Research paper

Learning Probability in the Arts Stream Classes: Do Colour Balls with STAD-Cooperative Learning help in Improving Students' Performance?

Authors' contributions

This work was carried out in collaboration between all authors. NKK designed the study, performed the statistical analysis, and wrote the protocol. SNM and SA managed the literature searches and wrote the first draft of the manuscript. All authors read and approved the final manuscript.

ABSTRACT

Aims: 1. To investigate the effects of concrete learning aids (Colour Balls) with Student Teams-Achievement Division (*STAD*) cooperative learning (CBCL) method on Form Four Arts Stream students' performance in probability; 2. To find out students' perception towards the use of CBCL method in learning probability.

Study design: Quasi experimental pre-test post-test control group design. Two treatment groups were employed in this design, they were CBCL (experimental group), and *STAD* cooperative learning (CL) (control group).

Place and Duration of Study: The study was carried out in two rural secondary schools in the District of Tambunan, 90 km from Kota Kinabalu city, Sabah, Malaysia for a period of 170 minutes.

Methodology: The sample consisted of 160 Form Four Arts Stream students (mean age 16 years old). The students were randomly assigned to one of the two conditions - CBCL method (N= 80) and CL method (N= 80) as intact groups. The Probability Performance pre-test and post-test, and open ended questions had been used to collect data. The student's performance mean scores were analysed using Independent-samples t-test and Paired-samples t-test at $\alpha = 0.05$ level of significance. The student's written comments on their learning experience in CBCL method were categorized into three parts, namely a positive perception, negative perceptions and suggestions for improvement.

Results: The findings revealed that students taught with the CBCL method performed significantly higher than the students who were taught with CL method (t (158) = 3.148, P = .002). The findings also showed that students in both CBCL and CL groups performed significantly better on the post test compared to the pre test (t (79) = 42.382, P = .000 *and* t (79) = 70.726, P = .000 respectively). A majority of students had positive perception towards the use of CBCL method in learning probability as it: (i) helped linking learning activities to probability concepts; (ii) boost their confidence in answering questions; (iii) helped them better understand and remember the concept of probability; and (iv) fostered their cooperation and discussion in solving problems. Majority of the students also felt that the CBCL activities conducted made learning fun and enjoyable. However, one big concern about the CBCL activities was that it had taken a longer time to complete.

Conclusion: This study shows that the Colour Balls concrete learning aids, when incorporated with the *STAD* cooperative learning (CBCL) method and implemented appropriately in the classrooms, is an effective method in improving the performance of Form Four Arts Stream students in the topic of probability.

*Keywords: Arts Stream; colour Balls; concrete learning aids; Student Teams-Achievement Division (*STAD*); probability.*

1. INTRODUCTION

Probability is part of the basic literacy in mathematics that deals with making sense of experiences involving chance and uncertainly [10]. Many skills which are used every day depend on knowing and

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understanding probability. In order to function effectively, an understanding of the probability theory is essential to enable comprehension of real-life situations such as politics, meteorology and weather forecasting, genetic research, engineering research, sports, and insurance policies. Hence, students should master the basic ideas of probability very early in the school programme.

Despite the importance of probability and its fundamental role in daily life, many ideas about probability are difficult to learn and therefore hard to teach [1]. According to [19], it was found that problems in learning probability such as those used in calculating, reporting, and interpreting probabilities will arise when students inadequately develop rational number concepts and proportional reasoning. As proportional reasoning revolves around ratios, it is therefore one type of rational number. As defined in [37], proportional reasoning involves recognising the ratio between elements within measure spaces and the functional relationship across measure spaces. The difficulties that students of all ages experience with proportional reasoning are documented in a number of studies [8, 18, 38, 46, 49, 50].

