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Utilising the Think-Pair-Share Technique in the Learning of Probability

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Abstrak

Tujuan utama dari penelitian ini adalah untuk mengetahui pengaruh pembelajaran kolaboratif terhadap pemahaman siswa pada materi peluang dan sikap siswa terhadap matematika. Subjek penelitian terdiri dari 15 siswa kelas 10 yang dipilih dengan menggunakan *convenience sampling* di sebuah sekolah menengah di Brunei Darussalam. Secara kesuluruhan, enam pembelajaran dengan perlakuan yang menerapkan strategi *Think-Pair-Share* telah dilakukan. Metode pengumpulan data mencakup serangkaian tes (*pre-test*, *post-test* pertama, dan *post-test* kedua), survey, wawancara siswa, dan observasi pembelajaran. Temuan menunjukkan adanya peningkatan nilai tes siswa dan para siswa tersebut mampu mempertahankan pengetahuan mereka setelah jangka waktu tertentu. Dari data triangulasi, ditemukan bahwa siswa menunjukkan peningkatan tingkat *self-efficacy*, partisipasi, pemahaman, dan kegembiraan setelah perlakuan. Kegembiraan siswa terhadap pembelajaran materi peluang berasal dari kemampuan berkomunikasi dengan teman sebayanya. Para siswa menunjukkan lebih banyak antusiasme dan partisipasi di kelas saat pembelajaran berlangsung.

Kata kunci: pembelajaran kolaboratif, strategi *think-pair-share*, peluang, matematika sekolah menengah

Abstract

The main objective of this study is to investigate the effects of collaborative learning on students' understanding of probability and their attitudes towards mathematics. The participants were 15 Year 10 students selected by convenience sampling at a secondary school in Brunei Darussalam. In total, six intervention lessons with the application of Think-Pair-Share strategy were conducted. Data collection methods included a series of tests (pre- and post-tests and delayed post-test), surveys, students' interviews and lesson observations. The findings revealed improvements in the students' test scores and they were able to retain their knowledge after a period of time. From the triangulated data, it was found that the students demonstrated an increase in their self-efficacy, participation, understanding and enjoyment levels after the intervention. Their enjoyment towards learning probability was derived from being able to communicate with their peers. The students showed more enthusiasm and participation in class as the lessons progressed.

Keywords: collaborative learning, think-pair-share strategy, probability, secondary school mathematics

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INTRODUCTION

Collaborative learning is an instructional method where students work in pairs or in groups to achieve a common learning goal. In collaborative learning, students are required to be responsible for their own learning and be actively engaged in

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discussion, debate and teamwork. During the process of collaborative learning, knowledge is constructed and transformed by students themselves. There are differences between 'collaborative learning' and 'cooperative learning', for example, in cooperative learning, students divide their tasks, individually solve them and subsequently arranging the results as a final product (Felder & Brent, 2007; Lim et al., 2016). However, in collaborative learning, group members are expected to do the work together (Dillenbourg, 1999). This means that cooperative learning focuses more on the final outcome, and collaborative learning stresses more on the group interactions and the process of learning. In order for collaborative learning to be effective, there should be both 'group goals' and 'individual accountability' (Slavin, 1989), implying that members will be held individually accountable to perform their own share of work, and it is equally important to assess the quality and quantity of each of the members contributions when working towards their group goals (Johnson et al., 1998).

The Think-Pair-Share Technique

There are many collaborative models of instructional methods that can be applied in class. Some examples are the snowball effect, the think-aloud pair problem solving approach and the Jigsaw method (Duraman et al., 2015; Kani & Shahrill, 2015; Azmin, 2016). These techniques differ from each other by nature but all shares the same characteristic of active student engagement. The teacher may prefer to choose from the variety of techniques that suit best based on the lesson the teacher is delivering, the materials that will be taught and the nature of the classroom.

Among the collaborative techniques, Think-Pair-Share provides many positive aspects towards students' learning (Braun et al., 2017; Siswati & Corebima, 2017). McTighe & Lyman (1988) defined the Think-Pair-Share technique as a multi-mode discussion cycle that is divided into three stages: (1) 'Think': Students are given time to think individually after a question is posed; (2) 'Pair': Discuss the ideas with each other within a paired setting to produce a final answer; and finally (3) 'Share': Each pair share their new improved answer with the rest of the class. The difference between Think-Pair-Share and other collaborative techniques is that each student is given some time to think quietly and that students work in small groups (pairs).

