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ABSTRACT

This study, conducted at the University of Memphis (Tennessee), compared the effects of a self-paced method of instruction on the attitudes and perceptions of students enrolled in an undergraduate statistics course with those of a comparable group of students taking statistics in a traditional lecture setting. The non-traditional course used a modified version of the Personalized System of Instruction. Students learned the material at different rates using the standard of unit perfection before advancing, retesting as necessary, and criterion-referenced testing. Many of those enrolling in the course were non-traditional students and female. The study surveyed 105 graduate and undergraduate students and of these, 18 were in the self-paced course and the others were in the traditional introductory course. The "Survey of Attitudes Toward Statistics" was used to assess students' attitudes before and after course completion. A comparison of post-test attitude scores found no significant difference in attitude between students enrolled in the self-paced statistics course and those in the traditional course. A test of attitude differences between males and females also found no significant difference between these two groups. Eleven tables provide additional detail on the study's findings. (Contains 15 references.) (JB)

THE RELATIONSHIP OF INSTRUCTIONAL METHODS WITH STUDENT RESPONSES TO THE SURVEY OF ATTITUDES TOWARD STATISTICS

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INTRODUCTION

The purpose of this study is to compare the effects of self-paced method of instruction on the student's attitudes and perceptions enrolled in undergraduate statistics course with those of comparable group of students taking statistics in a traditional lecture setting.

The course, entitled Fundamentals of Applied Statistical Methods for undergraduates was designed about twenty years ago in the College of Education at The University of Memphis. This course uses a modified version of Personalized System of Instruction which provides students a unique opportunity to develop an understanding and appreciation of statistics and its role in quantitative research. It also helps them to develop certain critical skills in reporting results of empirical research. The course involves a great deal of technical terms and procedures which are unfamiliar to most students. Students learn this material at different rates, considering the fact that students enter this course with widely varying ability and attitudes toward their abilities in relation to the mathematical tasks required in this course. The essential components of this method are unit perfection before advancing, retesting as necessary, and criterion-referenced testing. This program is slightly different from original Keller Plan, in that the grades are assigned to students at the end of each semester, as opposed to allowing students continue with the course material until all units have been completed. The experience of this course since its development in 1976 suggests successful results. Most of the students presently enrolling in this course are female nursing majors or students in other applied medical fields required to take this course. A large proportion of these students are non-traditional students who usually have full time jobs and a family. The flexibility of time and convenient format of this course is very appealing especially to these students. They seem to appreciate the fact that they can study at their own pace, take the test when they feel they are ready, and do

not have to compete with the other students. The course is offered during fall, spring, and summer of each academic year.

Personalized system of instruction is a self-paced learning strategy also known as Keller Plan, after Fred S. Keller. This method individualizes the teaching and learning process so that it is somewhat more effective than conventional instruction. It is designed based on the concepts that people differ in their aptitude for learning various subjects. If aptitude is normally distributed, and if all students receive the same amount and quality of instruction and spend the same amount of time learning, then their achievement at the end of the instruction will also be normally distributed. Keller (1968) suggested that if aptitude is normally distributed but the amount and quality of instruction and the amount of study time are varied to match the skill and needs of each student, then most students could probably achieve mastery of the subject.

PSI embodies the following concepts and procedures: the level of learning required to achieve mastery is defined and it is assumed that nearly all students can learn and will if instruction is properly designed. The course material is broken into small learning units which are sequenced so that material in later units builds upon that which came before. The instructional objectives are carefully specified and the tests are designed to allow both student and teacher to evaluate the students' achievement of the objectives. The use of several tests allows students to get a great deal of feedback that enable them to see how they are doing and correct misconceptions early. Students are graded on a absolute basis, meaning that they are graded based on their mastery of the material and not in comparison to each other. Course atmosphere is positive and designed to help students achieve the objectives, and they are not punished for mistakes and can repeat a test until mastery is achieved. Given a reasonable set of material to be covered, students can make their own decision concerning how much to do in the course and at what rate to progress.

Research results on PSI attest to its effectiveness in a very wide range

of subjects such as; psychology, engineering, mathematics, English composition, and most natural sciences. Kulik and Kulik (1975) pointed out that a significant difference has been found between PSI and conventional classes on final exam scores. In thirty-eight of 39 comparisons, exam performance was better in PSI course. Other studies also report positive results in learning from indiv.dualization, these studies dealt with such courses as physics (Stanley, 1978, and Gash, 1976), and psychology (Riedel, 1976, Johnson, 1975). Brooks (1976) reported that long term retention effects are significantly greater in PSI than other method, and that students have a more positive attitude toward the PSI.