According to Piaget's theory [48], an individual's thinking at the concrete operational stage is limited because of the individual's reliance on real objects and events. Concrete operational thinkers do not completely grasp proportionality, hypothetical argument, the concept of controlling variables, or probabilistic reasoning [14, 55]. On the other hand, students with formal operational thought patterns are capable of grasping abstract principles and multiple perspectives. Research, however, indicates that most students who enter college do not demonstrate sufficient formal operational thought when dealing with the laws of probability and probabilistic reasoning [20]. Similarly, the change from concrete operations to formal operational thoughts did not happen to most Malaysian students who have completed upper secondary school and those who have continued their education in college or university (Cheam, University of Science Malaysia, Malaysia, Unpublished results).

[27] found that students with concrete operational thought patterns were incapable of predicting events with equal probability in sample space. [28] concur that a learner in a concrete-operational period is neither able to differentiate between certain and random predictions nor formulate predictions. Due to the nature of randomness and random events in probability, the specific examples and results from chance events may not be the expected ones [12]. These 'unusual' results conflict with what is expected, and students are therefore faced with experimental evidence that does not clearly illustrate the concept. Consequently, probability ideas often appear to conflict with students' experiences and how they view the world [23]. As Moore [44] stated,

> The conflict between probability theory and students' view of the world is due at least in part to students' limited contact with randomness. We must therefore prepare the way for the study of chance by providing experience with random behaviour early in the mathematics curriculum.
>
> (p. 98).

This statement clearly demonstrates that an understanding of probability theory is essential early in the mathematics curriculum that allows learners to make sense of experiences involving chance. Effective instructional methods therefore need to be employed in helping concrete operational students to build a better understanding of abstract concepts in probability. The challenge is to relate to students and engage them in learning experiences with random behaviour in which they can construct their own understanding of probability.

Research has found some value of using games to assist learner's learning of probability concepts. In her study, [45] found that 4- and 5-year old children showed improvement in their understanding of probability after learning activities using an Internet game. However, [12] found that games, although are generally useful in helping children to learn in mathematics, may not automatically be as useful in helping students develop normative probability concepts. [9] also expressed caution about the use of games for probability learning because of the possibility that, as the students become more familiar with a game, they may become more skilful in the strategy required in the game without necessarily increasing their understanding of probabilities related to the dice outcomes. [21] also referred to the possibly passive role of children during the playing of games involving only chance if the players were not involved in some decision-making and to be explicitly thought about during the game. Based on these research findings, it revealed that games would not necessarily help develop an appropriate understanding of probability.

[47] implied that students with concrete operational thought patterns do not possess the mature mentality to grasp abstract mathematical concepts presented in words or symbols alone and thus,

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various experiences with concrete materials are required for learning to take place. Concrete materials, or concrete objects are defined as physical teaching tools that engage students in the hands-on learning of mathematics [7]. “Whether termed manipulatives, concrete materials, or concrete objects, physical materials are widely touted as crucial to the improvement of mathematics learning” [4].

Previous studies by [42, 54, 57, 58] showed that the use of concrete learning aids will increase a student’s achievement in mathematics; in particular the concept of probability. This is because through the interaction with objects, concrete experience and active participation through discussion among peers, it can help to accelerate students' understanding on abstract concepts of probability [43, 56]. Researchers have studied the use of concrete objects in several different grade levels and in several different countries [7, 13, 15, and 34]. The majority of the studies indicated that mathematics achievement increases when concrete objects are put to good use. [43] supports this by stating that it is the active manipulation of materials that ‘allows learners to develop a repertoire of images that can be used in the mental manipulation of abstract concepts’. To sum up, much of the research findings has shown that a student’s achievement levels are related to his/her experience in using concrete objects.

Based on several research findings, however, it showed that theoretical benefits of concrete materials in mathematics did not always translate into practice. In [25]’s study, they found that many of the 11- to 12-year-old students had difficulty in moving ‘from the concrete representations to the more formal aspects of mathematics. According to [17], some of these difficulties derive from the use of particular materials that are used within a ‘representational’ approach. In this approach students would work with an external representation in order to give meaning through ‘internal’ representations to a particular aspect of mathematics. On the part of the teacher, that specific mathematical meaning is actually embodied in the external representation, but [17] claims that while this may be true for the teacher, it is not necessarily true for the students. [23] agrees that ‘concrete embodiments do not convey mathematical concepts’ but it is the ‘experts’ who already have those concepts who will make sense of the ideas being modelled.