The purpose of the thinking time in Think-Pair Share aims to improve the quality of the students' answers. Incorporating the important concept of 'wait time' allows the students to come up with more elaborated answers (Rowe, 1987). Dedicating time for students to work individually also gives them a moment to organise their thoughts and have an equal chance of contributing to the discussion when they are paired (Lom, 2012). In comparison with working in larger groups, students who work in pairs have more speaking and listening time, resulting in increased observations and communications skills (Carroll, 2007), and this reduces the effect of free-riding as the students play a more active role in decision-making and determining the final outcome.

Students' Difficulties with Probability

There are many reasons as to why students find probability difficult. Orji & Umoru (2010) found that inability to apply correct operational steps used in solving probability questions as one of the reasons. For example, while independence is often to be interpreted as the multiplicative rule, Batanero & Diaz (2012) argued that the meaning of such concepts would only work in some circumstances, depending on the

context of applications. Consequently, students may be able to memorise the formula and follow the steps to do familiar problems, however, they may not be able to apply them in new situations (Garfield & Ahlgren, 1988; Garfield & Ben-Zvi, 2014).

RESEARCH METHOD

The objectives of this study are to investigate firstly, the effects of collaborative learning using the Think-Pair-Share technique on students' understanding of probability, and secondly, their attitudes towards mathematics. The participants were 15 Year 10 students, selected by convenience sampling, at a secondary school in Brunei Darussalam. All the relevant ethical considerations, such as approval letters and informed consents were sought before conducting this study. The sample size of this study is small and therefore, the findings should be taken as indicative of the sample to this study and not to generalise the whole population. The two research questions guiding this study are, "How does students' performance compare between the three sets of the given tests and how can the results of this comparison be explained by the implementation of the intervention?" and "What is the effect of this intervention on the attitudes of students towards learning mathematics?

This study employed an action research method. Action research can be conducted by a single teacher who aims to implement changes required for social improvement through repeated cycles of planning, acting, observing and reflecting (Stern et al., 2013). Furthermore, the teaching experimental methodology was also used. The key elements of this methodology include exploratory teaching, testing research hypotheses and making meanings of the teaching itself (Steffe & Thompson, 2000). The use of action research and the teaching experimental design will in turn bridge the gap between practitioners and researchers.

Design of Intervention Lessons

The first author took on the role as the teacher and conducted the intervention lessons. The intervention consisted of six lessons, which required students to work collaboratively and be involved in problem-solving activities, according to the 21st Century Learning Design rubrics (21CLD, 2012; 21CLD, 2014; Damit et al., 2015).

Lesson 1 – Introduction to probability

- Help students define events and probability.
- Interpret equally likely outcomes and random selection.

Lesson 2 – Venn diagrams and basic set theory

- Help students identify and differentiate union and intersection in Venn diagrams and set notation.

Lesson 3 – Mutually exclusive events and non-mutually exclusive events

- Help students define and differentiate mutually exclusive and non-mutually exclusive outcomes of single event.

Lesson 4 – Mutually exclusive events and non-mutually exclusive events

- Guide students to calculate the probability of mutually exclusive and non-mutually exclusive outcomes of single event.

Lesson 5 – Independent and dependent events

- Help students define and differentiate independent and dependent events.

Lesson 6 – Expectation and games

- Help interpret the formula for expected score.
- Guide students to define the terms stake and expected winnings.
- Help them recognise that a game is fair if stake is equal to expected winnings.

Figure 1. Lesson contents and objectives of the 6 intervention lessons

Using the collaborative learning strategy, which is the Think-Pair-Share technique, the students were paired according to their previous assessment results. Based on their previous results, the median split technique was used to divide students into 'high' and 'low' proficiency students. In each lesson, a 'high' proficiency student was paired randomly with a student of 'low' proficiency. Since there were an odd number of students, on some occasions the students had to work in a group of three instead of working in pairs. Figure 1 shows the lesson contents and objectives for each of the six lessons during the intervention phase. The teacher met with the students once or twice a week and the duration of each lesson was one hour.

