt that PALS was effective and generally feasible to be used in helping students to improve their mathematics performance, and (c) high achievers, average achievers, and low achievers benefited from PALS programme and it was effective and feasible for both students with and without disabilities.

Peer Tutoring in Fostering Attitudinal and Socio-Emotional Outcomes

Peer tutoring does not merely improve students' academic performance. Peer tutoring also contributes to fostering of students' interest, perceptions, self-efficacy, attitude, and self-concept. For examples, Evans, Flower, and Holton (2001), in a study that investigated the effects of peer tutoring in first year undergraduate

mathematics involving two different first year classes, concluded that students generally enjoyed their peer tutoring experiences. Calhoon, Al Otaiba, Greenberg, King, and Avalos (2006) explored the effectiveness of PALS in enhancing reading among 78 first-grade students in a New Mexico border town. They reported that students who had received PALS intervention showed positive perceptions toward PALS. Students reported that they liked PALS, worked at PALS, felt PALS helped them read better, and liked working with a partner.

Cheung and Winter (1999), on the other hand, were interested in exploring the effect of CWPT under two conditions – with reinforcement (CWPT + R) and without reinforcement (CWPT – R). Initially both CWPT groups showed high intrinsic interests toward integrated science. However, after the treatment, results suggested that the CWPT + R group have statistically significant reduced intrinsic interest in integrated science, but the CWPT – R group showed no improvement or reduction of intrinsic interest.

Peer Tutoring and Self-Efficacy

Griffin and Griffin (1997) conducted two experiments to examine the effects of RPT on graduate student achievement, test anxiety and academic self-efficacy. In experiment 1 (using RPT), pretest, posttest and questionnaire were administered to 93 graduate students who took part in four sections of an introductory course on educational research. In experiment 2, 38 graduate students who took part in two sections of an introductory course on educational research were divided into RPT and non-RPT groups. Results indicated that there was no significant difference in either test anxiety or academic self-efficacy between the RPT and non-RPT groups.

Golding et al. (2006) analysed the effects of peer tutoring, attitudes and personality on academic performance. Participants involved in the study were first year computing students in the University of Technology, Jamaica. Golding et al. (2006) explored the students' attitudes by considering three areas, namely personal confidence in programming, usefulness of programming, and perception of teacher motivation. They reported that students who received peer tutoring were more confident in their ability to learn programming than students who did not join the peer tutoring group. Hence, students' self-efficacy to learn was higher in the peer tutoring group than the traditional group.

Gender Differences in Mathematics Performance and Instructional Method

Gender differences in academic achievement have long fascinated researchers and policy-makers alike (LoGerfo, Nichols, & Chaplin, 2006) and there were interesting and contradictory results from previous studies on gender issues (Adedayo, 1999). While some results reported male superiority, some others reported superiority of females, and yet others there are who found no gender differences in mathematics achievement at various levels of the educational systems (Adedayo, 1999). This could be attributed to the diversity of teaching styles used, types of schools (primary, secondary, or higher education schools), and varied countries where the research was conducted. Some research suggested that both girls' and boys' mathematics performances were equal at the elementary level, but girls' performance tend to decrease in middle school (Callahan & Clements, 1984). LoGerfo et al. (2006) in their study investigating gender gaps in mathematics gains during elementary and high school by race and ethnicity, reported that males and females had similar mathematics scores during kindergarten, but girls started to show decline in mathematics scores in the first-grade, third-grade, and secondary school studies.

RESEARCH METHODOLOGY

Research Design

This research used a pretest-posttest with control group quasi-experimental research design. The quantitative data were analysed using a pretest, a posttest, and a questionnaire.

Samples

The population was all the form 4 students in a government secondary school in Kuching, Sarawak, Malaysia. This school has 11 classes of form four which consisted of three science classes and eight arts classes. Participants in the research were students in two randomly selected intact classes, namely Form 4 Arts 1 and Form 4 Arts 4. The

students were of varied abilities, academic achievements, gender, and ethnicity. The peer tutoring group (Form 4 Arts 1) and the traditional lecture-based instruction group (Form 4 Arts 4) has 33 and 34 students respectively.