The way in which the materials are used, would therefore appear to be important factors in helping students to translate their thinking processes from handling objects to symbolic representations. Students need to see through the objects of the mathematics which underpin the representation and to think with the representations [24]. As [4] points out, ‘although kinaesthetic experience can enhance perception and thinking, understanding does not travel through the fingertips and up the arm’ (p. 47]. Therefore, in itself, the physical exploration and manipulation of concrete materials alone will not always lead students to discover ‘correct’ mathematical concepts.

According to [39], accompanying mental activity is the crucial element of reaching ‘correct’ mathematical conclusions during concrete materials manipulation. Without some accompanying mental activity to reflect the purpose of the physical activity, concrete materials will not be able to develop students’ mathematical understanding [39]. In order for this to happen, there needs to be a discourse between the student and the teacher or between the student and more capable peers as this will allow the student to bridge the gap between the concrete materials and the abstract ideas.

In response to this view, [61] believes that social interaction involving group problem solving enables each student to extend his or her zone of proximal development. The difference between what the learners are able to achieve unaided and what they can achieve under guidance of an expert or more capable peers defines what Vygotsky termed as ‘zone of proximal’ development [41]. The belief that peer interaction may promote learning has been applied systematically under the rubric of “cooperative learning”. Cooperative learning is an instructional technique in which students work together in structured small groups to accomplish shared goals [31]. Research indicates that cooperative learning groups seem to help all students because the best students get to "share" their knowledge with others while the weaker students get peer coaching [26].

Research studies in the use of Student Teams-Achievement Division (STAD) have been applied with great success in various research projects [30, 59, 60]. Student Team Achievement Division (STAD) refers to a cooperative-learning method in which small groups of learners with different levels of ability work together to accomplish a shared learning goal [51]. [52] stipulates five major components of the STAD, namely: class presentations, teams, quizzes, individual improvement scores, and team recognition. According to [50] “the main idea behind STAD is to motivate and encourage students to help each other to master the skills presented by the teacher” (p. 23). As such, this study is conducted to investigate whether concrete learning aids, with the help of STAD cooperative learning, can help Form Four students to make sense of the ideas being modelled in the topic of probability.

In the Malaysian context, students have the opportunity to pursue two years of studies in the upper secondary (form 4 - form 5) upon completion of the lower secondary education. Students who are academically inclined can choose between two main streams: the Science or Arts Stream. Seemingly, there is an unfair social perception regarding students in the Science Stream and those in the Arts Stream. It is always considered that the Science Stream is for students who are considered highly intelligent while the Arts Stream is meant for those students who are of inferior intelligence. Hence, the Arts Stream students are perceived as less capable in mathematics performance, especially those from the rural schools. This is evidenced when [22] found that the performance of rural Arts Stream secondary school students was significantly lower compared to their counterparts of the urban secondary school for the Mathematics test (t = 19.10, P = .000).

The Malaysian School Mathematics Curriculum has included 'Probability' as one of the main topics on relationships at the upper secondary levels [40]. The mastery of probability I in Form Four will provide students with a stronger foundation for further study of probability II in Form Five. However, results reported by Kheong (Kheong, University of Technology Malaysia, Unpublished results) in his study indicated that many Malaysian Form Five students; especially those from the Arts Stream were generally weak in understanding the concept of probability. It was found that students have difficulties selecting the types of events that occur simultaneously and events that do not occur simultaneously.

It is plausible that the Arts stream students who do not have formal operational thought patterns are incapable of understanding probability because the process of making random predictions is an abstract process in itself. On the other hand, it is also plausible that learning aids, particularly those of a concrete, hands-on nature, may have much to offer students who cannot comprehend abstract probability concepts. Concrete learning aids such as colour balls may be a useful tool to help the Arts Stream students visualise non-observable, explanatory phenomena such as events in the sample space of probability.