Data Collection Methods and Data Analysis

Pre-test, post-test and delayed post-test

A pre-test designed by the first author was administered to the students before the start of the intervention. Careful selection and modifications of the pre-test questions were done from the General Certificate of Education Ordinary Level syllabus statistics past-year papers. The pre-test comprised of 16 questions and the students were given 45 minutes to complete the test. A week after the intervention lessons were completed, a post-test was administered to the students. Subsequently, five weeks after the administration of the post-test, the students were given a delayed post-test to test the extent to which they retained their knowledge. Questions from the post-test followed a similar style to that of the pre-test, such that the same questions were used but with some minor modifications on the values, thus ensuring the same level of difficulty for both test papers. According to Rudner & Schafer (2002), questions containing the same concept but with only the numbers modified could be considered to have the same level of difficulty.

The delayed post-test consisted of the same questions as the pre-test questions. In order to verify the accuracy of wording, the suitability to measure the objectives of the topic and the appropriate difficulty level of the papers for the students, the services of an experienced mathematics teacher was sought to ensure the content validity of all the three test papers. Furthermore, a Cronbach's alpha test was conducted using Statistical Package for the Social Sciences (SPSS). The internal consistency of the pre-test, post-test and delayed post-test were 0.681, 0.558 and 0.528 respectively, which are considered as acceptable reliability as long as a Cronbach's alpha value exceeds 0.5 (Bowling, 2009).

0 Mark = Students leave the question blank or answer is completely irrelevant.
1 Mark = Students' calculations and workings are incomplete but demonstrate some understanding of the problem.
2 Marks = Strong understanding of the concept but there are minor mistakes in the explanations.
3 Marks = Detailed workings that show a full understanding of solving the question.

Figure 2. Marking rubric for students' answers in the test papers

The pre-, post- and delayed post-test results were marked and then compared to check if there were any differences in the students' performance. The scores of all three tests were first checked for normality using SPSS. Then, a paired sample t-test was used to deduce whether there existed any significant difference between the three pairs of tests: (1) pre-test and post-test, (2) pre-test and delayed post-test, and (3) post-test and delayed post-test. The significance level was set at 0.05. The full mark for each question in the tests was three marks. For a more consistent grading, a marking

rubric was created by the first author and used as a guide to identify the students' performance criteria. A summary of the marking rubric is given in Figure 2.

Survey

The surveys were administered to the students before and after the intervention. This was done to investigate whether working collaboratively has any influence on their attitudes towards mathematics. The supporting data such as student interviews and lesson observations was used to help explain the responses from the surveys. The rigour of the surveys administered was strengthened by the use of triangulation, which is defined as the use of two or more data sources to study the same phenomenon (Anderson, 2010). The survey consisted of 16 items constructed under four subscales affecting student attitude: self-efficacy, enjoyment, participation and understanding. The four subscales were selected from a variety of established instruments.

The self-efficacy category and enjoyment category were taken from the survey by Ali et al. (2014) in relation to measuring mathematics attitudes, the participation category from the National Survey of Student Engagement (Noohi et al., 2013), and the understanding category from the Mathematics Beliefs Scale (Lester, 2007). The survey made use of a 4-point Likert scale (1 = Strongly disagree, 2 = Disagree, 3 = Agree, 4 = Strongly agree) to measure the students' level of interest with collaborative learning and their attitudes towards learning mathematics. Note that the 4-point Likert scale was chosen for this survey instead of the 5-point Likert scale because the absence of a neutral option can either minimise or eliminate any social desirability bias present, which may arise from the respondents' desires to please the investigator (Garland, 1991). In analysing the survey data, the pre-survey and post-survey results were compared item-by-item. There were 16 items altogether in the survey and there were four items for each of the four categories. Comparisons of the frequencies of each item between the pre- and post-surveys were then conducted in order to examine the differences in students' attitudes before, and on completion of the intervention.

Student Interviews and Lesson Observations

After the completion of the intervention, individual interviews were conducted at the school library with six selected students based on their pre- and post-test scores (three students that showed the highest improvement in their pre- and post-test results and three students with no or least improvements). The interview sought to obtain more in-depth answers that the survey alone cannot provide. There were 12 interview questions, all of which were semi-structured and open-ended. Each interview was audio-recorded and then transcribed for data analysis. The interviews with the six students were conducted within a week after the post-test was given and each interview lasted about 15-20 minutes.

