ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Paper ID #40831

Study of Students' Prior Statistical Knowledge and Attitude

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Investigating Students' Prior Statistical Knowledge and Attitude

As a requirement for graduation, Civil, Construction, and Electrical Engineering majors at The Citadel must take a Probability and Statistics course in their Junior year. A background knowledge probe (pre-test) was developed based on key elementary statistical concepts. The pre-test was administered at the beginning of the course to measure student's prior statistical knowledge and to identify student misconceptions. A survey of student attitudes toward statistics was also administered at the beginning of the semester. This study examines the pre-test data and the survey of students' attitude toward statistics.

Background

The fundamental goal of a statistics course is to introduce students to basic statistical concepts and skills. In addition, it should help students develop strong positive attitudes toward statistics [1]. Statistics educators routinely mention that many students enter statistics courses with negative views or later develop negative feelings about the domain of statistics [2]. The students should not have apprehension toward learning future statistics after completing a statistics course. [3] found that attitudes toward statistics were predictive of student achievement in an introductory statistics course. [3] suggests that prevailing attitudes toward statistics among students included feelings of anxiety, cynicism, contempt, and fear. [4] studied 700 students using SATS-36 [5], found that first year students with regards to interest in learning statistics achieved lower grades.

The Survey of Attitudes Toward Statistics (SATS-36) is designed to measure students' attitudes toward statistics [5]. This instrument contains six subcomponents (i.e., Affect, Cognitive Competence, Value, Difficulty, Interest, and Effort). The Affect component measures feelings toward statistics. A high score on this component indicates that students like learning statistics, they enjoy taking a statistics course and they are not nervous about learning statistics [5]. Cognitive Competence measures students' attitudes about their intellectual knowledge and skills when applied to statistics. A high score on this component indicates that students believe they have the ability and the mathematical aptitude to learn statistics [5]. The Value component measures students' attitudes about the usefulness, relevance, and worth of statistics in personal and professional life. A high score on this component indicates that students understand the usefulness of statistics in the curriculum of their chosen major, in their future profession, and in their daily lives. According to [5], the Difficulty component represents students' attitudes about the difficulty of statistics as a subject. Higher scores in this area indicate a belief that statistics are not difficult, while lower scores indicate that students find statistics to be more difficult. The Interest component measures how much interest a student has in statistics [5]. Lastly, the Effort component asks about the amount of work students expect to spend learning statistics. A high score on this component indicates that students intend to work and study hard during the statistics class and will complete all assignments and attend all class sessions.

Assessment Measure

A pre-course survey of student attitudes toward statistics (see Appendix) adapted from [5] was administered on the first day of semester. According to [5], each item on the survey is designed to measure one of six different components of student attitudes toward statistics. Each item is measured on a Likert scale from 1 to 7 and is scored so that a higher response to the question indicates a more positive attitude toward statistics.

A pretest (shown below) was also administered to all students in a Probability and Statistic course at The Citadel during the first day of the semester. The pre-test was administered to measure students' prior knowledge at the beginning of semester. Questions on the pretest asked students to calculate descriptive statistics, simple probability, and to describe a histogram.

Q1. Four students out of 15 are to be selected to participate in a team. How many different teams can be formed? A) 60 B) 32720 C) 12 D) 1365

Q2. There are 52 cards in a deck of cards. If three cards are selected at random, what is the probability of selecting three hearts from a deck of cards without replacement (13 hearts in a deck of cards)? A) 0.0577 B) 0.0129 C) 0.0156 D) 0.75

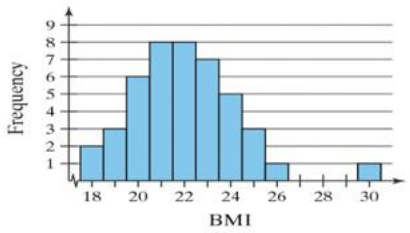
Q3. Bob rides his bike over 10-mile course 6 days each week. His times for this week were 60 mins, 58 mins, 55 mins.,54 mins, 47 mins, and 47 mins. What is the mode for the time it took for him to complete his ride? A) 58 B) 55 C) 54 D) 47

Q4. A president and vice-president are to be selected from a group of 12 members. How many ways can the selection be performed? A) 24 B)132 C) 66 D) 479001600

