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Effects of Peer Tutoring on Students' Achievement in Statistics

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Abstract - Peer tutoring is a system of instruction in which learners help each other to learn. In this study, peer means the classmate of the students in the statistics graduate class. This study made use of peer tutoring as an innovative strategy in teaching inferential statistics in the graduate school. Two classes of statistics were used, one experimental class and the other was the control class. The subjects were matched by the researcher based on their Otis Lennon Scholastic Ability Test (OLSAT) scores which were taken from the guidance office. Results show that the students' achievement with peer tutoring and without peer tutoring was significantly different in favor of those groups with peer tutoring. Graduate students could freely express themselves and they found the activities enjoyable. Anxiety and attitude of students were significantly different when the subjects were grouped as those with peer teaching and without peer teaching. Both anxiety and attitude toward the subject greatly influenced the achievement of students in inferential statistics.

Keywords - Peer tutoring, students' achievement, statistics

INTRODUCTION

Peer tutoring is beneficial not only to students and students being tutored but even for teachers as well. Studies have been done to support the claim that many students may feel more at ease, and thus can concentrate better on the subject matter, with a peer tutor rather than a professional teacher or consultant (Fuchs, et al., 2002). Peer tutoring in this study is also being referred to as peer teaching, hence, these two terms are often used interchangeably. Peer tutoring teaching is often described as a setting where the more capable students assist the less capable ones. Peer tutors or teachers should be mature and have a more concrete understanding of the topic area. It is important that the peer tutors have good communication skills in order to deliver the information to the other students effectively.

Peer tutoring is necessary in the statistics course as this is one of the most feared subjects by many graduate students. Statistics is viewed by many students as the hindrance to the attainment of a desired degree (Ravid and Perney, 2002). This is confirmed by many graduate students when they said that they are afraid to take statistics because they are not good in numbers. Based on the ambush interview of this researcher with 10 sample students in Statistics, it was evident that they have a negative attitude towards the subject. It is not uncommon for the students to delay taking the required or foundation courses like Statistics until just before graduation. The emphasis on computation, problem solving, analysis and interpretation has been generally assumed to be the major cause of difficulty.

Peer teaching involves students learning from and with each other in ways which are mutually beneficial and involve sharing knowledge, ideas and experiences between participants. The emphasis is on the learning process, including the emotional support that learners offer each other, as much as the learning itself. With the foregoing anxiety and negative attitude of graduate students towards Statistics, it is necessary that these concerns should be addressed by the professor handling the subject in the School of Graduate Studies of Bukidnon

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Graduate students of BSU come from different educational levels with varied specializations. Some are majors in Mathematics, Science, English, etc. Some do not have major subjects at all. These are the graduate students with Bachelor of Education degree. Most of them accept that they are really behind those who are mathematics majors and those who are statistically inclined. They need somebody to help them learn concepts in inferential statistics.

The researcher has been teaching statistics for many years, in fact for almost 20 years. She shares the same observations as those of Perney and Ravid. She notes that statistics courses have been the cause of frustrations and confusions among many students. With these observations, an immediate solution should be thought of. Hence, varied teaching strategies and styles in teaching statistics should be employed every semester to motivate the students to learn statistics and develop students' positive attitude towards statistics. Anxiety of students in statistics or in any subject for that matter should be avoided so that they would feel comfortable with their studies.

FRAMEWORK

This study is anchored on the concept that peer teaching allows students to work cooperatively in small groups, headed by peers who are knowledgeable to handle the discussion. This method allows students to work cooperatively and collaboratively in small groups headed by their peers instead of working individually. This gives students the opportunity to develop computational skills, analytical skills and problem solving skills through interaction, which enables them to establish rapport with their peers and basically develop the concept of helping one another (Hurley, 2002). In this case, students' scores improve dramatically and students overwhelmingly tend to have positive attitude and less anxiety. Anxiety will be reduced with this kind of approach in teaching statistics.

Attitudes are developed through classical conditioning by the pairing of something desirable or undesirable with the subject (Cacioppo, et al., 1992). According to the social-learning theory, many

of our attitudes are learned through observing others, particularly our parents or peers.

According to Harvey (2001), there are certain factors that relate to statistics achievement. Two of these factors have been identified and these are anxiety and attitude of students towards statistics. This is supported by Pernie and Ravid whose study revealed that most students attributed their success in statistics course to their instructor who is responsible for imparting knowledge and skills as well as the students' anxiety and attitude towards the subject. The latter can probably be developed positively through the initiative and innovation of the instructor and that employing peer tutoring is one of these innovations.