Furthermore, in order to observe the students' interactions with each other within their respective groups and their interactions with the teacher during the lessons, each intervention lesson was video-recorded. Each of the two video-recording devices used were located at the front of the classroom and at the back to capture the wide-angle view of the students as well as to frame the teacher in front of the class. After each lesson was completed, field notes were written by the first author to record the students' behaviours and other features observed from the recorded lessons as a way to reflect on the underlying meaning of these observations. The notes were written as soon as each lesson was completed in order to avoid forgetting and leaving

out any important details. Having a thorough description of each lesson might help in writing a general description of the situation during the analysis stage.

One of the ways in enhancing the reliability of the interview data is to have debriefing sessions between the researcher and his or her colleagues (Shenton, 2004). Consequently, before the interviews were conducted, the first and second authors checked and discussed the interview questions to confirm the appropriateness of the questions. Another way to improve credibility is to ensure honesty by the informants when contributing data (Shenton, 2004). Moreover, taking field notes will also be contributing to the study's credibility as a way for the researcher to reflect on the progress and process of the research itself (Tuckett, 2005). The interview transcripts and the field notes were coded in the attempt to organise the data into the four categories. For example from the field notes, a student's comment was recorded from one of the lessons: 'Teacher I don't understand the diagram' (the student drew a diagram for three events instead of two). This data was coded as understanding. After sorting the data into the respective categories, patterns were sought by identifying notable quotations by the interviewees and then relating them to relevant information from the field notes.

RESULTS AND DISCUSSION

Students' Performances on the Test Results

Presented in Table 1 are the descriptive statistics for all the three tests, and all were marked out of a total score of 48. The mean scores for the pre-test, post-test and delayed post-test are 10.93 (SD=7.015), 27.27 (SD=10.633) and 26.33 (SD=9.788) respectively.

Table 1. Descriptive statistics for the test measures of probability

	Number of Students	Lowest Score	Highest Score	Mean	Std. Deviation
Pre-test	15	0	24	10.93	7.015
Post-test	15	8	43	27.27	10.633
Delayed post-test	15	8	42	26.33	9.788
Valid N (list wise)	15				

From Table 1, the lowest, highest and mean scores increased from the pre-test to post-test, suggesting that the students performed better in the post-test than in the pre-test. For example, only one of the 15 students scored 24 and above for the pre-test while in the post-test, there were nine students who scored 24 and above. There was not much difference between the post-test and the delayed post-test, since the mean score of the delayed post-test was slightly lower than that of the post-test. It is worth noting that the student who obtained the highest score for the pre-test did not obtain the highest score for the post-test. It was observed that the students who participated in discussions and engaged more during the Think-Pair-Share stages had more improvements in their test results compared to those who were not as engaged. The increase in the mean test score might be related to the students' level of involvement during the three stages of Think-Pair-Share. During the 'think' stage, the students were required to think for themselves and justify the answers that they had provided. After attempting to solve the problems individually, the students were asked to compare their answers during the 'pair' stage. The 'pair' stage elicited more discussions and the students often sought for help from their partner or the teacher if they had any

difficulties. The teacher used questions or hints to help the students arrive to their answer instead of providing them with the answers. At the end of the intervention lessons, the students were observed convincing each other that their solution was correct and making substantive decisions in preparation for the 'share' stage.

The scores of the three tests were checked for normality using SPSS. In terms of the Kolmogorov-Smirnov test and the Shapiro-Wilk test, the p-values were shown to be above 0.05, indicating that the data were (almost) normally distributed. Consequently, a paired-samples t-test was performed to evaluate the significance of the differences between the students' pre- and post-test scores, as well as between the post- and delayed post-test scores (McDonald, 2009). The results in Table 2 show that there was a statistically significant difference in the test scores between the pre-test and the post-test ($t(14) = -5.35$, $p < 0.05$). The t-test result suggested that the students performed significantly better in the post-test than in the pre-test. Despite the slight decrease of scores between pre-test and delayed post-test, the paired samples t-test employed showed that there were no significant differences between the two tests ($t(14)= -5.49$, $p = 0.089 > 0.05$). The paired-samples t-test was also employed for the post-test and delayed post-test scores and the results indicated that there was a significant increase between the two sets of test scores ($t(14)= 1.83$, $p = 0.000 < 0.05$).

