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Cooperative Learning Versus The Lecture Method of Instruction in An Introductory Statistics Course

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Abstract

Traditionally, the teaching of introductory statistics course in many colleges around the world is through the lecture method where the emphasis is on giving students the rules and techniques to be memorized and drill set for practicing algorithms. Active learning in learning statistical activities, is rarely, if ever, being encouraged. The work done in an introductory statistics classroom can therefore become dry and technique-oriented and consequently fail to show the power and nature of statistics. This paper describes an experimental study where the relative effects of cooperative learning versus lecture method of instruction in an introductory statistics course for student teachers were examined. The experimental group was given learning materials or units using the cooperative learning method while the control group was given none of the units but received the same cognitive input through the lecture method. The study was carried out over a period of five weeks with an hour-long session per week with each group. Student teachers in both groups were given questionnaires before the study and an assessment test after the study. In both groups, neither their readiness to study statistics nor their attitudes to learning statistics differ significantly. However, in the assessment test, student teachers in the experimental group achieved higher test scores. The implications of these findings on the teaching and learning of the introductory statistics course are discussed briefly.

Keywords: Cooperative learning, lecture method, introductory statistics course

Abstrak

Secara tradisi, pengajaran pengenalan statistik adalah melalui kaedah syarahan di mana penekanan ke atas penghafalan teknik-teknik algoritma diutamakan. Pembelajaran secara aktif dalam mempelajari aktiviti-aktiviti statistik jarang sekali digalakkan. Oleh itu pembelajaran pengenalan statistik adalah agak membosankan dan berorientasikan teknik dan akibatnya gagal untuk menunjukkan kebolehupayaan dan apa sebenarnya statistik. Kertas ini memperihalkan kajian eksperimen tentang kesan-kesan pembelajaran koperatif dengan membandingkan dengan kaedah syarahan dalam mempelajari statistik pengenalan bagi guru-guru pelatih. Kumpulan eksperimen mempelajari statistik pengenalan menerusi pembelajaran koperatif yang menggunakan bahan-bahan pembelajaran yang khusus manakala kumpulan kawalan menerima input yang sama tetapi menggunakan kaedah syarahan. Kajian dijalankan dalam tempoh lima minggu dengan sesi sejam seminggu bagi setiap kumpulan yang terlibat. Kesemua guru pelatih bagi kedua-dua kumpulan diberi soal selidik sebelum kajian dimulakan dan satu ujian penaksiran selepas kajian. Bagi kedua-dua kumpulan, tidak terdapat perbezaan yang signifikan tentang kesedian atau sikap terhadap pembelajaran statistik. Walau bagaimanapun, keputusan ujian penaksiran menunjukkan yang guru pelatih dalam kumpulan eksperimen memperolehi skor yang lebih tinggi. Implikasi daripada hasil kajian ke atas pengajaran dan pembelajaran pengenalan statistik juga dibincangkan secara ringkas.

Kata kunci: Pembelajaran koperatif, kaedah syarahan, kursus pengenalan statistik

Introduction

Lecturing is a common teaching strategy at tertiary level especially involving large classes and in teaching courses like introductory statistics. Some people may argue that it is the traditional form of teaching at tertiary level and, therefore, is expected by students and lecturers alike. Students and lecturers often have the same mental image of how the lecture method works: the lecturer, as a figure in authority, talks and writes something on the board and the students listen and take copious notes of what is written on the board (Middendorf & Kalish, 1996). Lectures are generally presented from the lecturer's perspectives and the emphasis is on facts and skills and not on the relationships between them, especially in quantitative courses like mathematics and statistics. McIntosh (1996) points out that lecturing is frequently a one-way verbal communication unaccompanied by discussion, questioning or immediate practice. Students' need for interaction with the lecturer is not given due consideration or is assumed to be unimportant. Despite its limitations, the lecture method is still popular among educators in teaching the introductory statistics courses. However, in recent years statistics educators have gradually incorporated active learning strategies in their classrooms (Gunawardena, 2002). Research and anecdotal evidence strongly support the claim that students learn best when they actively participate in their learning (e.g. Bonwell & Eison, 1991). This active learning strategy involves 'providing opportunities for students to meaningfully talk and listen, write, read, and reflect on the content, ideas, issues, and concerns of an academic subject' (Meyers & Jones, 2003). Instead of traditional lectures where teachers disseminate information to students for them to remember, lecturers should be encouraged to introduce active learning activities where students would be able to construct their own knowledge. A form of active learning favoured by many educators who are concerned about improving education regardless of discipline or level of instruction is the cooperative learning strategy (e.g. NCTM, 1991; Johnson & Johnson, 1994; Garfield, 1993; Felder & Brent, 2001).