Peer teaching increases the students' learning at the same time fosters self-confidence and makes the students more active in and responsible for their education. Peer teaching also encourages cooperative learning, communication, problem-solving, and social actions. These ideas include students giving lectures to their peers and senior students learning from reflection on seminars with junior students. The reflection seminar discusses subject in detail that lectures have brought. Senior students can co-supervise and discuss papers written by junior students.

Jones (1991) introduced peer teaching on learning activities in several sections of a statistics course and observed dramatic increase in attendance, class participation, office visits and student attitudes and anxiety. Another advantage for using peer teaching relates to the constructivist theory of learning on which much of the current reform in mathematics, science education and statistics is based. This theory describes as actively constructing one's own knowledge. Constructivists view students as those who bring to the classroom their own ideas, experiences, and beliefs that affect how they understand and learn new materials. Rather than "receiving" material in class as it is "delivered," students restructure the new information to fit into their own cognitive frameworks. In this manner, they actively and individually construct their own knowledge rather than copying knowledge "transmitted" or "conveyed" to them.

In peer teaching, group-learning activities are designed and students are able to work collaboratively on projects and to solve

problems as a team. Therefore, it is important to give students' practice in developing these skills by working cooperatively through collaborative problem-solving skills. It will also help students learn to respect others' viewpoints, other approaches to solving a problem and other learning styles.

Longaretti, Godinho, Parr, and Wilson, (2003) stated the peer teaching process involves teams of three to six students collaboratively researching a topic that relate to curriculum or teachers' work issue, and teaching it to their tutorial groups. As models in the learning and teaching workshops, the peer teaching must be interactive and student-centered. Provocative lecturing is deemed unacceptable. Following the peer teaching session and the assessment, students are required to individually complete a reflective statement about the process undertaken. In sum, the assignment or task involves the collaborative planned peer teaching session; the assessment process (completed by the tutor, the peer teaching team, and four peer assessors); and an extended writer reflective statement by individual students about the peer teaching process with some reference to assessment of the team, the tutor and the peer assessors.

According to Zaslavsky (1994), there are other factors that may have caused students' anxiety towards statistics. Such factors are inadequate schools, poor teaching, inappropriate programs, and stereotypes and myths about who can and who should do statistics. Additionally, Tobias (2002) stated that the predominant causes of statistics anxiety are environmental factors created by the statistics teachers. She identified anxiety propagated by teachers and she discussed what she identified as misfit between students' learning characteristics and instructors' teaching styles in mathematics. Only a small percentage of students are "statistics minded". The rest, she said, have learning style preferences or needs that do not fit traditional modes of mathematics instruction.

Gardner (2001) revealed that faculty responses indicated they thought attitudes and levels of math anxiety improved over the semester. Most groups did show some improvement. The only statistically significant differences detected were in math anxiety by gender and combination of math anxiety and attitude by age. Females had higher levels of math anxiety than males and while older students

appeared more "math anxious", they also reflected a more positive attitude about mathematics.

Luh, et al.(2004) presented a paper at the 10th International Congress on Mathematical Education in Denmark about attitude of cadets and college students towards statistics. Both groups think statistics has its own value and they have positive attitude towards statistics. In addition, the college students have higher perceived math ability and math attitude than the cadets. Despite the fact that statistics is probably the least favored area of study for most students, the present investigation is useful and constructive to both students and instructors. The implication of the results is that we must enhance the perception of the cognitive competence for college students while teaching, Furthermore, future studies investigating the relationship between the variables considered here need to be replicated using other samples.

OBJECTIVES OF THE STUDY

The general objective of this study was to determine the effects of peer teaching on students' performance, attitude and anxiety towards Inferential Statistics during the first semester of the school year 2003-2004. Specifically, this study pursued the following objectives: to compare the students' performance in inferential statistics when they are grouped as those with peer tutoring and without peer tutoring and to relate anxiety and attitude to the students' performance in inferential statistics.

METHODOLOGY

This study utilized a quasi-experimental design, specifically the posttest design. There were two classes formed by intact grouping based on the class list during the enrollment period. One class was the experimental class while the other was the control group. The experimental class received a treatment of peer teaching while the control group was handled by the researcher herself. Both groups were given the posttest after the end of the formal instruction.