Table 2. Paired samples test for the probability tests

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1: Pre-test – Post-test	-16.333	11.812	3.050	-22.875	-9.792	-5.355	14	.000
Pair 2: Pre-test – Delayed Post-test	-15.400	10.868	2.806	-21.419	-9.381	-5.488	14	.000
Pair 3: Post-test – Delayed Post-test	.933	1.981	.511	-.164	2.030	1.825	14	.089

Students' Attitudes Before and After the Intervention

Students' responses to items in the self-efficacy category

In the interviews, when the students were asked how collaborative work affected their learning of probability, most interviewees replied that they felt either more responsible or motivated to their own learning, which was also supported by the results of the students' survey responses. From Table 3, the frequencies of students' responses to items 1 and 3 showed an increase of students giving 'agree' and 'strongly agree' responses for motivation and responsibility towards learning after the intervention. Additionally, there was also an increase of 'agree' and 'strongly agree' responses to items 2 and 6, implying that the students felt more confident in learning probability and believed that they could obtain good grades in probability. From the video-recordings, it was observed that the students became more interested in their work as they exhibited behaviours, such as accomplishing group goals and providing feedback to their peers, by the end of the intervention lessons.

Table 3. Frequency of students' responses for the self-efficacy category

Survey questions		SD	D	A	SA
(1) I am motivated to learn probability.	Before	0	6	8	1
	After	1	1	12	1
(2) I feel confident in learning probability.	Before	0	8	6	1
	After	0	3	11	1
(3) I feel responsible in my own learning.	Before	3	2	8	2
	After	1	2	7	5
(4) I believe I can get good grades in probability.	Before	1	2	9	3
	After	0	1	9	5

Note: SD = Strongly Disagree; D = Disagree; A = Agree; SA = Strongly Agree

The students' responses in item 2 showed that more than half of the students (8 out of 15) disagreed feeling confident when learning probability prior to the intervention. During the first few lessons of the intervention, it was observed that several students tended to leave the questions blank during the 'thinking' stage. They waited until the 'pair' stage to discuss with their partner. Also, it was observed that when the students achieved in getting different answers or solutions, they were not confident to convince their partner that their justification was correct and often went to seek the teacher's advice. By the end of the intervention, however, it was seen that most students attempted to solve the questions individually and justified their answers to their partners, after constant encouragement from the teacher. This was supported by the decrease in the number of 'disagree' responses to item 2, whereby only three students did not feel confident in learning probability.

Students' Responses to Items in the Participation Category

A breakdown of the items in the participation category is shown in Table 4. After the intervention, there was an increase in students who agreed that learning in groups make them participate more in class (item 7). They listened more carefully to the teacher's instructions (item 9) as well as to their classmate's opinions (item 10), and expressed their ideas more in class especially during the 'pair' stage (item 11). One of the interviewees stated that they could openly express their difficulties during the intervention lessons. Another interviewee said that they could find out their strengths and weaknesses, and made improvements from interacting with their friends.

Table 4. Frequency of students' responses for the participation category

Survey questions		SD	D	A	SA
(7) Learning in groups makes me participate more in class.	Before	0	4	9	2
	After	0	2	8	5
(9) I listen more carefully to teacher's instructions.	Before	0	1	13	1
	After	0	0	12	3
(10) I listen carefully to my classmate's opinions.	Before	0	3	10	2
	After	1	0	10	4
(11) I express my ideas often in class.	Before	1	10	4	0
	After	0	8	6	1