Additionally, it is also plausible that the Arts Stream students may be motivated to learn probability with the assistance from their more able peers inherent in STAD cooperative learning. These arguments present an interesting conundrum. Should teachers use concrete learning aids with STAD cooperative learning method to teach abstract and difficult concepts such as 'probability' to Form Four Arts stream students in rural schools? Or is the use of STAD cooperative learning method alone sufficient to facilitate Form Four Arts stream students in learning probability? Through the findings of this research, it can give insights to mathematics educators on the role of concrete learning aids with STAD cooperative learning and how it can make the abstract concept of 'probability' comprehensible to Arts Stream students in rural schools. This in turn will provide useful information to educators about the appropriateness of using concrete learning aids with STAD cooperative learning in the teaching of probability. Moreover, little empirical research was focused on the effectiveness of this instructional method in improving learner's performance in probability.

1.1 Purpose of Study

The purpose of this study, thus, was to investigate the effects of Colour Balls with Student Teams-Achievement Division (STAD) cooperative learning (CBCL) method versus STAD cooperative learning (CL) method on performance in probability among Form Four Arts Stream students in rural schools. A further purpose was to find out the students' perception towards the use of the CBCL method in learning probability. More specifically, this study addressed the following questions:

1. Is there a significant difference in student's pre-test mean scores on probability between learners learning with CBCL method and learners learning with CL method?;

2. Is there a significant difference in student's post-test mean scores between learners who are taught with CBCL method and learners who are taught with CL method?;

3. Is there a significant difference between pre-test and post-test mean scores between learners in the CBCL learning group?

4. Is there a significant difference between pre-test and post-test mean scores between learners in the CL learning group?

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5. What are the students' insights and experiences about using CBCL method in learning probability?

2. RESEARCH METHODOLOGY

2.1 Sample

The study was carried out in two rural secondary schools in the district of Tambunan, 90 Km from Kota Kinabalu city, Sabah, Malaysia. The samples were made up of 160 Form Four upper secondary Arts Stream students (mean age 16 years old). They were 85 (53.13%) females and 75 (46.87%) males. The participating students were at the low proficiency level or below in terms of Mathematics achievement. It was found that 41.25% of the students obtained a Grade C, 51.88% obtained a Grade D, 1.25% obtained a Grade B, and 5.62% of them failed in Mathematics in the national, standardized Malaysian Examination or *Penilaian Menengah Rendah* (PMR) that students sat at the end of their lower secondary level of schooling. This study employed two classes or 80 students from each of two randomly selected schools. The classes were further randomly assigned to one of the two conditions - CBCL method and CL method as intact groups.

2.2 Research Design

The study employed a quasi-experimental pre-test post-test control group design. The quasi-experimental was employed to examine the effects of two different instructional methods on student's performance in learning probability. The independent variable in this study was the method of instruction and a variable with two categories: i) Colour Balls with STAD cooperative learning method (CBCL) (experimental group); and ii) STAD cooperative learning method (CL) (control group). The dependent variable was the student's performance mean scores in the probability test.

The study used two equivalent probability tests in which each consisted of 10 items posed in structure formats**.** Bloom's taxonomy [6] was used as a guide to develop a blueprint for the pre-test and the post-test. The items belonged to the "comprehension," "application" and "analysis" classifications of Bloom's Taxonomy. A pre-test was administered to all students prior to the treatment. The pre-test was helpful in assessing students' prior knowledge of probability and also in testing initial equivalence among groups. A post-test was administered to measure treatment effects. On analyzing the pilot study data, the Pearson's correlation coefficient for the pre-test and post-test was found to be 0.76.

Immediately after the instructions were given, the CBCL learning group students were asked to give some written feedback on the activities for the open ended questions such as: - What is your experience or feelings towards these activities? In what ways can these activities be improved? The written comments were shared with a mathematics teacher as an independent rater to check if he had interpreted the information in the same way. The congruence between independent rater and researcher in categorizing student's thoughts was looked for to establish validation in the finding.