Cooperative learning is defined as the instructional use of small groups in which students work together to maximise their own and each other's learning in solving problems, completing tasks and accomplishing common goals (Johnson & Johnson, 1999). Thus, each member of the group is responsible not only for learning what is taught but also for encouraging and supporting other group members to learn and, consequently, creating an atmosphere of achievement. In cooperative learning, the role of the teacher is that of a facilitator rather than as an expert dispensing knowledge (Cooper et al., 2001). The facilitator may allow students to form the groups themselves or the groups may be formed by the facilitator to be either homogeneous or heterogeneous (Garfield, 2000). While the groups in the cooperative learning class work on their tasks, the facilitator will move from group to group, observe the interactions between group members and will intervene if necessary. This will provide the facilitator with an ongoing and informal assessment of how well students are learning and understanding the course material. Working together in a small group to get a job done, like in cooperative learning, has the potential to benefit students in many ways. Small group learning activities often result in peer teaching where students teach each other especially when a group member understand the material better or learn more quickly than others (Garfield, 2000). Research has shown that having students teach each other often leads to their own improved understanding of the learning material (Johnson et al., 2004). It seems that teaching each other '… *allows students to cognitively rehearse and relate course material into existing schema or conceptual frameworks, thus producing a deeper, contextualised level of understanding of content'* (Cooper & Robinson, 1998).

Student interaction makes cooperative learning meaningful. During discussions, members are given the opportunity to demonstrate their knowledge of what they have learned as well as allowing for clarification, questions and expressions of opinion (Tinzmann et al., 1990). Members, especially the reserved individuals, are likely to be less inhibited to ask questions and to contribute to the discussions in small groups. For example, in a statistics class, members discuss their approaches to solving a statistics problem, explain their reasoning and defend their work Thus, this encourages the comparison of ways of understanding the problem, problem solving strategies and different solutions to the problem. According to Garfield (2000), this allows students to learn first-hand that there is not just one correct way to solve most statistics problems. Consequently, students engaged in interaction often exceed what they can achieve by working independently (Tinzmann et al., 1990). Learning by means of small group activities also increases students' motivation because they feel more positive about completing a task successfully working with others than by working individually (e.g. Johnson et al., 2004; Nichols & Miller, 1994). By working together towards a common goal, group members may develop positive feeling and show greater commitment towards the group and may result in building up considerable camaraderie. This increase in motivation may also lead to improved students' attitudes towards a subject or a course. Studies carried out by many researchers in various disciplines have reported about students' positive attitudes toward cooperative learning (e.g. Schultz, 1989; Nichols & Miller, 1994; Giraud, 2002; Magel, 2003; Felder & Brent, 2001). In a review of studies dealing with the impact of cooperative learning in science, mathematics, engineering and technical classes at tertiary level, Springer et al. (cited in Cooper & Robinson, 1998) report that students exposed to small group instruction produced better achievement in several types of tests and assessments than students taught in more traditional methods like lectures.