Note: SD = Strongly Disagree; D = Disagree; A = Agree; SA = Strongly Agree

Despite the increase of the frequency of 'agree' and 'strongly agree' responses to item 11, more than half of the students (8 out of 15) still disagreed that they felt comfortable with expressing their ideas after the intervention. The two interviewees revealed their concerns for the 'share' stage: for Interviewee 1: "But the sharing part. I find it a bit intimidating because I am quite uncomfortable with public speaking." For Interviewee 2: "...some of the students like (friend's name), he's not really a people person and he's kind of shy so I think it is kind of unfair for him... to know how to speak in front of people." There were four out of the six interviewees who expressed that they felt embarrassed when the answer that they shared with the whole class was incorrect, while the others did not feel humiliated and viewed making mistakes as part of learning. The interview data also revealed why there was still more than half of students (8 out of 15) who disagreed that they expressed their ideas often after the intervention. For example, two interviewees described themselves as talkative, but their role when working in pairs was reliant on the partner and the question. One of the interviewee said "...if the question is hard or I don't really know the person, I will listen more than talking." Also, it was observed that at times, a student would be dominating the conversation and consequently, the teacher had to intervene in order to encourage more contribution from the other students.

Students' Responses to Items in the Understanding Category

Table 5 shows the frequencies of the students' responses to items in the understanding category. The frequency of 'strongly disagree' responses for item 14 contributed the most to the overall increase of 'strongly disagree' responses. Before the intervention, only two students strongly disagreed that they learnt more in collaborative learning. After the intervention, this number increased to seven students.

Table 5. Frequency of students' responses for the understanding category

Survey questions		SD	D	A	SA
(4) I find probability an easy topic.	Before	0	10	5	0
	After	2	7	6	0
(5) I understand probability.	Before	0	9	5	1
	After	1	4	8	2
(8) Learning in groups helps me understand probability more than learning individually.	Before	1	1	7	6
	After	0	1	7	7
(14) I learn more in collaborative learning than direct teacher instructions.	Before	2	11	2	0
	After	7	6	2	0

Note: SD = Strongly Disagree; D = Disagree; A = Agree; SA = Strongly Agree

From the interviews, two students believed that they gained more knowledge in a shorter amount of time from direct teacher instruction, and that they preferred this method because they were more used to it. A drawback from working in pairs was brought up by one of the interviewees. When asked to share any good or bad experiences encountered during pair work, the interviewee responded that not everyone would do their fair share of the work. She had to complete the work all by herself in a past project due to the partner's lack of commitment. Due to the unfairness, this student claimed that she preferred to work on her own rather than burdened with the stress of doing other people's work.

The number of students who gave the 'agree' responses for item 4 only increased by one. The analysis of the six interviews revealed some similarities between the responses. When the question "How did you find the topic of probability?" was asked, all six interviewees found this topic difficult and confusing. One of the students who had a low post-test score mentioned that, "It's probably one of the hardest (topic)." Despite this, the frequency of item 5 in the post-survey showed that more than half of the students (10 out of 15) students either agreed or strongly agreed that they understand probability. Furthermore, for item 8, almost all the students (14 out of 15) either agreed or strongly agreed that learning in groups helped them understand probability more than learning individually after the intervention. The responses for items 5 and 8 were also consistent with the data from the interviewees' remarks. For example, they expressed common positive views towards the topic of probability as a result of Think-Pair-Share. Some examples are: "I really understand it better now since we can help each other in pairs"; "It's good that I can try (the questions) myself first"; and "For the first one (direct teacher's instruction), I tend to forget it after a while. For group work, we think ourselves first so it's better."

Students' Responses to Items in the Enjoyment Category

The frequency of the responses for each item in the enjoyment category is shown in Table 6. While there was only a small increase in the frequency of 'agree' and 'strongly agree' responses to items 12 and 13, it was noticeable from Table 6 that the only one 'strongly disagree' response to the item 12 in the pre-survey became nil in the post-survey. As for item 13, the only 'disagree' response in the pre-survey also became nil in the post-survey. The responses to these two items suggested that there was a positive impact on the level of students' enjoyment and their relationships with their classmates after the intervention.