2.3 Learning with Colour Balls learning aids

The development of Colour Balls learning aids and its accompanying module was largely based on the theories of Piaget [26], Vygotsky [58] and constructivism. Based on the premises held by those theories, learners were engaged to: - (a) work cooperatively with group members on tasks that require coordination of actions or thoughts; (b) work together, develop positive interdependence, interpersonal, interaction and verbal interchange skills as they solve problems and construct their own knowledge; (c) explore, try, and manipulate the colour balls learning aids as they solve problems.

The colour balls learning aids (Figure 1) developed by the researcher, consisted of a box (29.7 cm X 21 cm X 23 cm) filled with a collection of colourful balls, large dice (letters and numbers), small dice with polystyrene cups, beads, pieces of plastic coins (10 cents, 20 cents, and 50 cents), and Othello pieces (black and white). The balls with different colours were used to enable students to experience and recognize various random events of sample space. The purpose of using a half-transparent box with its colourful balls was to enable students to visualize the sample space and possible outcomes of the experiment. In addition, beads, black and white pieces, toy coins, marbles, and small dice (letters and numbers) were also provided to be used in STAD cooperative learning group activities.

Prior to the start of the instruction for CBCL groups, the teacher used the big colour balls and large dice (letters and numbers) to introduce the concept of sampled space, events, and chance. In groups of four or five members (Figure 3), students were then requested to carry out activities such as throwing a dice and tossing a coin to determine whether an outcome is a possible outcome of an experiment or whether an event is possible for a sample space. They helped each other to learn through tutoring, testing each other, sharing their work, discussing and solving problems posed in the provided learning module (Figure 2). The learning module consisted of series of questions which were arranged according to the level of difficulty; from easy to difficult.

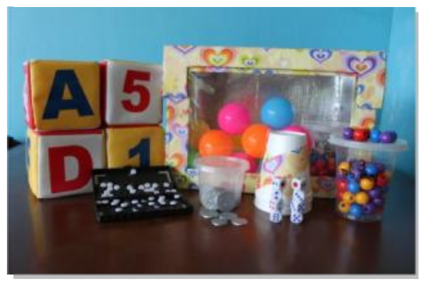

Fig. 1. Colour Balls learning aids

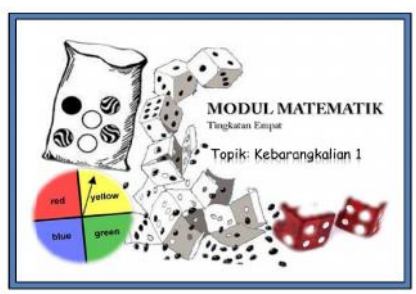

Fig. 2. Colour Balls learning module

Fig. 3. STAD cooperative learning group activities with the aid of Colour Balls learning aids

2.4 Learning with the Modified STAD cooperative learning

The study implemented a modified STAD during the learning sessions and focused on elements such as group hands-on activities, peer tutoring, group discussions, quizzes, individual accountability, and team recognition. The main purpose of STAD in this study was to improve and accelerate the learner's performance in probability. The teams for the CBCL and CL groups consisted of

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heterogeneous groups of four to five members composed on the basis of random selection in accordance with gender and ethnicity (diversity), The teams were assigned by the teacher so that it included students of high and low ability levels based on their individual pre-test score. Team members studied the questions posed in the module (CBCL group) and textbook (CL group) and learnt materials together until all students had successfully mastered the content of probability. Both CBCL and CL groups were taught by assigned mathematic teachers over a period of 170 minutes and 135 minutes respectively.

At the end of the lesson, a quiz testing the concepts of probability was held. Total scores achieved by each group would be calculated, announced, and rewards would be given to the successful group with the highest score. As the goal of each group was to win in the quiz, it was therefore in the interest of every group member to spend time explaining concepts to group mates to ensure that every group member has learned something. The teacher acted as a facilitator, monitored groups and intervened to provide task assistance when needed.

The CL group served as a control group. The first phase of teaching method applied in CL group involved teacher' presentation of content through whiteboard and marker pen, while the students listened and took down notes. The teachers related the concept of probability to daily life activities, gave examples of sample space by drawing the box on whiteboard, and gave examples of how to identify and calculate the probability of an event in the sample space. The students then formed groups and carried out STAD cooperative learning to discuss and solve problems in the text book and workbook. In general, a key difference between CBCL and CL group was that in the latter, students were given a task and asked to work on it in STAD groups with no access to colour balls learning aids, whereas in CBCL group, colour balls learning aids and its accompanying module were carefully planned, prepared, and utilized in the STAD cooperative learning group.

