

The Efficiency of Three Methods of Teaching on Students' Performance in Introductory Statistics

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Abstract: *Knowledge and training in Basic/introductory statistics is relevant for a successful university education hence mastery of basic statistical skills proves indispensable in doing research without mentioning the demand of professional statisticians in the job market. The paper will peruse/examine the following method in teaching Basic Statistics: guided constructivist approach, a computer assisted instruction and a lecture method. This study used the pretest – posttest non comparable quasi – experimental design to determine the effectiveness of the three methods of Statistics instruction. The study found out that there was a significant influence of the mental ability to the respondents' achievement in Statistics. There is no significant effect of the methods of instruction to the respondents' achievement in Statistics when they are grouped in terms of mental ability. The constructivist group is as good as the computer assisted and lecture group. There was no significant interaction of the respondents' achievement in Statistics as influenced by their mental ability and methods of instruction. One of the significant features of the study is the futuristic research terrain offered to explore the research gaps of the present study.*

Keywords: Effectiveness, Methods, Instruction, Achievement, Statistics.

1. Rationale

Statistics courses have become an essential part in many degree programs of higher education institutions. The rationale for teaching Statistics is to enable students to handle, use and interpret research data and to prepare them to deal effectively with statistical aspects of the world outside the classroom (Gal and Ginsburg, 1994).

Despite the efforts that instructors of introductory statistics devote in simplifying the subject, many students encounter difficulties in their introductory statistics courses. Del Vicchio (1995) demonstrated how critical these difficulties are by stating “statistics courses are viewed by most college students as an obstacle in attaining their desired degrees”. There is a growing consensus among statistics educators that the introductory statistics course needs to be reformed (Cobb, 1993). Arguments for reform can be made in two areas. On one hand, we can argue that we should be teaching concepts over processes (Watts, 1991). A better understanding of the appropriate use and interpretation of various procedures result from conceptual learning. Also, processes are better handled by computer packages which can process data faster and more accurately than we can by hand. The second argument for reform is that students learn better and retain more if they engage in learning activities that require them to think and process information rather than passively listen to lectures.

Given these views, I believe that a variety of instructional strategies or methods that can be effective in teaching statistics can be used by instructors to improve students' performance. These strategies or methods can be in a form of a guided constructivist approach, a computer assisted instruction or a lecture method.

2. Theoretical Foundation of the Study

This study was based on Bruner's theory that learning is an active process in which learners construct new ideas or

concepts based upon their current and past knowledge. The learner selects and transforms information construct hypotheses and makes decisions relying on a cognitive structure to do so. Cognitive structure provides meaning and organization of experiences that allow an individual to go beyond the information given.

As far as instruction is concerned, the instructor should try and encourage students to discover principles by themselves. The instructor and student should engage in an active discourse. The task of the instructor is to translate information to be learned into a format appropriate to the learner's current state of understanding.

This study was also anchored on Jean Piaget's theory of constructivism. According to Bencze (2005), this theory is based on observation and scientific study about how people learn. It says that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on these experiences. When we encounter something new, we have to reconcile it with our previous ideas and experience, maybe changing what we believe or maybe discarding the new information as irrelevant. In any case, we are active creators of our own knowledge. In the classroom, the constructivist view of learning can point towards a number of different teaching practices. In the most general sense, it usually means encouraging students to use active techniques such as experiments, real world problem solving, to create more knowledge then to reflect on and talk about what they are doing and how their understanding is changing. The instructor makes sure he understands the students' preexisting conceptions and guides the activity to address them and then build on them.

3. Statement of the Problem

This study aimed to compare the learning effectiveness of the guided constructivist, lecture computer assisted methods of instruction in a college Statistics course of the students at Surigao del Sur State University Main Campus in Tandag

City, Surigao del Sur, Philippines for the second semester of the academic year 2009 – 2010. Specifically, this study sought to answer the following questions:

1. How do students' achievement scores in Statistics compare as influenced by their mental ability?
2. How do methods of instruction influence students' achievement scores in Statistics?
3. Is there a significant interaction of the students' achievement in Statistics as influenced by the methods of instruction and mental ability?