Motivation

The success of implementing cooperative learning strategies in teaching statistics (especially introductory statistics courses at tertiary level) has been reported by many statistics educators such as Steinhorst & Keeler (2001). Giraud (2002), Rinaman (1998), Magel (2003) and Gunawardena (2002). Their studies support the hypothesis that cooperative learning in statistics class results in students obtaining higher achievement than students in lecture instruction. Findings also suggest that cooperative learning promotes retention of learning material for most students as evidenced by differences in statistics examination scores The studies also reveal that cooperative learning is especially beneficial for students who are least prepared for statistics since the strategy help them to learn statistics without anxiety.

Previous studies of cooperative learning method in introductory statistics courses might have compared cooperative learning methods to the lecture method that might not be directly comparable such as from the statements by the students themselves or from comparing grades. However, the studies did not compare cooperative learning method to control classes taught using the lecture method in the same period of time and by the same lecturer or instructor. This study tried to compare classes that employed the cooperative learning method and classes that totally relied on the lecture method. Both groups of classes which consisted of student teachers were taught by the same instructor using the same learning materials. Comparison was made in terms of the student teachers' scores on identical tests.

In light of the previous studies and the importance of evaluating a potentially effective means of teaching statistics, this study was designed to investigate the effects of the cooperative learning method as applied in a basic and simple form to instruction in introductory statistics. The study was designed to answer the following main research questions:

a) Did student teachers in cooperative learning classes have better attitudes toward learning statistics than those in the classes using the traditional lecture method?
b) Did student teachers in cooperative classes obtain higher scores on tests than student teachers in a traditional classroom?

c) Did cooperative learning benefit student teachers who were from non-mathematical backgrounds?

Methodology

To achieve the objectives of this study, a quasi-experimental design was adopted. According to Campbell & Stanley (cited in Robson, 1994), a quasi-experiment is a research design using an experimental approach but where random assignment to treatment and control group has not been used. For several reasons such as administrative problems and the constraint of time, it was not possible to randomly assign student teachers that were enrolled in the introductory statistics courses to treatment and control groups. Thus, a 'pre-test post-test non-equivalent groups' quasi-experimental design (Robson, 1994) was seen as appropriate for this study.

The Study Sample

In this study, the participants were student teachers from three teacher training colleges as well as from Universiti Pendidikan Sultan Idris (UPSI) who were enrolled in the introductory statistics courses. The three colleges were chosen because they also conducted some of the Bachelor of Education (B.Ed) courses offered by UPSI. As far as the introductory statistics course was concerned, the contents of the syllabus and the methods of assessment in these colleges were similar to the one that could be found at UPSI. Two introductory statistics classes from each college were selected by the college lecturers themselves. One class was assigned as the experimental group while the other class was assigned as the control group.

The Instruments

For both the experimental and control groups, questionnaires (pre-questionnaire) to survey their attitudes toward learning statistics as well as a basic mathematics test were given. Basically, the main purpose was to find out whether or not the two groups differ before treatment. For the treatment, learning units were given to the experimental group while the control group received none of them. However, it was decided that it would be fair and appropriate if both groups received the same cognitive input. Thus, the contents of the learning units were delivered to the control group through the normal lecture method. As mentioned earlier, the learning units were student-based and the student teachers carried out all the activities by themselves through small cooperative groups (in pairs or at most three student teachers to a group) and also independent of the lecturer's involvement. Finally, post-tests consisting of a questionnaire (post-questionnaire) and an achievement test were given to both groups.

Results and Discussions

a) Pre-questionnaire survey

The two main sections in the pre-questionnaire were concerned with student teachers' attitudes toward learning statistics and their opinions on the introductory statistics courses. The opinions of both experimental and control groups on these two areas were examined by investigating the differences in their performances. To analyse the differences in the performances between the two groups, the chi-square (χ^2) test was used. It was decided to use the chi-square test (test for homogeneity) instead of the chi-square goodness-of-fit test. The latter is used to determine whether the observed frequencies differed significantly from the theoretically expected frequencies. Thus, the goodness-of-fit test was not considered appropriate because there was no reason to assume that the results of one of the groups represented expected frequencies. The chi-square test for homogeneity evaluates whether or not the two groups are homogeneous with respect to the proportion of observations in each of the five categories in the assessment of attitudes and opinions (Sheskin, 2005).