In order to control for the "teacher quality" variable, the classroom teachers were trained on how to use the colour ball learning aids and its accompanying module and STAD cooperative learning two weeks prior to the start of the study. The researcher guided the teachers through a detailed lesson plan which explained the procedure on how to conduct the learning activities in both the CBCL and CL groups. The teachers in all the groups taught the probability unit using the same content outline.

3. RESEARCH FINDINGS

3.1 Participants' Performance Test

In this study, Independent samples t-tests and Paired samples t-tests for performance test comparing the mean scores of the pre-test and the post-test between/within the CBCL and CL group were computed to determine if a significant difference existed.

First, an independent samples t-test was conducted on pre-test and post-test scores for the two treatment groups. Based on the data in Table 1, the mean of pre-test scores for the participants in the CBCL group was not statistically significantly different from the pre-test scores in the CL group ($t (1.313) = 0.597$, $P = .55$). Hence, it was concluded that pre-test differences among treatment groups were not significant. The results of the post-performance test indicate that the mean of post-test scores for students in the CBCL group (62.25) was higher than the CL group (54.69). An independent samples t-test on the data showed a significant difference between the two groups ($t(158) = 3.148$, $P = .002$).

Table 2 reported the paired samples t-test result of data gained from the performance test. The use of the paired sample t-test on the gathered data reveals that both the Colour Balls with STAD cooperative learning (t (79) = 42.382, $P = .000$) and STAD cooperative learning method experience (t (79) = 70.726, $P = .000$) were statistically effective for the performance of students in probability. The CBCL learning experience, however, leads to a better performance than the CL method.

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Table 1. Independent t-test results of data gained from probability test

Test	Groups	N	Mean	SD	df	t	Sig-p
Pre-Test	CBCL	80	19.19	13.628	1.313	0.597	0.551
	CL	80	17.88	14.159			
Post-Test	CBCL	80	62.25	14.050	158	3.148	0.002*
	CL	80	54.69	16.252			

*Significant at p<0.05

Table 2. Pair sample t-test results of data gained from probability test

Groups	Test	N	Mean	SD	df	t	Sig-p
CL	Pre-Test	80	17.88	14.159	79	70.726	0.000*
	Post-Test	80	54.69	16.252			
CBCL	Pre-Test	80	19.19	13.628	79	42.382	0.000*
	Post-Test	80	62.25	14.050			

*Significant at p<0.05

3.2 Findings from the Open-Ended Questions

The CBCL learning group participants were asked to write comments on their learning experience. In order to analyze the open-ended informal responses, they were categorized into three parts: namely; a positive perception (benefits focusing on learning process using the CBCL method), negative perception (Negative aspects of CBCL learning) and suggestions for improvement. The comments along with the number of participants who made those comments are described in Table 3.

Almost all the participants felt that the CBCL activities were suitable for the topic of probability as it helped linking learning activities to probability concepts. They commented that: - “The numerous examples given in the activities had enabled us to make connection to the concepts of probability;”, “The learning aids given had made it easier for us to understand the meaning of probability;”, and “The colour Balls are suitable and ideal to represent events in sample space”. They also felt that the CBCL method boost their confidence in answering questions. Some of the related responses were: - “There are friends to help me, so I feel more confident when answering questions;”, “Probability is not that difficult as what I had thought, I can answer the questions in the module easily;” and “I do not need to ‘think long’ to solve the problem, there are many heads to help me”. Students generally felt that the CBCL activities had helped them better understand and remember the concept of probability. Some of their responses were: -“The learning activities are easy to understand; the box represents the sample space, and the balls represent the events;” and “The activities using colour Balls are easy to follow. Now I can understand the main concepts of probability”.