4. Methodology

This study used the pretest – posttest non comparable quasi – experimental design to determine the effectiveness of the three methods of Statistics instruction. The respondents of this study were the students enrolled in Bachelor of Arts, Bachelor of Science in Business Administration, and Bachelor of Science in Computer Science and Bachelor of Secondary Education degree programs who took the course Stat 1 – Elementary Statistics. This study used a self - made achievement test in Statistics with 25 multiple choice items. Analysis of Covariance was used to determine if a significant influence on the students' achievement in Statistics was made by the methods of instruction, mental ability and type of degree program.

The study used a teacher – made achievement test in statistics, the mathematics anxiety self test and the attitude towards mathematics test instrument. Analysis of Covariance was used to determine if there is a significant influence of the method of instruction, mental ability and type of degree program on the students' achievement scores in Statistics. From the different sections that were formed/prepared by the mathematics department, the researcher randomly chose three sections that were included in the study. Furthermore, the researcher again randomly assigned one section for the guided constructivist approach, another section for the computer assisted instruction and the third section for the lecture method.

When the students are grouped according to mental ability, there are eight (8) of them who belong to the above average group, thirty two (32) belong to the average group while fifty four (54) belong to the below average group, a total of ninety four (94) students who are subjects of this study. In terms of the degree program enrolled by the students, thirty eight (38) are Bachelor of Arts students, thirty three (33) are Bachelor of Science in Business Administration students, sixteen (16) are Bachelor of Science in Computer Science students and seven (7) are Bachelor in Secondary Education students. The table also shows that there are thirty five (35) students comparing the guided constructivist group, twenty eight (28) for the computer assisted group and thirty one (31) for the lecture group.

5. Results

The means, standard deviations and the coefficient of variations of the students' pretest and posttest achievement scores in Statistics were recorded. In terms of mental ability, the pretest mean score of the respondents are very low with 5.87 for the above average group, 4.34 for the average group

and 4.15 for the below average group. This result indicates that students have insufficient knowledge in Statistics before the treatment. However, in the posttest, the students with above average mental ability obtain a higher mean of 20.13 compared to the average group whose mean is 13.84 and the below average group with a mean of 11.35.

In terms of the method of instruction, the pretest mean are also very low with 4.46 for the constructivist group, 4.53 for the computer assisted group and 4.10 for the lecture group. After the treatment, the respondents in the lecture group get a higher mean of 14.61 compared to the constructivist group with a mean of 12.17 and computer assisted group with a mean of 12.07. As regards to the variability of the students' achievement scores, It can be viewed that with respect to the mental ability of the students, the standard deviations of the pre-test scores in all the three groups are smaller compared to the post-test standard deviations. However, the coefficients of variation of the pre-test scores in all the three mental ability groups are higher than those in the post-test. This indicates that the achievement scores in the pre-test are more dispersed than the scores in the post-test since a larger coefficient of variation would indicate that its variation is larger relative to the mean. As to the variability of the achievement scores of the students in terms of the methods of instruction, it is observed that the standard deviations of the pre-test scores in the three groups are smaller compared to the post-test standard deviations. However, the coefficients of variation of the pre-test scores in all the three method of instruction are also higher than those in the post-test. This also indicates that the achievement scores in the pre-test are more dispersed than the scores in the post-test.

To determine if there is a significant influence on the students' achievement as regards the method of instruction and mental ability, two ways analysis of covariance with unequal no's was applied. For factor A which refers to the mental ability, the analysis yielded an F-ratio of 5.07 which is greater than the critical value of 3.10 at 0.05 levels. This result suggests that mental ability has an influence in the achievement of the students in statistics. This confirms to the findings of Sanchez (2004) that mathematical ability influenced the achievement scores of students in algebra.

The comparison of the post-test mean among the three levels of mental ability revealed that the above average group has better achievement scores compared to the average and below average group as evidenced by a Scheffe r-value of 4.91 and 7.19, respectively.

Comparing the average and the below average groups, the Scheffe test yield an r-value of 3.51 which implies that the average group has better achievement scores than the below average group. This result signifies that the above average group of students is superior over the low levels of mental abilities. This implies further that students with above average mental ability perform better than students with average and below average mental abilities. This means that whatever method of instruction used, the students with above average mental ability always achieve better compared to students with average and above average mental abilities.

With respect to the variability of the respondents' achievement in Statistics, the standard deviation of the pretest scores are smaller compared to the standard deviation of the posttest scores. However, the coefficients of variation of the pretest scores are higher than the coefficients of variation of the posttest scores. This would indicate that the respondents' achievement in Statistics in the pretest are more dispersed than the respondents' achievement in Statistics in the posttest since a larger coefficient of variation relative to the mean would indicate a larger variation.