The subjects of this study were the students who enrolled in ED 202 (Inferential Statistics) during the first semester of school year 2004-2005. Enrollment trend showed that every first semester there were two classes of ED 202 offered. The actual number of subjects included in the study were 35 on the experimental group and 35 in the control group.

The Otis Lennon Scholastic Ability Test (OLSAT) compiled in the guidance office was used to establish the comparability of the two groups. The midterm grades of the students were used as basis in the distribution of the pupils to the two groups and in selecting the peer teachers of the experimental class. Each team in the experimental group was assigned a peer teacher.

The experimental group and the control group received the same method of presenting the lesson from the researcher. Three hours each meeting every week was allotted to the two groups. In the experimental class, the peer teachers were briefed before the start of every session on the subject matter to be discussed by the researcher. In two hours, the researcher spent 45 minutes in lecture/presentation of the lesson and giving sample problems. Forty five minutes was allotted to solving exercises where the students work in groups with the assigned peer teacher in each group. The researcher supervised the activities and facilitated whenever questions were raised by a student or by the peer teachers. Finally 30 minutes was spent in answering the evaluation test about the topic discussed and students worked individually and independently.

In the control group, the same time allotment was followed as in the experimental group but during the exercises/seatwork, the students worked individually under the teacher's supervision. There was no peer tutors in the control group so the students directed their questions to the researcher whenever there was a problem. Seatwork/exercises were given after the researcher finished the presentation and discussion of the lessons. The students worked individually under the supervision and assistance of the teacher.

To avoid contamination, peer teachers in the different groups were rotated every meeting. This enabled them to handle different group members in the period of study. Seatwork/exercises were given after the discussion of the researcher. To monitor individual progress, a

member of each group was asked to solve one of the given exercises. The peer teacher recorded the progress of their respective members by checking their work, and recording them and submitting the results to the researcher. Peer teachers asked the assistance of the researcher when they encountered difficulties during the actual peer teaching.

Both groups were given evaluation tests with 15 to 20 numbers after each topic. Peer teachers were graded according to their respective scores in every test given and an incentive for being a tutor depending on the achievement of their assigned group.

Three research instruments, namely, test anxiety scale, attitude scale and achievement test were used in this study. The test anxiety scale and attitude were adapted from Sacro (2002). For the achievement test in statistics, a total of 60 items of multiple choice type achievement tests was developed and validated by the researcher. Of the 60 items, it was expected that a more refined 50 items were retained in the final instrument. The test was presented to a statistics professor in the graduate school of the neighboring state university for content validation. After integrating the suggestions of the experts this was tried out during the summer 2003. Then it was item-analyzed by the researcher using a reliability coefficient of 0.78 which is acceptable for an achievement test (Nunnally, 1982).The study used the descriptive statistics, t-test for independent samples for problem one, while regression analysis was used to determine the effects of peer teaching on the achievement of students in problem 2,

RESULTS AND DISCUSSION

Performance of students. Out of the 50-item achievement test, the results reveal that those students with peer teaching have higher mean compared to those without peer teaching. This shows that peer teaching improves the performance of students in Inferential Statistics. Although they obtained the same qualitative description of very satisfactory, it is evident from the mean that those exposed to peer teaching learned inferential statistics more than those who were not exposed to peer teaching.

Table 1. Comparison of student performance, anxiety and attitude

	Without Peer Teaching			With Peer Teaching			
	$\bar{X}$	SD	QD	$\bar{X}$	SD	QD	t-ratio
Performance	40.95	5.85	VS	35.73	6.54	VS	4.03*
Anxiety	2.00	.19	NA	2.44	.24	A	3.08*
Attitude	4.16	.45	F	3.18	.35	F	2.29*

Legend:
* - Significant at .05
VS- Very Satisfactory NA – Not Anxious
A - Anxious F - Favorable

The higher mean obtained by the students with peer teaching indicated that improvement in performance of students is exhibited by them. Students are actively participating and each of them really worked hard in their lessons as observed by the researcher. There was openness in sharing ideas and opinions particularly if there are slight differences in their answers among team members. They discussed their answers with supporting reasons and ideas until they came up with a common answer with the guidance and support of their peer teacher. Longarette, Godinho, Parr and Wilson (2003) stated that the peer teaching process involves teams of three to six students collaboratively researching on the lessons. Students helped each other understand concepts following the procedures of getting the answer and analyzing and interpreting the results obtained. Students demonstrate their involvement in the process of collaboration. On the part of teachers they said that it was very challenging task to be a peer teacher. One said you have to organize your ideas so that you could pass it on to the next form when you are doing the presentation and sharing ideas with the team.