Research Instruments

The research instruments used in this research were the academic achievement tests and a questionnaire. The academic achievement tests comprised the pretest and posttest, and were used to measure the students' mathematics achievement and ability in solving the straight line topic in the form four mathematics syllabus. Each test consisted of 20 questions and was divided into Section A (15 multiple-choice questions) and Section B (5 open-ended questions). Both the pretest and the posttest were validated by the Head of the Mathematics Department in the school. Section A of the questionnaire collected information regarding the student's demographic details. The other three sections of the questionnaire comprised 26 items, with Section B (students' interest in mathematics) having eight items, Section C (students' perceptions of the instructional method) with 10 items and Section D (students' mathematics self-efficacy) consisting of eight items.

Examples of items in Section B were "I like the lessons in this subject" and "Lessons in this topic is fun". For Section C, the sample items were "I learn from other students in this class" and "I explain my ideas to other students". Section D consisted of items such as "I outdo most of my classmates in this subject" and "I find it easy to get good grades in this subject". Each item in the questionnaire was based on the five-point Likert scale response choices, ranging from "strongly agree" to "strongly disagree". The questionnaire was validated by a mathematics educator at Universiti Malaysia Sarawak. To determine the reliability of the research instrument, the Cronbach alpha coefficients were calculated for the Section B, C, and D of the questionnaire, and a post-test. From the results shown in Table 1, it was concluded that all the three sections showed high reliability, with alpha values for Section B, C, and D of 0.910, 0.843, and 0.766 respectively. Based on results shown in Table 2, the posttest was also considered reliable with alpha values of 0.720 and 0.733 for the multiple-choice and open-ended questions respectively.

Table 1

Realibility of the Instrument

	Number of Items	α
Students' interest in mathematics	8	0.91
Students' perceptions of instructional method	10	0.84
Students' mathematics self-efficacy	8	0.77

Table 2

Reliability Coefficients for Posttest

		Number of Items	α
Posttest	Multiple-Choice Questions	15	0.72
	Open-ended Questions	5	0.73

Data Collection Procedures

All the students in Form 4 Arts 1 and Form 4 Arts 4 were administered a pretest. Then, each class was taught using a different instructional method for two weeks. Form 4 Arts 1 was the treatment group (taught using the peer tutoring) while Form 4 Arts 4 was the control group (taught using the traditional instructional method, which consisted of lectures and class exercises). The lessons covered included three subtopics of the straight line (gradient of a straight line, gradient of a straight line in a Cartesian coordinate, and intercept).

The following steps were employed in the treatment group: before implementing the peer tutoring in class, the entire class was given training regarding procedures involved in peer tutoring. Then, the teacher divided the entire class into two groups based on their scores in the pretest. The teacher assigned a partner for each tutor. The teacher trained the entire class on the steps involved in peer tutoring and the strategies used to fulfil their role as tutors or tutees. Once the students could handle the tutoring session, the teacher started the treatment. Firstly, the teacher taught the students a subtopic under the topic of straight line. Then, the teacher gave tutoring materials (express notes) to tutors as the main resources to teach the tutees. The tutors presented materials previously covered by the teacher and explained the examples in the express notes. The tutors also provided some related questions for the tutees to solve

and the tutors would provide feedback. The tutoring session took at least 15 to 20 minutes and then the tutors and tutees switched roles to give an opportunity for the tutees to repeat or recall what they have learnt from their tutors. Then, all students received a worksheet containing the topic they have learnt in the lesson. Once they completed the worksheets, they exchanged the worksheets and scored them. These procedures were repeated for the next subtopic in the topic of straight line. After two weeks, students in both classes were administered a posttest to test their level of understanding of the subtopics. After the students completed the posttest, they completed the questionnaires.