(The Surigao del Sur State University of Tandag City, Philippines The setting of the study. Photo Credit: Dr. Ramel D. Tomaquin)

To determine if there is a significant influence of the mental ability and methods of instruction to the achievement in Statistics, two way analysis of covariance was applied. For mental ability, the analysis of covariance obtained an F – ratio of 5.07 which is greater than the critical value of 3.10 at 5% level. This result suggests that mental ability has a significant influence on the respondents' achievement in Statistics. For methods of instruction, the analysis of covariance obtained an F – ratio of 1.17 which is less than the critical value of 3.10 at 5% level. This result simply suggests that the methods of instruction have not influenced the achievement of the respondents in Statistics.

Furthermore, the analysis of covariance also resulted in a no significant interaction on mental ability and methods of instruction as evidenced by the computed F – ratio of 0.50 which is less than the critical value of 2.47 at 5% level. This implies that the respondents' scores of the above average, average and below average groups have no mixed effects on the scores in the three methods of instruction, that is, those with higher mental ability have a higher increase in scores from the pretest to the posttest and those with lower mental ability have lower increase in scores from pretest to the posttest.

Before the treatment, the mean achievement scores of the students in the different degree programs are very much close to each other; 4.7 for the AB group, 3.95 for the BSBA group, 4.31 for the BSVA group and 4.59 for the BSED group. After the treatment, the BSED group gets the highest mean achievement score of 17.43 followed by the BSCS group with a mean of 13.63 then followed by the AB group with a mean 12.66 and the lowest mean of 11.97 is obtained by the BSBA group.

As regards to the variability of the achievement scores when students are grouped by type of degree programs, table 6 also shows that the standard deviations of the pre-test scores are smaller compared to the standard deviations of the post-test scores. However, if the coefficients of variation considered, it is revealed that the coefficient of variation of the pre-test scores are higher than the coefficients of variation of the pro-test scores. The findings further reveal that after the treatment, the BSED group gets a smaller coefficient of variation of 21% compared to the other three groups. This result indicates that among the four degree programs taken by the student, it is the post-test achievement scores of the BSED group that is more homogenous compared to the post-test achievement scores of the other three degree programs.

To determine if there is a significant influence of the methods of instruction and type of degree programs on the achievement scores of the students, two factor analysis of covariance with unequal no's was applied. For factor at which refers to type of degree program taken by the students, the analysis yields an F-ratio 7.39 which is greater than the critical value of 2.72. at 0.05 level. This result implies that students' degree program has some influence on the achievement scores of the students in Statistics.

To determine further which degree program has been influence better as shown by the students' achievement scores, a posteriori test of significance was applied using Scheffe method. It can be gleaned from the results of this test that the comparison of the adjusted posttest means between the AB and BSED students produces an r-value of 3.35 which is greater than the critical value of 2.86. This implies that the BSED group has been influence better as shown on the achievement scores of the students compared to the AB group.

Comparison of the adjusted post-test means between the BSBA and BSED, the Scheffe test produces an r-value of 3.49 which is greater than the critical value of 2.86. This implies that BSED group also has better influence on the achievement scores than the BSBA group. However, the BSCS students are as good as the BSED students as evidenced by their r-value of 1.96 which is less than the critical value of 2.86. These results denote that among the degree programs, BSED students have better influence on the achievement scores over AB and BSBA, but not to the BSCS students. The BSCS students are as good as the AB and BSBA students as evidenced by a Scheffe test result of 0.41 and 0.61, respectively which is less than the critical r of 2.86.

With respect to factor B which is the methods of instruction, the analysis of covariance yields an F-ratio of 4.3 which is greater than the critical value of 3.11 at 0.05 levels. This implies that they are grouped according to degree programs. In order to determine which method has better influence on the achievement scores of the student, a posteriori test on significance was applied using Scheffe method. Comparing the adjusted post-test mean of the constructivist group and the computer assisted group, the Scheffe test yields an r-value of 1.05 which is less than the critical value 2.49. This implies that the effect of the constructivist approach and computer assisted instruction on the achievement of the

students are relatively the same. This implies further that constructivist approach is as good as the computer assisted method of instruction.