Students' attitudes toward personalized system of instruction, and the perception of differences between regular classroom and PSI, are extremely important in obtaining feedback, and are critical for the success of this method of instruction. Aiken and Braun (1980) suggested that attitudinal studies are needed to measure such factors as study habits and attitudes. Attitudes and belief about a medium may effect learning. Cennamo (1993) stated that there is convincing evidence that students' preconceptions about the effort required to learn will indeed influence the learning outcome. Robert and Saxe (1982) also reported positive relationship between students' attitudes toward a course and their achievement, more positive the attitude the higher the achievement. Benson (1989) in his study of statistics test anxiety of students found that the more anxious the student in learning statistics the lower their course grades are. Such studies can be useful to planners and designers, and to evaluators of this method.

Statistics is considered a complicated field, which is relatively close to mathematics. Statistics is used for describing data and as an inductive method in research methodology. Because of its importance most colleges require their students to take statistics in an attempt to increase the students' interest in quantitative methods and research, to increase students awareness about the importance of quantitative studies, and to increase the students' ability to understand the concepts used in empirical research

reports. However, statistics may evoke anxieties and negative attitudes that are associated with mathematical computation (Dillon, 1982). Other research findings also show that statistics anxiety exists among most college students (Roberts & Saxe, 1982, Roberts & Bilderbrack. 1980). Most students consider statistics courses as a barrier to their goal of getting a degree and often delay taking required statistics courses until just before graduation. Considering these facts, recognizing variables that are closely related to students' attitude will help in designing a method of instruction that is best suitable for teaching this material and alleviate some of the fear and anxiety of the subject.

METHOD

Subjects

The study involved 105 university students (75 undergraduate and 30 graduate students). Thirty-five percent of the sample was males and 65% females. In this sample there were 25% African-American, 68% Caucasian, and 7% other ethnic groups. The undergraduate students were a cross-section of different majors in the university such as business, psychology, nursing, and education. In contrast, the graduate students were all education majors. Eighteen of the seventy-five undergraduate students in the study were enrolled in the self-paced statistics course while the remainders were enrolled in traditional introductory statistics courses. Other demographic information included was: class level, students' GPA, and previous math and statistics background.

Instrument

The Survey of Attitudes Toward Statistics (SATS) was used to assess the student's attitudes. This instrument was recently developed by Candace Schau and Joseph Stevens (1995) at the University of New Mexico in Albuquerque. The survey consists of 32-items that measure four facets of attitudes toward statistics: (1) Affect: positive and negative feelings concerning statistics (7 items); (2) Cognitive Competence: attitudes about intellectual knowledge and skills when applied to statistics (7 items); (3) Value: attitudes about

the usefulness, relevance, and utility of statistics (10 items); and (4) Difficulty: attitudes about the difficulty of statistics as a subject (8 items). For all items, the response scale consisted of a 7-point Likert scale anchored at both ends and in the middle (1=Strongly Disagree, 4=Neither Disagree nor Agree, 7=Strongly Agree). The items were prepared in pre-test and post-test form and each form included the SATS items followed by background items that would give information about students' demographic, self-efficacy, and achievement. Reliability and validity information is reported by Schau and her colleagues (Schau, Stevens, Dauphinee & Del Vecchio, 1995).

Procedures

The SATS was administered to undergraduate students enrolled in introductory statistics courses in the departments of Counseling, Educational Psychology and Research within the College of Education, Information Systems & Decision Science within the College of Business, and Psychology within the College of Arts & Sciences at the University of Memphis. The survey was also administered to graduate education students enrolled in a course in the department of Counseling, Educational Psychology and Research. The pre-test was administered to the students during the first week of first summer semester of 1995. The students were told that a second measure or a post-test would be administered during the last week of classes. The procedure for administering the post-test to students enrolled in the self-paced statistics course (the undergraduate course in the department of Counseling, Educational Psychology and Research) was different due to the different format of the course. The students were given the post-test as they completed the final unit test throughout the prolonged summer semester. The Approximate time for the completion of the survey was 10-15 minutes. All other students took the post-test at the end of their final week of classes.

The primary focus of this study was to compare the results of the student's post-test attitudes scores for the four groups in the study. In addition, differences in changes in attitudes from pre-test to post-test were expected to be influenced by gender (Male vs. female) and ethnicity (Caucasian

vs. African-American). Thus a mixed design ANOVA was used to examine changes from pre-test to post-test by using pre-test and post-test as an attitude scale with repeated measurements and between subjects variables of group (4 levels: 1=Business, 2= Psychology, 3=EDPR undergraduate, and 4=EDPR graduate), gender (1=male, 2=female), and ethnicity (1=Caucasian, 2=African-American). Analysis of covariance was also used on the post-test four attitudes scale using the corresponding pre-test scale as the covariate. A comparison of pre-test total scores was made utilizing a one way analysis of variance to insure no significant differences existed between the four groups prior to the study (F=.569, p=.639).