The null hypothesis that there is no significant difference in the students' achievement when taught with peer teaching and those without peer teaching was tested at .05 level of significance. As shown

in Table 1, results reveal that indeed peer teaching is a good strategy to increase students' performance in statistics. This is because the mean is superior using this teaching strategy. The t-ration is significant at 0.5 level which means the null hypothesis is rejected.

When students work with their peers in small groups, they work together to maximize their own and each other's learning. There is face-to-face interaction with an atmosphere of cooperation, mutual helpfulness and individual participation (Davidson, 1990). This is really true as observed by the researcher. The students were very relaxed and comfortable in solving, computing, analyzing, interpreting the problems required and they gave their answers spontaneously when they were with their peers. When students were interviewed at random, they said that they enjoy learning inferential statistics with their peers. One even said, "I am not afraid" with this course when I was taught by my peer. I have learned the lessons "slowly but deeply." This means that students said that "It is advantageous to have peer teaching because those who finished first present their work and with the peer with them they help the slow students using a lower pace of teaching. There is not much pressure to work with peers because we are of the same status, students."

Dietz (1993) found that a cooperative learning activity on methods of selecting a sample allowed students to "invent" for themselves standard sampling methods, which resulted in better understanding of those methods. Jones (1991) introduced cooperative learning activities in several sections of a statistics course and observed dramatic increase in attendance, class participation, office visits and student attitudes.

The feelings of the students when they were with their peers are in consonance with the description of Boud's el al. (2001) conceptualization of peer teaching. As highlighted in the excerpt from a student interview, peer teaching demonstrates the value of students placed in a collaborative setting in relation to peer teaching, "There was a whole bunch of good ideas because students had a range of peers from different learning areas and as a consequence there was a whole bunch of perspectives that we had to wrestle with a group." Students experienced the process of forming and storming and they see this process as happening. But in the end students came out with something, which was really good. They had to organize their ideas so

that they could pass it on to the next student when they were doing the presentation. The interviewee's ideas accord with the investigators' definition of peer teaching as students learning from and with each other in ways that are mutually beneficial.

On anxiety. Looking at the same table, it is shown that the anxiety of students reduced when they were exposed to peer teaching. This is clearly seen in the means of students' anxiety without peer teaching and with peer teaching with means having the qualitative descriptions from anxious to not anxious, respectively.

The null hypothesis that there is no significant difference in the students' anxiety when they are grouped with peer teaching and without peer teaching was tested at .05 level. The higher mean obtained in those students without peer teaching signifies that students are anxious about Inferential Statistics course. On the other hand, those students with peer teaching obtained a lower mean which means that they are not anxious towards studying Inferential Statistics. This indicated that when student were exposed to peer teaching their fears in statistics were gone. This could be due to the fact that they gave helped one another with their lessons. Whatever difficulties they have met in their Inferential Statistics activities, they have the courage to approach one another and discuss these difficulties with each other. They are very comfortable with their peer teachers. Although each team was provided with a peer teacher, all the peer teachers are very approachable and accommodating to all students. Hence, their bonding is very strong. The null hypothesis which states there is no significant difference in the students' anxiety when they are grouped with peer teaching and without peer teaching was rejected.

According to the cognitive perspective of anxiety (Zimbardo, 1992), the attitude of a person in estimating the danger causes anxiety. Anxiety exists when a person either overestimates the nature/reality of a threat or underestimates his/her ability to cope with threat effectively. The fact that the students' attitude improve much means that their anxiety has gone down. There is no threat felt by the students in their inferential statistics class under peer teaching.

On attitude. Attitude of students towards statistics has something to do with their prior knowledge about statistics. It has something to do also with feedbacking they have heard from the previous students. It

is natural that some students are not comfortable working with figures or numbers. Student enrolled in Statistics do not have away to escape numbers in Inferential Statistics. It is therefore worth investigating whether or not they have fully maximized their learning in the subject.