Data Analysis

Data collected from the study were analysed using two-way ANOVAs and independent-t-tests. For research questions 1, 2, and 3, two-way ANOVA and descriptive statistics such as means and standard deviations were used to determine whether there was any significant differences in mathematics achievement based on instructional method and gender, and also the interaction effect between them. As for research questions 4, 6, and 8, independent t-test and descriptive statistics such as means, standard deviations, and frequencies were used to determine significant differences in terms of students' interest in mathematics, students' mathematics self-efficacy, and students' perceptions toward instructional method for students' in the two methods of instruction. Next, for research questions 5, 7, and 9, independent t-tests were conducted to examine students' interest in mathematics, students' mathematics self-efficacy, and students' perceptions toward instructional method respectively in the peer tutoring group.

RESULTS

As shown in Table 3, there were significant differences in the mean gain in mathematics achievement (posttest – pretest) between the classes taught using different instructional methods ($F(1, 63) = 81.02$, $p < 0.005$). Referring to Table 4, students in the treatment group using peer tutoring instructional approach had higher mean gain scores for the mathematics achievement tests ($M = 42.96$, $SD =$

2.45) compared to those in the control group (M = 12.19, SD = 2.38). Table 3 also showed that there were significant differences in the mean gain in mathematics achievement tests scores based on gender (F (1, 63) = 5.41, p = 0.02). Female students had higher mean gain in mathematics achievement tests scores (M = 31.55, SD = 2.00) than male students (M = 23.60, SD = 2.77). However, there was no significant interaction effect between gender and instructional approach used (F (1, 63) = 0.57, p = 0.45).

Table 3

Results of Two-way ANOVA for Gain in Mathematics Achievement (Pretest-Posttest Scores)

	SS	MS	F	F	F
Instructional method	14282.06	1	14282.06	81.02	<0.0005
Gender	953.64	1	953.64	5.41	0.02
Instructional method × Gender	100.97	1	100.97	0.57	0.45
Error	11591.10	63			
Total	24684.99	66			

Table 4

Means and Standard Deviations for the Gain in the Pretest and Posttest

Instructional method	Male	Female	Total
Peer Tutoring	M = 40.27	M = 45. 64	M = 42.96
	SD = 4.00	SD = 2.83	SD = 2.45
Traditional	M = 6.97	M = 17.45	M = 12.19
	SD = 3.83	SD = 2.83	SD = 2.38
	SD = 2.77	SD = 2.00	
Total	M = 23.60	M = 31.55	

Notes: N: Number of students, M: Mean, SD: Standard deviation

Based on Table 5, there was a significant difference in students' interest in learning mathematics between the groups taught using peer tutoring method and traditional lecture-based instruction

method (t (65) = 6.00, p < 0.0005). Students who received peer tutoring intervention (M = 1.62, SD = 0.43) showed higher interest to learn mathematics than students who did not received the intervention (M = 2.47, SD = 0.70).

Table 5

Independent t-test Results for Differences in Students' Interest in Learning Mathematics based on the Instructional Methods

		M	SD	t	p-value
Interest	Peer Tutoring	1.62	0.43	6.00	<0.0005
	Traditional	2.47	0.70		

Note: 1 = high interest in mathematics, 5 = low interest in mathematics

Likewise, Table 6 showed that there was a significant difference in students' interest in learning mathematics based on gender in the peer tutoring group (t (31) = 2.40, p = 0.02). Female students (M = 1.50, SD = 0.42) had higher interest to learn mathematics than male students (M = 1.85, SD = 0.34).

Table 6

Independent t-test Results for Differences in Students' Interest in Learning Mathematics based on Gender in the Peer Tutoring Group

		M	SD	t	p-value
Interest	Male	1.85	0.34	2.40	0.02
	Female	1.50			

Note: 1 = high interest in mathematics, 5 = low interest in mathematics

Based on the results shown in Table 7, there were significant differences in students' mathematics self-efficacy between the groups taught using peer tutoring and traditional lecture-based instruction method (t (65) = 3.71, p < 0.0005). Students who had received peer tutoring intervention (M = 2.36, SD = 0.60) showed higher efficacy to learn mathematics than students who did not receive the intervention (M = 2.91, SD = 0.62).