RESULTS

Although there appeared to be a moderate positive attitude shift in three of four groups from pre-test to post-test the results of our mixed-design analysis of variance did not show that to be significant. The means and standard deviations on pre-test and post-test are shown in Table 1 for the Total attitude scale. Similar statistics for the four groups in our study are also shown in Table 2 for the Affect scale, Table 3 for the Cognitive Competency scale, Table 4 for the Value scale, and Table 5 Difficulty scale.

Although the results of the analysis of variance did not show any significant interaction of group by pre/post-test, our main hypothesis, the analysis revealed a significant interaction effect of students ethnicity and pre/post-test score on three of four different attitudes scale and a total significant interaction effect. The significant interaction was found in Affect (F=7.21, p=.009), Cognitive Competency (F=7.09, p=.009), and Value (F=8.98, p=.004) scales and not significant for the Difficulty scale (F=1.75, p=.189). The results of analysis of variance for between and within subjects are reported in Table 6.

The nature of the significant interaction effect of ethnicity and pre/post-test was investigated via the means of the four attitude scales for the two different ethnic groups were obtained. Tables 7, 8, 9, 10, and 11 show the means and standard deviations of the Affect, Cognitive Competency,

Value, and Difficulty scales and of the Total Attitude scale for both ethnic groups. It was discovered that African-American students have higher pre-test attitude score on Affect, Cognitive Competency, and Value scale than their white students counter parts. However, their gain score on the post-test are smaller than the other group, and on the Value scale is negative meaning they have less positive attitudes toward the value and utility of statistics course after participating in the course.

To further examine the attitudes among the four groups, one-way analysis of covariance was performed using post-test as the dependent variable and pre-test as the covariate. No significant difference was found between the four groups on the total post-test means. That is, after adjusting for the covariate pre-test scores, no significant difference was found on the students post-test attitudes toward statistics among the four groups ($F=1.227$, $p=.304$). However a significant difference was observed on two of the four attitude scales among the four groups. These significant differences were identified on the Value scale ($F=2.721$, $p=.048$) and Difficulty scale ($F=3.209$, $p=.026$). It is likely that these differences did not appear on the mixed-design analysis of variance because the numbers of students in each group and by ethnicity and gender are so varied that when the sums of squares were partitioned into the unique components these possible differences were removed. Put more simply, these potential differences between the groups on these two attitude scales could have resulted from the different composition of the groups in terms of gender and ethnicity.

CONCLUSION

The result of our study did not support the hypothesis that students who are enrolled in the self-paced statistics course will gain more positive attitudes toward the statistics as a result of the individualized instruction than those who are enrolled in traditional statistics courses. This result does not support the majority of research on PSI that indicate the superiority of this method over traditional method. There are other factors such as the quality of instruction, the instructor, and other variables involved that this

study didn't control for. Perhaps further research is needed, or this study can be replicated with including variables such as students' achievement in the course, or student's major to gain insight about the students attitudes. Other important findings that also contradicts the research about gender difference was also found to be non significant in this study. The test of hypothesis on the equality of attitudes toward statistics of males and females did not show any significant difference between the mean attitudes of the two groups ($P>.05$).

TABLE 1
Means and Standard Deviations for Total Attitude Scale

Total	Pre-test	Pre-test	Post-test	Post-test	
	Mean	S.D.	Mean	S.D.	N
Total	4.35	0.71	4.43	0.71	105
Business	4.37	0.77	4.41	0.72	35
Psychology	4.27	0.56	4.23	0.57	22
ED.Undergr	4.53	0.60	4.69	0.73	18
ED. Grad	4.28	0.81	4.48	0.76	30

TABLE 2
Means and Standard Deviations for Affect Scale

	Pre-test	Pre-test	Post-test	Post-test	
	Mean	S.D.	Mean	S.D.	N
Total	3.89	1.30	4.24	1.32	105
Business	4.03	1.29	4.43	1.28	35
Psychology	3.62	0.97	3.70	1.15	22
ED.Undergraduate	4.46	1.06	4.78	1.30	18
ED. Grad	3.58	1.53	4.09	1.37	30