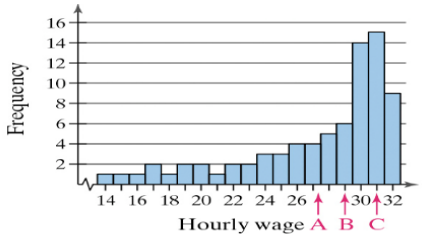
Q5. For the following data set [4, 1, 9, 8] the value of sample variance is 13.66, determine the value of standard deviation of the data set. A) 22 B) 3.20 C) 3.69 D) 4

Q6. Which measure of central tendency best represents the graphed data.

A) mean B) mode C) median D) standard deviation



Q7. Letters A, B, and C are shown on the horizontal axis. Which letter represents the mean of data. A) A B) B C) D D) I do not know



Q 8. Researchers would like to use the weight of a car to predict its miles per gallon. Which is the response variable?

A) The cars B) Miles per gallon C) The researchers D) Weight of the car

Q 9. Identify the population and the sample in the following statement. "A survey of 182 undergraduate and graduate students found that 60% have had difficulty coping with stress in a healthy way."

Participants

Thirty-one participants completed the attitude and prior knowledge surveys. Fourteen students were from the day program and 17 were from the evening program. Thirteen percent of the students were Construction majors, 26% were Electrical majors, and 61% were Civil majors.

Results and Discussion

The analysis of the pre-course survey of attitudes toward statistics required computation and analysis of the measures for each of the six components. Figure 1 illustrates the means, standard errors, and sample size for each component on the pre-course survey for both day and evening programs. The scores represent means from a 7-point Likert scale, with mean scores of 4 as neutral. Except for the Value component, all other five components resulted in mean scores of above 4. Since the Value component measures the perceived usefulness, relevance, and worth of statistics in personal and professional life, lower values indicate that statistics are not useful to these students in personal and professional life. The Affect component resulted in the highest score in both day and evening programs. This indicates that students in both programs like learning statistics, and they are not afraid of learning statistics.

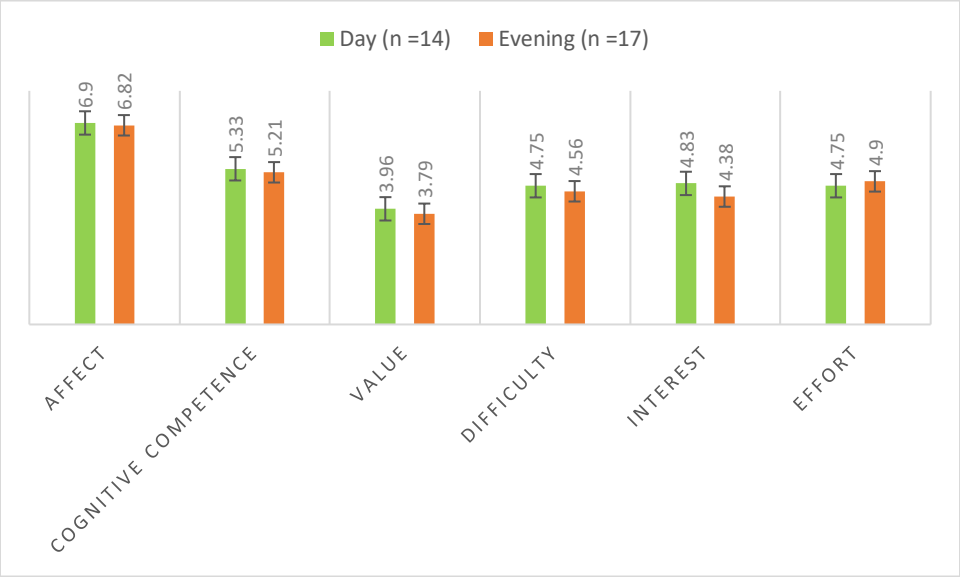


Figure 1. The pre-course scores for the attitude components.

Since the questions on the perception survey employ a Likert-scale response and the sample sizes are small, the component subscale scores were analyzed using nonparametric statistical methods. The two-tailed Mann–Whitney test was used to test for a significant difference between the day and evening classes in the distributions of the subscale score for each of the six components. All *p*-values were found to be nonsignificant; this meant that there was no significant difference in the student attitudes about statistics at the start of the semester between the day and evening programs.