Table 7

Independent t-test Results for Students' Mathematics Self-Efficacy based on the Instructional Methods

		M	SD	t	p-value
Mathematics Self-Efficacy	Peer Tutoring	2.36	0.60	3.71	<0.0005
	Traditional	2.91	0.62		

Note: 1 = high mathematics self-efficacy, 5 = low mathematics self-efficacy

However, the results in Table 8 showed that there were no significant differences in students' mathematics self-efficacy based on gender in the peer tutoring group ($t(31) = 1.87$, $p = 0.07$).

Table 8

Independent t-test Results for Differences in Students' Mathematics Self-Efficacy based on Gender in the Peer Tutoring Group

		M	SD	t	p-value
Mathematics Self-Efficacy	Male	2.63	0.29	1.87	0.07
	Female	2.23	0.67		

Note: 1 = high mathematics self-efficacy, 5 = low mathematics self-efficacy

Results in Table 9 showed that there were significant differences in students' perceptions of the instructional method between the two groups ($t(65) = 3.94$, $p < 0.0005$). Students who received peer tutoring intervention ($M = 2.09$, $SD = 0.39$) showed more positive perceptions of the instructional method they have gone through than students who did not receive the intervention ($M = 2.56$, $SD = 0.57$).

Table 9

Independent t-test Results for Differences in Perceptions of the Instructional Methods

		M	SD	t	p-value
Perception	Peer Tutoring	2.09	0.39	3.94	<0.0005
	Traditional	2.56	0.57		

Note: 1 = Positive perception of instructional method, 5 = Negative perception of instructional method

Results in Table 10 indicated that there were no significant differences in students' perceptions of the instructional method based on gender in the peer tutoring group (t (31) = 0.44, p = 0.66).

Table 10

Independent t-test Results of Differences in Students' Perceptions of Peer Tutoring based on Gender

		M	SD	t	p-value
Perception of Peer Tutoring	Male	2.13	0.43	0.44	0.66
	Female	2.06	0.37		

Note: 1 = Positive perception of instructional method, 5 = Negative perception of instructional method

DISCUSSIONS

Overall, both peer tutoring and traditional lecture-based instruction groups did improve in their scores on the posttest as compared to the pretest. However, the findings of this study showed that the peer tutoring group showed better gains compared to the control group. This finding is consistent with previous research findings reported by Early (1998), Fuchs et al. (2001), Presbitero (2002), and Fuchs et al. (2002). Early (1998), Presbitero (2002), and Fuchs et al. (2002) reported that that students who were taught using peer tutoring performed better than students who did not receive peer tutoring. Fuchs et al. (2001) also reported that the PALS group exceeded the non-PALS group in the SESAT scores.

The findings of this study also indicated that female students performed better than male students. However, this finding contradicted results reported in Western studies. For example, Adedayo (1999) reported that gender was found to have no effect on mathematics achievement. LoGerfo et al. (2006) on the other hand concluded that males performed better than females in mathematics.

Additionally, the findings of this study also showed that there was no interaction effect between gender and instructional method on gain in mathematics achievement scores. This finding contradicted Adedayo (1999) who stated that male students favoured the interactive method with group use of learning materials while female students preferred the interactive method with individual use

of learning materials. On the other hand, some researchers reported that females preferred to use a conversational style in learning whereas males tended to like individual style (Ong, 1981, as cited in Schwartz & Hanson, 1992). Richardson (2001) further reported that female students would prefer more interactive methods of learning than male students.

Results of the present study also showed that although both groups showed high interest in learning mathematics, students in the peer tutoring group had significantly higher interest to learn mathematics compared to the traditional instruction group. This finding was in line with findings reported by Topping et al. (2004). They stated that both tutors and tutees reported that they enjoyed learning science more after they participated in the intervention. Cheung and Winter (1999) also suggested that students taught using RPT either with reinforcement or without reinforcement have shown higher intrinsic interest toward Integrated Science.