Comparing the adjusted post-test mean of the constructivist group and the lecture group, the Scheffe test yields an r-value of 6.43 which is greater than the critical value 2.49. This implies that the lecture method has a better effect on the achievement of the students compared to the constructivist approach. Comparing the computer assisted and the lecture method, the Scheffe test yields an r-value 7.1 which is also greater than critical value of 2.49. This implies that lecture method has a better effect on the achievement of the students compared to the computer assisted method. These results indicate that the students exposed to the lecture method of teaching statistics performed better compared to the students exposed to the constructivist approach and computer assisted method of teaching. This result implies further that among the three methods of teaching statistics used in this experiment, the lecture method has the greater effect on the achievement of the students. This can be attributed to the fact that statistics involves so many complex underlying principles that can only be explained comprehensive through lecture.

This result conforms to the findings of Lopez (2003) whose study brought forth positive results of lecture method in teaching algebra to a large class. However, this result contradicts the findings of the study of Ramos (2000) and Sanchez (2004) where constructivist method came out be the best method in improving students' achievement in mathematics. The result of this analysis also reveals that there a significant interaction between the type of degree program method of instruction as evidence by the computed F-ratio of 14.58 which is greater than the critical value of 2.21 at 0.05 level. This result implies that the effects of the method of instruction and type of degree program on the achievement scores of the students are not the same. This implies further that the methods of instruction and the type of degree programs have mixed effects on students' achievement scores.

6. Conclusions

1. There is a significant influence of the mental ability to the respondents' achievement in Statistics.
2. There is no significant effect of the methods of instruction to the respondents' achievement in Statistics when they are grouped in terms of mental ability. The constructivist group is as good as the computer assisted and lecture group.
3. There is no significant interaction of the respondents' achievement in Statistics as influenced by their mental ability and methods of instruction.

7. Recommendations

1. Lecture method should still be used in teaching Statistics. Constructivist and computer assisted methods can be incorporated when appropriate to let the students be familiar with the computer technology and to develop their logical and critical thinking skills which is promoted by the constructivist approach.

2. Another experimental study should be done to measure the effects of the different methods of instruction on the students' anxiety and attitude towards Statistics.
3. Sectioning of Statistics classes should be done by course discipline. In this way, the instructor could incorporate the applications of Statistics that would relate to the students' field of interest thereby promoting the sensitivity of the students towards their course discipline.
4. The three methods of instruction should be tried in other fields of mathematics in order to determine the effects of the methods of instruction to the achievement of the students in other mathematics courses.

8. Futuristic Direction of the Research

The study can be replicated with other State Universities (SUC's) in the Philippines in order to bridge the research gaps. Computer aided instruction would be a great terrain to explore in academic performance of the students. Imploring computer software's, e- books and the likes would greatly improve the teaching and learning of Basic Statistics. Similarly in the future offering of BS Statistics in the university /college can give an avenue in training of professional statisticians for academe and industry needs. A good academe linkage in training the future statisticians in Caraga region is widely sought. Making Statistics also a required GEC (General Education Course) would provide an opportunity for the students across programs to learn the practical use of statistics. Thus, the teaching of the course/subject would be more meaningful. Developing a university wide syllabus for basic Statistics would present uniformity in the teaching the subject. Adequate funding for academe-industry linkage /internship in Statistics surely will reinforce the teaching and learning process. In the future also it is suggested that the faculty members should acquaint themselves with the trends of the subject for applying membership to Statistics professional associations or related associations in the like of Philippine Statistical Association and Philippine Population Association for trainings of demographers where the knowledge in Statistics is indispensable. The university can design a program of learning module in Basic Statistics that would be sold to the students which is a good source of income generation activities while is serving the academic needs of the students. Links in the on line lesson should be available in the university library in order to attune the e-learning approach in teaching the subject. Perhaps virtual lesson presentation is a fertile research topic in the future. Converting the module develop by the researcher into an e-book would make it available in open access mode to the students/learners thus facilitate learning. Funding for a statistical center of the Surigao del Sur State University, Philippines would provide an avenue of training in the academe and industry thus will promote closer collaboration of the academe and industry partnership. Likewise the purpose of statistical center will also serve the research function of the university and significant contributor in development of statistics based researches. The university should be a producer of knowledge so the Surigao del Sur State University, Philippines should be one. It can only attain such stature if it has a strong research capability. One of the indispensable tools in research is Statistics therefore creating/establishment of a statistical center is timely indeed.

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