The chi-square statistic was calculated using sets of five cells because five-point scales were used in both Likert method and Osgood's semantic differential method. However, for clarity and also due to the constraint governing the use of the chi-square test, it was found that combination to produce three cells was frequently necessary. Thus, for items using the Likert method, cells representing 'strongly agree' and 'agree' were combined to represent the opinion 'agree' while the cells representing 'strongly disagree' and 'disagree' were combined to represent the opinion 'disagree'. For items using the semantic differential method, the first two cells on the left were combined to represent the opinion to the left while the last two cells on the right were combined to represent the opinion to the right. The middle cell was to represent the neutral opinion. The frequencies of responses to these items were expressed in the form of percentages and these are shown in Table 1. However, the chi-square tests were performed on the raw data. In these tables, responses from the experimental group (N = 370) and comparison (N = 275) group were put next to each other after each statement so as to compare the differences that might exist between the two groups before the experiment was conducted.

The main conclusion that could be drawn from the Table 1 is that statistically significant differences between the experimental and comparison groups did not occur for any item concerning the attitudes toward learning statistics. In general, student teachers' attitudes toward learning statistics were positive although they believed that learning statistics was a challenging task.

Table 1 Student teachers' attitudes toward learning statistics

Statement	G	SA	A	N	D	SD	χ^2 (df)	sig. lev
I like to study statistics	E	8.9	43.2	44.1	2.7	1.1	1.3(2)	not sig.
	C	13.8	41.8	41.8	2.5	0		
Statistics is difficult to learn	E	1.4	24.3	54.9	17.0	2.4	3.6(2)	not sig.
	C	4.0	23.8	58.5	13.5	0.4		
Statistics is a useful tool in every day life	E	24.6	58.3	15.5	1.4	0.3	0.1(2)	not sig.
	C	28.7	53.1	17.5	0.7	0		
I don't like statistics	E	1.9	5.1	28.4	48.1	16.5	0.8(2)	not sig.
	C	0	5.5	27.6	45.4	21.5		
Statistics is easier than other branches of mathematics	E	1.4	13.8	50.3	31.6	3.0	2.3(2)	not sig.
	C	4.0	14.2	52.4	28.8	0.7		
A lot of difficult concepts in statistics	E	3.5	37.6	43.5	14.9	0.5	0.3(2)	not sig.
	C	3.3	37.1	42.5	15.6	1.5		
Statistics is a challenging subject	E	15.7	58.6	23.5	2.2	0	1.9(2)	not sig.
	C	10.5	61.8	23.6	4.0	0		
I don't enjoy the statistics course that I'm currently studying	E	6.8	27.8	44.1	18.9	2.4	3.2(2)	not sig.
	C	7.6	31.6	37.1	23.3	0.4		
It would be easier to learn statistics using software packages	E	20.8	48.6	24.9	4.9	0.8	0.6(2)	not sig.
	C	11.6	55.3	27.6	5.1	0.4		
I feel confident about coping with my statistics course	E	5.4	35.4	46.8	10.8	1.6	2.8(2)	not sig.
	C	9.5	36.0	45.8	8.0	0.7		

Legend: G-Group, E-Experimental, C-Control, SA-Strongly Agree, A-Agree, N-Neutral, D-Disagree, SD-Strongly Disagree, df-degrees of freedom, sig.lev.-significant level

From Table 2, it is clear that once again statistically significant differences between the experimental and control groups did not exist for all but one item regarding the opinions about their introductory statistics courses. The exception was on the response to the item 'Real life data rarely used in examples/Real life data always used in examples' where the difference was significant at 5% level (χ^2 = 7.1, df = 2, $p < 0.05$). A higher proportion of student teachers in the experimental group (14.4% compared to 7.6% for the control group) believed that the lecturers always used real data when statistical examples were given. It was quite difficult to explain the reason behind this difference because in each of the colleges, only one lecturer was involved in teaching the introductory statistics course. Perhaps the student teachers themselves could not distinguish the difference between real data (obtained empirically and through research reports etc.) and artificial data (made up by the lecturers).