Within the peer tutoring group, female students had higher interest in learning mathematics than male students. This finding contradicted the findings reported by Terwilliger and Titus (1995), who reported that male students showed significantly higher levels of motivation, confidence, and interest in mathematics than female students. They also reported that although the learning environment has been adjusted to suit the female students, yet female students' enthusiasm decreased over time.

Students in the peer tutoring group also showed higher mathematics self-efficacy compared to those in the traditional instructional group. This result was similar to finding from Topping et al.'s (2003) study, which reported that academic self-efficacy and learning self-efficacy of students in the peer tutoring group improved after they attended tutoring programmes. Golding et al. (2006) also reported that students who received peer tutoring were more confident in their ability to learn programming than students who did not join the peer tutoring sessions. Hence, students' self-efficacy in learning improved with peer tutoring. However, Griffin and Griffin (1997) reported that there was no statistically significant difference in academic self-efficacy between RPT and non-RPT groups, which contradicted the results of this study.

The present study showed that in the peer tutoring group, female and male students did not significantly differ in their mathematics self-efficacy. This finding contradicted those reported by Meech and Jones (1996), who reported that females showed less

confidence than males in their science abilities. Meech and Jones (1999) also found that both females and males showed greater confidence when they participated in small group rather than whole-class instruction.

The results of the study further indicated that students in the peer tutoring group showed more positive perceptions of the instructional method compared to those in the traditional instruction group. This corroborated with the findings of studies by Cheung and Winter (1999), Calhoon et al. (2006), and Griffin and Griffin (1997). They reported that the students showed positive perceptions toward peer tutoring (CWPT, PALS, and RPT) interventions.

The findings of this study also showed that in the peer tutoring group, females and males did not significantly differ in their perceptions toward peer tutoring. However, there were no past study results that looked at perceptions toward peer tutoring while taking into consideration gender differences.

CONCLUSION

The results of the study, generally, indicated that peer tutoring is an instructional approach that could impact positively on secondary students' learning of mathematics in Malaysian schools. This instructional approach also contributed toward improving students' interest in learning mathematics and their mathematical self-efficacy. Students also have positive perception toward peer tutoring. While the samples used in this study is limited, the results showed that peer tutoring is an instructional approach which could be implemented in the Malaysian secondary mathematics classes.

REFERENCES

Adedayo, O. A. (1999). Differential effectiveness by gender of instructional methods on achievement in mathematics at tertiary level. *Educational Studies in Mathematics, 37*(1)*,* 83-91.

Bettenhausen, S. (2002). Students as teachers. *Kappa Delta Pi Record, 38*(4), 188-190.

Boud, D., Cohen, R., & Sampson, J. (2001). *Peer learning in higher education: Learning from and with each other.* United Kingdom: Kogan Page.

Callahan, L. G., & Clements, D. H. (1984). Sex differences in rote-counting ability on entry to first grade: Some observations. *Journal of Research in Mathematics Education, 15*, 378-382.

Calhoon, M. B., Al Otaiba, S., Greenberg, D., King, A., & Avalos, A. (2006). Improving reading skills in predominantly Hispanic title 1 first grade classrooms: The promise of peer-assisted learning strategies. *Learning Disabilities Research and Practice, 21*(4), 261-272.

Cheung, C. C., & Winter, S. (1999). Classwide peer tutoring with or without reinforcement: Effect on academic responding, content coverage, achievement, intrinsic interest and reported project experiences. *Educational Psychology, 19*(2), 191-205.

Early, J. W. (1998). *The impact of peer tutoring on self-esteem and Texas assessment of academic skills mathematics performance of tenth grade Students* (Unpublished master's thesis). Texas A&M University, Commerce.

Evans, W., Flower, J. & Holton, D. (2001). Peer tutoring in first-year undergraduate mathematics. *International Journal of Mathematics Education in Science and Technology, 32*(2), 161-173.

Fuchs, L., Fuchs, D., Bentz, J., Phillips, N. B., & Hamlett, C. L. (1994). The nature of student interactions during peer tutoring with and without prior training and experience. *American Education Research Journal, 31,* 75-103.