Table 6. Frequency of students' responses for the enjoyment category

Survey questions		SD	D	A	SA
(12) I enjoy learning in collaborative groups.	Before	1	1	8	5
	After	0	1	11	3
(13) Learning in groups improves my relationship with my classmates.	Before	0	1	9	5
	After	0	0	12	3
(15) I prefer to work in groups than to work alone.	Before	3	5	5	2
	After	0	4	8	3
(16) I am comfortable with speaking in front of the class.	Before	4	5	4	2
	After	3	7	3	2

Note: SD = Strongly Disagree; D = Disagree; A = Agree; SA = Strongly Agree

Item 12 from Table 6 showed an increase from 13 to 14 students who enjoyed learning in collaborative groups after the intervention. Some of the interviewees' comments stating their enjoyment were derived from communicating with their partner: "It's fun yeah. I like the part we can discuss with our friends before sharing with the whole class and correct our answers if they are wrong" and "We get to talk to our friends instead of listening to the teacher all the time."

The frequencies of the items 13 and 15 showed that all students agreed that learning in groups improved their relationship with their classmates and 11 of them preferred to work in groups than individually after the intervention. One of the students mentioned "…better connections with friends" as one of the advantages of

working in pairs. From the interviews, it was found that the reasons that led students to enjoy pair work are, fewer distractions from friends, easier to concentrate and less disagreements. The number of students who gave either 'agree' and 'strongly agree' responses to item 16 decreased from six to five students. Only five out of 15 students felt comfortable with speaking in front of the class after the intervention. The reason could be associated with the reason for item 11 where students were intimidated by speaking in front of their peers either due to shyness or embarrassment from giving a wrong answer.

The findings of the test results showed that after the intervention, the students' mean test scores improved significantly from the pre-test to the post-test, which is also consistent with the findings of previous studies (Bamiro, 2015; Bataineh, 2015; Parmar, 2015). Although the students' test results decreased from the post-test to the delayed post-test, the differences were not significant (see Table 2). The results of the delayed post-test showed that the students were able to retain most of the concepts that were introduced during the intervention. Knowledge retention could be achieved by reducing the amount of information students are expected to memorise, and instead of memorising, more effort should be placed in helping them become active and independent problem-solvers so that meaningful learning could be enhanced (Lujan & DiCarlo, 2006).

Sampsel (2013) stated that students who engaged more during the Think-Pair-Share stages are more likely to obtain better grades. It was explained that students who are additionally involved in class discussion communicate their thinking more to their classmates and the teacher. The concept of 'wait time' given during the think stage allows students to provide more elaborated answers. As the number of long explanations given increases, they are provided with opportunities to develop their mathematical vocabulary and practice their mathematics reasoning skills. Furthermore, it is important that both students and teacher listen to each other's ideas and use discussion to arrive at a common understanding especially if they had different opinions at first. Inviting other students to listen to other students' different viewpoints during whole class discussion can provide a forum for broader interpretations and opportunities for students to clarify their understanding (Anthony & Walshaw, 2009).

Besides the students' academic achievement, various studies have also provided evidence for the relationships among students' attitudes and collaborative learning (Sumarsih & Sanjaya, 2013; Kwok & Lau, 2015). The findings from the interviews, lesson observations and surveys showed that the implementation of the intervention may have a positive impact on the students' attitudes in terms of self-efficacy, participation, understanding and enjoyment which may explain the increased scores between the pre-test and the post-test. Data from the present study showed that the students' level of self-efficacy increased. After the intervention, more students felt motivated, responsible as well as confident in learning probability and believed that they could obtain good grades in the topic of probability. Previous studies found that students' confidence level and self-regulation correlated positively with their achievements (Motlagh et al., 2011; Ong & Shahrill, 2014; Lim et al., 2016).

The students' participation level in this present study improved during the intervention as they were given more chances to express their ideas. However, not all the students were fully engaged in all the three 'think', 'pair' and 'share' stages while doing their problems. One of the findings showed that some students were not fully engaged in the 'think' phase and preferred only to discuss during the 'pair' phase.

Students who were at a lower engagement state in the 'think' stage could progress to a state of higher engagement in the 'pair' stage (Kothiyal et al., 2013). Thus indicating that students may not have learnt from completing the activity individually but could learn more from discussing with their peers.