They also found that the physical features of the learning aids had attracted them to learn probability. Their feedbacks were:- “The colour Balls are very cute, simple and easy to manipulate;”, “The Colour Balls have all sorts of colors, very attractive;”, “Everything is available in the Colour Balls learning kit, very interesting;”, and “In the previous math lesson, we always feel sleepy. But this time we do not feel it”.

Students generally felt that using colour ball learning aids in the probability classroom made learning fun and enjoyable. Their responses were:- “There are many games in the activities, we have a lot of fun;”, “We are learning while playing;”,and “We enjoy learning with Colour Balls”.

The activities had also fostered their cooperation and discussion in solving problems. Consequently this had encouraged them to participate actively in the process of learning probability. They pointed out that:- “We have active discussions during group activities. We always work together;”, “We no longer sit quietly like before. We share our ideas in the group activities;”, “ We work in a very friendly environment. We get to know one another better;", "I rarely talk to them. This is our first time working together;", "We are able to get along with students who are not our good friends. I get to know more friends now;", "If I do not know the answer, I can refer to friends for help ;", "We help and support each other so that all members can answer the given questions;", and "There is always a friend to offer help whenever I encounter problems".

Students get to see that whatever they had studied could actually be applied to real-life situations. Their feedbacks were: "I only get to know today that lucky draw is one type of probability;", and "I know what it means when the weather forecast man says there's an 85% chance of rain today".

However, there was one big concern being brought out by more than half of the students: they needed a longer time to complete their activities. They had this feeling simply because they needed a lot of time to explain the materials to the weaker group members. They even mentioned that they felt tired teaching group members who are too weak. Another concern was that they felt there were tendencies in the group to be jealous of those groups who had won in the quiz. They pointed out that:- "Other groups do not like us to win in the quiz;", "We completed all the questions first, so for sure they would not feel happy;" and "They say we are cheating!". Some others indicated that they had difficulties understanding some of the questions in the module as no further explanation was provided by the teachers.

On the other hand, the students had also offered some suggestions for improvement in response to the open ended question, "In what ways can the CBCL activities be improved?". Almost all participants proposed that numerous types and more Colour Balls learning aids be provided for the learning session. Related suggestions were:- "The learning will be more intresting if numerous types of Colour Balls were used;" and "I wish to see more balls in the kit". A couple of students had proposed that a teacher should be there to guide them and discussion sessions should be held in order to explain the difficult questions prior to the quiz.

Table 3: Categorical Description of Students' Open-Ended Responses Regarding CBCL Learning.

A	**Benefits focusing on learning using CBCL method (No. of responses)** The learning aids is simple, attractive and easy to manipulate (68) The activities make understanding probability easier(68) It was fun and enjoyable (72) The activities were suitable for learning probability (75) Encourages us to discuss during learning and teaching session (67) Promotes friendship & cooperation among group members (58) Helps to understand the concept of probability (55) Related to daily life activities (43) Boost confidence to answer questions (70) Helps to remember the concept of probability (67) Increases active participation in answering questions (69) Gains more interest in learning probability (75)
B	**Negative aspects of CBCL learning (No. of responses**) Some questions in the module were difficult to understand as explanation was not provided by the teachers (5) Group tends to get jealous with the winning groups (34) Feels tired teaching group members who are too weak (22) Requires a longer time to complete the task (43)
C	**Suggestions for improvement (No. of responses)** More explanations needed from teacher for the difficult questions (5) Creating a question and answer session prior to the quiz (8) Provide more types and number of Colour Balls learning aids (75)

4. DISCUSSION

After conducting an analysis on the test scores, it was found that students who had participated in the CBCL learning had performed significantly better on the probability post-test than the students who studied in the CL group. It was also found that both groups performed significantly better on the post test compared to the pre test.