Fuchs, L. S., Fuchs, D., & Karns, K. (2001). Enhancing kindergartners' mathematical development: Effects of peer-assisted learning strategies. *Elementary School Journal, 101,* 495-510.

Fuchs, D., Fuchs, L. S., Mathes, P. G., & Simmons, D. C. (1997). Peer-assisted learning strategies: Making classrooms more responsible to diversity. *American Educational Research Journal, 34*, 174-206.

Fuchs, L. S., Fuchs, D., Yazdian, L., & Powell, S. R. (2002). Enhancing first-grade children's mathematical development with peer-assisted learning strategies. *School Psychology Review, 31*(4), 569-583.

Golding, P., Facey-Shaw, L., & Tennant, V. (2006, October). *Effects of peer tutoring, attitude and personality on academic performance of first year introductory programming students.* Paper presented at The 36th ASEE/IEEE Frontiers in Education Conference, San Diego. Retrieved November 9, 2009, from http://www.fie-conference.org/fie2006/papers/1692.pdf

Griffin, B. W. & Griffin, M. M. (1997). The effects of reciprocal peer tutoring on graduate student achievement, test anxiety and academic self-efficacy. *The Journal of Experimental Education, 65*(3), 197-210.

Ismail H., & Alexander, J. M. (2005). Learning with scripted and non-scripted peer tutoring session: The Malaysian context. *The Journal of Educational Research, 99*(2), 67-77.

LoGerfo, L., Nichols, A., & Chaplin, D. (2006). *Gender gaps in math and reading gains during elementary and high school by race and ethnicity.* Retrieved November 9, 2009, from http://www.urban.org/UploadedPDF/411428_Gender_Gaps.pdf

Meech, J. L., & Jones, M. G. (1996). Gender differences in motivation and strategy use in science: Are girls rote learners? *Journal of Research in Science Teaching, 33*(4), 393-406.

Ng, L.Y., Bakar, K. A., Roslan ,S., Wong, S. L., & Rahman, P. Z. M. A., (2005). Predictors of self-regulated learning in Malaysian smart schools. *International Educational Journal, 6*(3), 343-353.

Northwest Regional Educational Laboratory (2001). *Peer and cross-aged tutoring*. Retrieved July 31, 2007, from http://www.nwrel.org/scpd/sirs/9/c018.html

Presbitero, N. L. (2002). *Peer tutoring and mathematics achievement* (Unpublished master's thesis). University of Nueva Caceres.

Richardson, J. (2001). An evaluation of virtual learning environments and their learners: Do individual differences affect perception of virtual learning environments. *Interactive Educational Multimedia, 3,* 38-52.

Robinson, D. R, Schofield, J. W., & Steers-Wentzell, K. L. (2005). Peer and cross-age tutoring in math: Outcomes and their design implications. *Educational Psychology Review, 17*(4), 327-362.

Rohrbeck, C., Ginsburg-Block, M., Fantuzzo, J., & Miller, T. (2003). Peer-assisted learning interventions with elementary school students: A meta-analytic review. *Journal of Educational Psychology, 95*(2), 240-257.

Schwartz, W., & Hanson, K. (1992). *Equal mathematics education for female students.* Retrieved November 9, 2009, from http://www.ericdigests.org/1992-4/equal.htm

Terwilliger, J. S., & Titus, J. C. (1995). Gender differences in attitudes and attitude changes among mathematically talented youth. *Gifted Child Quarterly, 39*(1), 29-35.

Topping, K. J. (1996). The effectiveness of peer tutoring in further and higher education: A typology and review of the literature. *Higher Education, 32,* 321-345.

Topping, K. J., Campbell, J., Douglas, W., & Smith, A. (2003). Cross-age peer tutoring in mathematics with seven- and 11-year-olds: Influence on mathematics vocabulary, strategic dialogue and self-concept. *Educational Research, 45*(3), 287-308.

Topping, K. J., Peter, C., Stephen, P., & Whale, M. (2004). Cross-age peer tutoring of science in the primary school: Influence on scientific language and thinking. *Educational Psychology, 24*(1), 57-75.