Table 2 Student teachers' opinions on the introductory statistic course

Word & Statement Pairs	G	SA	A	N	D	SD	χ^2 (df)	sig. lev
Easy/Difficult	E	3.2	26.8	55.7	13.2	1.1	4.1(2)	not sig.
	C	2.2	23.6	54.2	17.1	2.9		
Boring lectures/Interesting lectures	E	5.9	26.2	42.2	17.8	7.8	2.2(2)	not sig.
	C	9.1	27.6	36.7	20.7	5.8		
Heavy workload/Light workload	E	5.1	27.3	43.8	18.9	4.9	1.3(2)	not sig.
	C	2.5	25.8	45.5	23.6	2.5		
Course too mathematical/Course less mathematical	E	5.4	29.2	48.9	15.4	1.1	3.1(2)	not sig.
	C	4.0	36.0	47.6	11.6	0.7		
Too many test and quizzes/ Too few tests and quizzes	E	1.4	15.4	54.1	24.6	4.6	2.5(2)	not sig.
	C	1.1	11.6	54.2	28.7	4.4		
Real life data rarely used/ Real life data always	E	14.6	43.0	28.1	12.2	2.2	7.1(2)	not sig.
	C	17.1	43.5	31.8	6.9	0.7		
Too many tedious calculations/ Not many calculations involved	E	5.9	55.9	21.9	14.6	1.6	0.4(2)	not sig.
	C	8.0	55.6	21.5	13.8	1.1		
Software packages are used in class/ Software packages are not used	E	3.8	14.1	19.5	43.5	19.2	4.5(2)	not sig.
	C	4.7	18.9	14.9	42.2	19.3		
Interpretations of statistical results emphasised/ Little emphasis is given to interpretations	E	2.2	8.1	20.5	55.9	13.2	1.8(2)	not sig.
	C	2.2	10.5	21.8	48.0	17.5		
The lecturer shows how statistics is used in daily life/ the lecturer does not show how statistics is used in daily life	E	5.7	15.4	34.1	31.9	13.0	3.9(2)	not sig.
	C	4.4	11.3	33.1	36.0	15.3		

Legend: G-Group, E-Experimental, C-Control, SA-Strongly Agree, A-Agree, N-Neutral, D-Disagree, SD-Strongly Disagree, df-degrees of freedom, sig.lev.-significant level

b) Basic mathematics test

The test consisted of 30 multiple choice items concerning knowledge of basic algebra and mathematical reasoning adapted from the test used by Giraud (2002). It was used as a measure of statistics readiness as it was thought that an understanding of algebra and basic mathematical reasoning was a pre-requisite to study statistics successfully. The mean score and its standard deviation of the test are given below in Table 3.

Table 3 The descriptive statistics of the test's scores

Group	N	Mean	Std. Dev.
Experimental	370	21.27	6.24
Comparison	275	20.88	5.59

By employing the t-test to compare the two independent groups, it could be concluded that there was no reason to reject the null hypothesis that the means were identical ($t = 0.88$, $df = 274$, $p > 0.05$). Thus the two groups were thought to be equivalent in term of their readiness to study statistics.

c) Post-questionnaire survey

The main section in the post-questionnaires given to both experimental and control groups was exactly the same and consisted of ten items that used the Likert method's five-point scale designed to assess the student teachers' opinions on how they would like to learn statistics best. The frequencies of responses, expressed in percentages, for both the experimental and control groups are shown in Table 4.