TABLE 3
Means and Standard Deviations for Cognitive Competency Scale

CogComp	Pre-test	Pre-test	Post-test	Post-test	
	Mean	S.D.	Mean	S.D.	N
Total	4.81	1.16	5.07	1.07	105
Business	4.79	1.18	5.08	1.12	35
Psychology	4.69	0.98	4.89	0.95	22
ED.Undergr	5.33	1.00	5.60	0.87	18
ED. Grad	4.61	1.29	4.89	1.12	30

TABLE 4
Means and Standard Deviations for Value Scale

Value	Pre-test	Pre-test	Post-test	Post-test	
	Mean	S.D.	Mean	S.D.	N
Total	4.70	0.81	4.75	0.89	105
Business	4.52	0.92	4.50	0.91	35
Psychology	4.82	0.68	4.66	0.90	22
ED.Undergr	4.49	0.89	4.60	0.83	18
ED. Grad	4.93	0.67	5.20	0.75	30

TABLE 5
Means and Standard Deviations for Difficulty Scale

Difficult	Pre-test	Pre-test	Post-test	Post-test	
	Mean	S.D.	Mean	S.D.	N
Total	3.33	0.97	3.32	0.99	105
Business	3.46	1.03	3.42	0.94	35
Psychology	3.22	0.93	2.84	1.00	22
ED.Undergr	3.69	0.73	3.87	0.99	18
ED. Grad	3.06	1.01	3.20	0.91	30

TABLE 6
Analyses of variance Between and Within Subjects

		Affect	Cognitive Comptncy	Value	Difficulty	Total
Source	D.F.	F	F	F	F	F
Within Cell Err	82					
Group	3	1.80	0.84	2.04	1.71	0.48
Gender	1	0.28	0.40	0.27	0.51	0.79
Ethnicity	1	0.32	0.67	1.14	2.20	0.01
Group x Gender	3	0.23	0.30	0.19	0.12	0.09
Group x Ethnicity	3	0.25	0.04	0.13	0.34	0.1
Gender x Ethnicity	1	0.57	1.63	0.09	0.18	0.89
Grp x Gender x Ethnicity	2	0.08	0.64	0.07	0.36	0.09
Within Subject Er	82					
Pre-Post	1	1.03	3.03	0.47	0.30	0.8
Group x Pre-Post	3	1.37	0.66	0.32	1.19	0.17
Gender x Pre-Post	1	1.97	0.19	0.24	0.01	0.28
Ethnicity x PrePost	1	7.21**	7.09**	8.98**	1.75	12.29**
Group x Gender x Pre-Post	3	1.74	2.19	0.85	0.35	0.6
Group x Ethnicity x PrePost	3	0.14	1.53	0.09	0.23	0.48
Gender x Ethnicity x PrePost	1	1.15	0.33	2.20	0.04	0.19
Group x Gender x Ethnicity x PrePost	2	0.22	1.14	0.52	2.08	0.85

* p<.05, ** p<.01

TABLE 7
Means and Standard Deviations of Affect Scale for Different Ethnic Groups

	Pre-test	Pre-test	Post-test	Post-test	
	Mean	S.D.	Mean	S.D.	N
Total	3.86	1.31	4.23	1.31	97
Caucasian	3.72	1.32	4.21	1.30	71
African-American	4.26	1.24	4.28	1.37	26

TABLE 8
Means and Standard Deviations of Cognitive Competency scale for Different Ethnic Groups

	Pre-test	Pre-test	Post-test	Post-test	
	Mean	S.D.	Mean	S.D.	N
Total	4.80	1.61	5.10	1.01	97
Caucasian	4.63	1.16	5.07	0.95	71
African-American	5.26	1.05	5.19	1.16	26

TABLE 9
Means and Standard Deviations of Value Scale for Different Ethnic Groups

	Pre-test	Pre-test	Post-test	Post-test	
	Mean	S.D.	Mean	S.D.	N
Total	4.70	0.83	4.77	0.87	97
Caucasian	4.70	0.80	4.89	0.78	71
African-American	4.72	0.93	4.41	1..2	26

TABLE 10

Means and Standard Deviations of Difficulty Scale for Different Ethnic Groups

	Pre-test	Pre-test	Post-test	Post-test	
	Mean	S.D.	Mean	S.D.	N
Total	3.33	0.97	3.34	1.00	97
Caucasian	3.36	0.98	3.43	0.95	71
African-American	3.27	0.97	3.07	1.11	26

TABLE 11

Means and Standard Deviations of Total Attitude Scale for Different Ethnic Groups

	Pre-test	Pre-test	Post-test	Post-test	
	Mean	S.D.	Mean	S.D.	N
Total	4.35	0.71	4.43	0.71	97
Caucasian	4.27	0.73	4.48	0.66	71
African-American	4.54	0.65	4.33	0.76	26

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