Table 1 presents the results of students' attitude towards Inferential Statistics. As reflected in the table, the graduate students show a favorable attitude in both classes, with peer teaching and without peer teaching. Considering the means, the students with peer tutorial have higher mean compared with those students without peer tutorial. Nevertheless, the qualitative descriptions in both means are the same, which is favorable. The higher mean with the peer teaching group signifies that students are very much at ease with this strategy. It means that they are more relaxed and comfortable with the group. The greater mean might also be due to change of students' beliefs and opinions about the subject. From previous students they have heard that the course is very difficult, yet when they have their peer teacher they feel that it is not really that difficult.

According to Oskamp (1991), changing a person's belief s or opinions can change how he/she feels about a particular object or even making it more or less desirable. For example, a graduate student has positive feelings about his/her statistics subject, these positive feelings are likely to become associated with the student's job. If he/she learns from a co-worker that the supervisor has negative attitude about the subject , his/her opinions about the subject is likely to be affected, even though nothing has been observed and experienced about the subject yet.

Several studies used measures of students' attitudes towards statistics or anxiety about statistics as dependent variables. In this study, these variables are also the dependent variables. Negative attitude and high levels of anxiety have often been associated with learning statistics. Therefore citing increase positive attitudes or decrease anxiety as outcome measures may make sense to some research. However, the main goal of the researcher in conducting this study is to help students learn statistics, the secondary goal might be to improve students' attitudes and reduce their anxiety in learning the subjects. Therefore, if attitudes and anxiety are used as outcome measures they should only be examined in conjunction with assessments of learning

outcomes. In addition, Gals Ginsburgand Schau (1997) point out that these types of studies are not actually designed to provide information about causal factors and sources of students' attitudes and beliefs. They suggest several approaches that can be taken to obtain this type of necessary information, e.g., interviews, focus group discussion think-aloud protocols and journal or histories of present or past mathematics experiences.

A second way that attitude and anxiety measures have been used is to predict student performance in statistics courses. Most published studies have used Likert-type scale or semantic differential scales designed to measure students' attitudes towards statistics as independent variables in the prediction of statistics performance. In a survey of research studies related to attitudes toward statistics, Mayer (1999) found that overall results ranged from attitudes accounting for little or none of the variance (Wise, 1985; Pearney & Ravid, 1990; Green, 1994), to accounting for 79% of the proportion of variance in performance (Wochlke, 1991). She concluded that the difference in these findings may be attributable to a number of variables, such as the time attitude measures administered, the types of students in the study, the use of different measures, and the use of different subscales within measures.

Table 2. Summary of multiple regression analysis on achievement of graduate students on inferential statistics

Variables	Regression Coefficients		F-value
	beta	b	
Constant	55.98	54.74	16.98*
Anxiety	-0.95	-0.79	5.79*
Attitude	0.85	0.73	5.56*

The beta coefficients are significant at .05 level. This implies that anxiety and attitude of students towards inferential statistics influence the achievement of students. This means that when students have positive or favorable attitude towards inferential statistics, their achievement is better. Likewise, the anxiety of students influences their

achievement. The beta coefficients are negative which implies that as the students tend to be less anxious their achievement increases. The results as indicated by R^2 signifies that 31.36% of their achievement in Inferential Statistics is being attributed to their anxiety and attitude. There could be other variables that would likely contribute to their achievement but these variables are not considered in the study.

The null hypothesis which states that anxiety and attitude of students towards inferential statistics do not significantly influence the achievement of students is therefore rejected. This result is in consonance with the research of Gardner (2001) in Mathematics when he claimed the faculty responses indicated they thought attitudes and levels of math anxiety improved over the semester. Most groups did show some improvement. The only statistically significant difference detected were in math anxiety by gender and attitude by age. Females had higher level of math anxiety than males. While older students appeared more math anxious, they also reflect a more positive attitude about mathematics.

CONCLUSIONS

The study revealed that the achievement of students with peer teaching and without peer teaching is significantly different in Favor of the peer teaching. Anxiety and attitude of students also were significantly different when the subjects were grouped with peer teaching and without peer teaching. Finally, both anxiety and attitude towards the subject greatly influence the achievement of students in inferential statistics.

Peer teaching strategy is a very good teaching strategy for inferential statistics since it improves the achievement of students. Anxiety towards inferential statistics course was reduced if not totally eliminated while the attitude of students was greatly influence the achievement of students. It is therefore concluded that this innovative teaching strategy is effective and relevant in teaching Inferential Statistics. Peer teaching occurs when students (e.g., peers) teach and learn from one another. Students are quite comfortable learning with the peer teacher.

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