Table 4 Student teachers' opinions on how they would like to learn statistics best

Statement	G	SA	A	N	D	SD	χ^2 (df)	sig. lev
The lecturer gives all the input and the students take down the notes without question.	E C	3.0 2.5	10.5 17.1	21.9 23.6	61.4 52.4	3.2 4.4	5.5(2)	not sig.
Need to have discussions between lecturer and students and between themselves	E C	35.4 27.6	55.4 44.7	9.2 26.5	0 0.7	0 0.4	37.9(2)	0.1 %
Just have to memorise the fact and figures given by he lecturer	E C	0.3 0.4	6.2 12.4	16.5 21.1	67.8 53.8	9.2 12.4	11.1(2)	0.1 %
Do not need to do practical work in the classroom	E C	1.1 2.2	2.2 2,5	11.4 16.0	70.3 60.0	15.1 19.3	4.2(2)	not sig.
The lecturer should use real life data in examples		21.1 20.4	60.0 50.9	17.8 21.8	1.1 6.9	0 0	10.8(2)	0.1 %
Need to use the software packages and the tedious calculations and doing the graphs	E C	16.2 15.3	47.8 50.5	28.1 28.7	7.6 5.5	0.3 0	1.4(2)	not sig.
The lecturer should use real life data in examples	E C	9.5 9.1	38.4 38.2	44.6 42.2	7.0 10.2	0.5 0.4	2.0(2)	not sig.
I do not need to understand the concepts and interpretations to pass the statistics course	E C	0.3 0.4	4.0 3.6	10.0 24.4	59.2 46.9	26.5 24.7	24.1(2)	1 %
Students should be taught how to use statistics effectively to make decisions in real life	E C	19.7 13.8	62.7 60.7	16.5 23.6	1.1 1.5	0 0.4	5.9(2)	5 %
Test and exam question should focus more on the calculation rather than interpretations	E C	16.2 11.3	43.5 47.3	34.3 31.6	4.9 8.4	1.1 1.5	3.5(2)	not sig.

Legend: G-Group, E-Experimental, C-Control, SA-Strongly Agree, A-Agree, N-Neutral, D-Disagree, SD-Strongly Disagree, df-degrees of freedom, sig.lev.-significant level

As with the pre-questionnaire, the chi-square (χ^2) test was used to compare the results from the experimental group with those obtained by the control group. Since the observed frequencies were obtained under two different conditions and it was the intention of this study to see whether any differences that might occur between the two groups were statistically significant, the chi-square test was used as a test of differences between independent groups.

From Table 4, it is evident that there were statistically significant differences to the opinions given on the following statements:

i) 'Need to have discussions between lecturer/students and student/student' (χ^2 = 37.9, df = 2, $p < 0.001$) – strongly favoured by the experimental group.
ii) 'The learning should be interactive and the lecturer's role is just as a facilitator' (χ^2 = 10.8, df = 2, $p < 0.01$) – strongly favoured by the experimental group.
iii) 'Students should be taught how to use statistics effectively to make decisions in real life situations' (χ^2 = 5.9, df = 2, $p < 0.05$) – favoured by the experimental group.
iv) 'Just have to memorise the facts and figures given by the lecturer' (χ^2 = 11.1, df = 2, $p < 0.01$) – strongly disagreed by the experimental group.
v) 'I do not need to understand the statistical concepts and interpretations to pass the course' (χ^2 = 24.1, df = 2, $p < 0.001$) – strongly disagreed by the experimental group.

A much higher proportion of the student teachers in the experimental group than in the control group agreed with each of the statements i), ii) and iii). Similarly, more student teachers in the experimental group than in the control group disagreed with the statements iv) and v). Perhaps, the significant differences in the responses given to these five statements could be attributed to the positive experience of learning statistics offered by the learning units where activities were carried out in groups co-operatively. Thus, the student teachers in the experimental group could see the benefits of learning statistics through this method where discussions among group members were frequent and encouraged. In addition, discussion sessions with the facilitator were also held after the completion of each unit. Nevertheless, it should be pointed out that even with the control group where the lecture method alone was employed, the majority of the student teachers seemed to favour learning statistics where discussions prevailed and group work done co-operatively and they should be taught on how to use statistics effectively in everyday situations. Most of the student teachers in the control group also agreed that there was more to learning statistics than just memorising facts and figures and that they needed to understand statistical concepts and interpretations in order to succeed in the statistics course. The other five items in Table 5 did not produce statistically significant differences between the groups although the general pattern of responses from the experimental group did appear to be slightly more favourable.