There were some students who were intimidated to speak in front of their classmates during the 'share' stage. The fear of giving an incorrect answer may inhibit class participation and cause students to be reluctant to share their answers, as they do not want to risk the humiliation of being wrong in front of their peers. Fear of speaking is considered as a form of mathematics anxiety (Denhere, 2015). In Mathematics, these fears may potentially be reinforced by the importance on getting correct or incorrect responses. Without following the teacher's examples, as they would do in a traditional 'chalk and talk' class, the students in this present study did not feel confident of their answers even after discussing with their partners. The students' shyness in expressing themselves in class could be related to cultural influence (Salam & Shahrill, 2014; Shahrill & Clarke, 2014). That is to say, Asian students generally tend to adopt a receptive role in class and they depend on the teacher to provide the materials needed in order to do well in the subject. Similarly, students in Brunei consider their teachers as an authoritative figure, and they tend to agree with their teachers at all times (Dhindsa & Salleh, 2009). In this present study, it was also observed that the students tended to be more like passive learners at the beginning of the intervention. However, the use of Think-Pair-Share helped in getting the students out of their comfort zones and their participation level of discussion increased as the intervention progressed.

Many students found probability a difficult topic. The results of this study, in relation to understanding showed that the number of students, who claimed they understand probability, increased after the intervention. From the interviews, the students revealed that a better understanding of probability was because they were given the opportunity to attempt the questions individually during the 'think' time and then received help from their partner during the 'pair' time. This echoes the findings of Usman (2015). Think-Pair-Share could help develop the kind of personal communications that are necessary for students to process and retain knowledge. Indeed, the results of the student interviews in this study also suggested that the students considered Think-Pair-Share as an effective way to help them remember what they have learnt in class.

The results of this present study also indicated an increased student numbers who enjoyed learning in collaborative groups. Previous studies on collaborative learning reported that being able to communicate with their peers made the students enjoy the lessons more (Terenzini et al., 2001; Tsang & Shahrill, 2015). From the surveys, student relationships were shown to have improved after the intervention. As was mentioned earlier, 11 of the 15 participating students reported having the preference to work in groups rather than individually. There were also no complaints regarding the pair work from the students.

After the intervention, the results of the post-survey showed that 13 of the 15 students agreed that they would learn more with direct teacher instructions, although 14 of them agreed that learning in groups helped them understand probability more than learning individually. From the interview data, two of the students believed that they could learn more materials in a shorter period of time with traditional teaching. This is consistent with the findings of Sulaiman and Shahrill (2015). Partly because students in Brunei are used to traditional teaching, and they tend to believe that they would learn more from direct teacher instruction rather than from the Think-Pair-Share process.

CONCLUSION

As was observed in this present study, the empirical evidence obtained from both the quantitative and qualitative methods of data collection provided the confirmation that students' involvement in collaborative activities had a positive effect on their academic achievements and their attitudes. The pre-, post- and delayed post-test results indicated that there were improvements in students' performances on the tests and that they were able to retain their knowledge five weeks after the intervention was completed.

The findings from the survey responses, individual student interviews and class observations indicated that improvement and retention of the test scores could be explained by the increased interactions between students during the intervention lessons. The students engaged in active learning by spending more time in discussions, providing more opinions and receiving constructive feedback from their peers and the teacher. This in turn promoted students' self-efficacy, participation, understanding and enjoyment towards learning mathematics.

The use of the Think-pair-Share method helped create opportunities for the students to express their difficulties in probability, and they enjoyed communicating with their peers, which made the lessons more enjoyable. While most students enjoyed the lessons that incorporated the concept of Think-Pair-Share, some lacked the necessary confidence in sharing their opinions to the whole class. The shyness and fear of embarrassment from giving incorrect answers displayed by the students still remains a concern that teachers need to take into account when teaching. Peer support should constantly be encouraged in the classrooms with the creation of a comfortable learning environment whereby the students should be brave in sharing their opinions and views making mistakes as part of learning.

It appears that collaborative learning is a feasible way to help students become more involved in active learning. Yet, the students in this present study were still used to the traditional method of teaching. For future studies, attention needs to be made to students' hesitation in believing that they could learn as much from collaborative learning as direct teacher instructions. Student-centred teaching approaches should be conducted more frequently in aiding the students to appreciate and value the benefits that these approaches can bring to their own learning. It is important for teachers to be more flexible towards new approaches and go beyond the examination syllabus to ignite the students' passion in the learning of mathematics. With more teachers designing student-centred lessons, the students will be cultivated to learn effectively and develop the 21st century learning skills.

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