The result of this study shows the effects of CBCL on student's performance in probability providing optimistic support for this instructional method. More performance gains were observed in the CBCL learning group. This indicated that many of the Arts Stream students in the study were able to move 'from the concrete representations to the more formal aspects of mathematics'. The main cause of this change can be accredited to the active involvement of students in the manipulation of Colour Balls learning materials that is aided with STAD cooperative learning. This finding is consistent with similar performance gains previously reported [29, 32, 57]. All the studies reported that the use of concrete learning aids had helped students understand abstract mathematical concepts better. The result was also supported by [16] in his research which states that concrete learning aids were able to give concrete meaning of abstract concepts as oppose to teaching through words. In fact, Colour Balls in CBCL method had increased the effect of STAD cooperative learning in learning probability. As indicated in the student's written comments, colour Balls learning aids provide them with a clearer picture of what sample space was and they had more opportunities to explore the sample space freely through a variety of activities. Students also worked closely with their group members within STAD cooperative learning group in answering questions. Weak students could seek help from more capable peers when they encountered difficulties, thus boosting their confidence in solving problems. This study environment and tasks given had helped to promote the understanding of the abstract concepts of probability.

On the other hand, the findings had also reflected that there were significant differences between the mean score of the pre and post test in the CL group. This result is in agreement with the learning theories proposed by proponents of cooperative learning. According to Vygotsky [61], students are more capable to perform at higher intellectual levels when they were asked to work in cooperative situations than when asked to work individually. Group diversity in terms of knowledge and experience contributes positively to the learning process. The peer support system makes it possible for the learner to internalize external knowledge and to convert them into tools for intellectual functioning [10]

These findings were in line with the results of previous studies which found that the STAD method has significantly boost the academic achievement compared to the traditional methods [2, 3, 62, 35]. This effect can be accredited to the provision of smaller groups in STAD learning which is characterized by mutual interdependence of group members, individual accountability, peer pressure due to common learning goals, continuous assessment and performance rewards. In the present study, each student will not only be responsible for their own self-advancement, but will also help the weaker members of the group to make sense of the probability being modelled. This was mainly to ensure their team goal would be achieved, that was to gain the highest score in the quiz. As claimed by [5] and [36], each group member will strive to help each other, give guidance, discuss, and motivate each other in order to boost the performance of the cooperative learning group.

The analysis of open response showed that a majority of students had positive perception towards the use of CBCL method in learning probability. Most of them felt that the CBCL method was suitable for the topic of probability as it helped linking learning activities to probability concepts. The CBCL activity shows that learning an abstract topic like probability is perceived by most students as enjoyable and fun. Students found that the learning aids were simple, attractive and easy to be manipulated and thus attracting them to learn probability. Students also saw the relevance of colour balls activities to daily life activities which they are familiar with.

However, despite the strong support for the CBCL method, there were students who found limitations of this method such as:- a longer period of time needed in completing a task; fatigue in explaining to group members who are too weak; difficulties in understanding some questions in module; and the feeling of jealousy on the success of other groups. This suggested that the limitations mentioned may inhibit how a CBCL activity can be implemented effectively.

5. CONCLUSION

Concrete objects like colour balls are tools to support learning. As with any other educational tools, the effects of colour balls are limited by the ways in which they are used. In order to maximize the potential use of colour balls in the teaching and learning of probability, two instructional strategies were employed to investigate the effects on student's performance in learning probability. This study shows that the Colour Balls concrete learning aids, when incorporated with the *STAD* cooperative learning method is an effective method in improving the performance of Form Four Arts Stream students in the topic of probability. Colour Balls had increased the effect of STAD cooperative learning in learning probability in CBCL method. The lesson was founded on familiar ideas from Piaget and Vygotsky and assembled from locally available concrete learning objects that students were familiar with or intuitively able to use. With a little effort, any mathematics teacher can now learn to build his or her own Colour Balls learning aids that support and scaffold learning probability using STAD cooperative learning method.

However, in future lessons where colour balls learning aids are used, the method should be improvised. For example, more preparations such as increasing the number and numerous types of colour balls are needed for effective group activities. This is to ensure that students use the aids effectively and efficiently in exploring the concept of probability. In addition, students need to be involved in a teacher guided sharing session to explain the difficult questions. Additional research that investigates the possible long-term effects of the CBCL method in teaching other mathematics topics can be conducted in the future.

COMPETING INTERESTS

The author has declared that no competing interests exist.

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