d) The classroom test

The classroom test consisted of 10 items in the form of structural communication grid and 20 multiple-choice items. The test was piloted with a group of students and any ambiguities found were rectified. The final form of the test was reviewed by two statistics lecturers who agreed that the test items concurred with the content of the introductory statistics course and also appropriate for the student teachers' level of understanding. The mean score and its standard deviation of the test are given in Table 5 below.

Table 5 The descriptive statistics of the test's scores

Group	N	Mean	Std. Dev.
Experimental	370	20.52	5.89
Comparison	275	14.61	6.25

In both groups, the distributions were slightly skewed positively indicating that the classroom test was quite difficult for the student teachers. However, the distribution of the test scores for the experimental group was a bit less spread-out than the distribution for the control group. It is also obvious from the descriptive statistics that the student teachers in the experimental group performed much better than the student teachers in the control group. Nevertheless, to test whether the difference in performance was significant or not, the Mann-Whitney U test was used. *The hypothesis tested was that the experiment group would perform better than the control group in the classroom test*. The t-test was not used because the score variances of the two groups did not meet an equality of variance test. According to Sheskin (2005), the sampling distribution for the Mann-Whitney U test is not as affected by violation of the homogeneity of variance assumption as is the sampling distribution for the t-test.

From the Mann-Whitney U test, it was found that there was a significant difference in the test's performance between the experimental group and the control group ($U = 34349$, $N_{exp} = 370$, $N_{comp} = 275$, $z = 7.182$, $p < 0.001$ (one-tailed)). Therefore, it could be deduced that the experimental group performed significantly better than the control group in the classroom test. What could be the reason behind the superiority of the former over the latter? Could it be that the test favour the experimental group? Both groups were not familiar with the format of the test and the items asked were based on the same materials that were covered in both the learning units and the lectures. Thus, it would be fairly certain that the test did not favour one group over the other. It might be that most student teachers in the control group, where the lecture method was employed, had forgotten all the facts and figures from the notes that they had copied down. Since the student teachers in both groups were not informed that they were going to be assessed a week after the end of the experimental study, perhaps no effort were being made to study the materials given to them either with the learning units or with the lecture notes. However, the learning units which were student-centred and put emphasis on group activities and discussions might have helped the student teachers in the experimental group to remember more what they had learned and experienced. It must also be pointed out that the experimental group also took down notes but based on the discussions between the student teachers themselves and also from the points summarised by the lecturer at the end of the learning units sessions. Perhaps, it can be argued that the learning units, being a novelty, possibly made the student teachers to appreciate more the learning of statistics that was engaging and enjoyable. Thus, it could be assumed that the learning units had positive effects on some of the student

Conclusion

This study revealed that the cooperative learning method results in higher achievement than the lecture method for almost all students and is especially beneficial for those students who were not inclined towards mathematics. The findings of this study also suggested that the cooperative learning method promoted retention of material learned for majority of the student teachers as shown by the significant differences in the classroom test. Student teachers from the experimental group who experienced the learning units were more likely than their counterparts from the control group to opt for learning statistics interactively and based on small group co-operative learning where they would be able carry out practical activities as well as having discussions with their fellow students and also their lecturer. They were also more likely to express disapproval of the 'spoon-fed' method where they would receive all the facts and figures from the lecturer, memorised and regurgitated them when the tests and examination came along. Instead, they believed that they needed to understand fully the statistical concepts and interpretations and also be taught of how to effectively use the statistical knowledge acquired and applied them in real life situations. However, it must be noted that the majority of the student teachers in the control group also opted for a student-based approach to learning statistics but to a lesser extent.

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