Question #9 of the prior knowledge instrument was scored using the following standardized rubric: a score of zero (0) was awarded for an incorrect, off-base answer or no answer at all; a score of 0.5 was awarded for a partially correct answer; or a score of one (1.0) was awarded for a correct answer.

Figure 2 provides an overview of students' prior understanding of probability and statistics concepts. Figure 2 also illustrates the day program's performance vs. the evening program on each question on the pre-test. Evening students were slightly outperformed on all questions except Questions 3, 5, and 8 by the students from the day program. The questions with the lowest pre-test scores were Questions 1, 5, and 7. The student's high pre-test performance on certain questions suggests that they are sufficiently able to apply their prior knowledge to certain aspects of probability and statistics. The question with the highest pre-test score (Question 8) concerns the regression analysis. Two other questions with high performance are Question 3 (mode of data) and Question 4 (counting principles). This may indicate student familiarity with descriptive statistics and regression concepts, but a lack of real exposure to other key statistical concepts.

Figure 2 also depicts that there were no significant differences between students' pre-test scores for the two programs. One question with a notable difference is Question 7, in which students from the day program displayed a stronger understanding of descriptive statistics (mode) than the evening program.

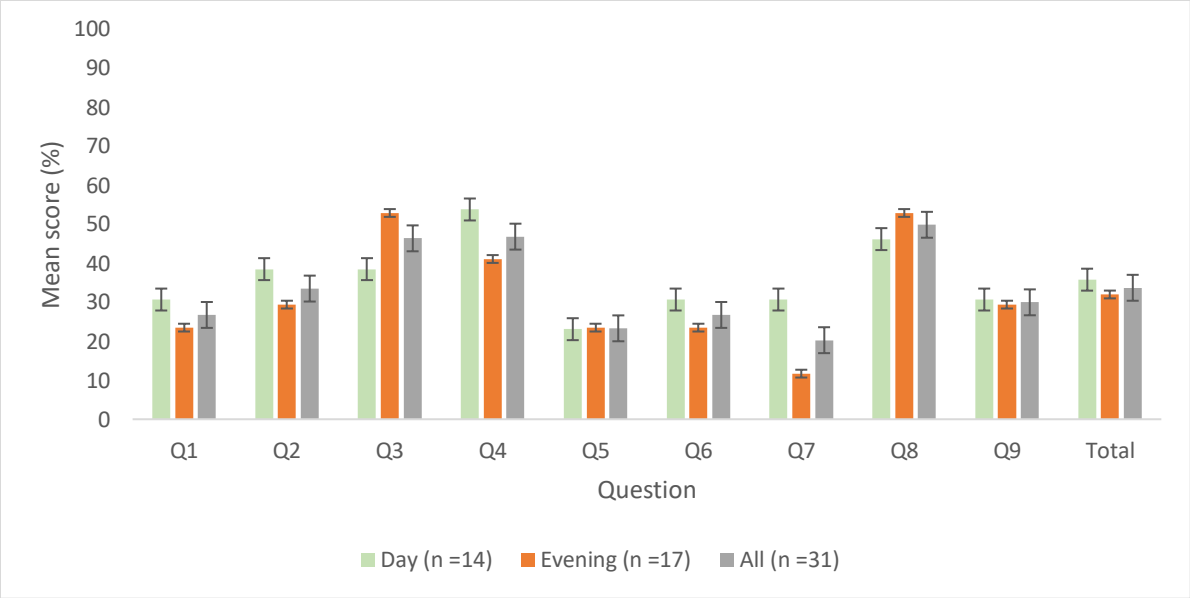


Figure 2. Pre-assessment results of statistical concepts.

Conclusions

There were no significant differences between students' prior knowledge of statistical concept scores for the two programs. Students from the day program displayed a stronger understanding of descriptive statistics (i.e., mode) than the evening program.

The Affect component of the pre-course survey resulted in the highest score in both day and evening programs. This indicates that students like learning statistics, they enjoy taking a statistics course and they are not afraid of learning statistics. The value component of the pre-course survey resulted in the lowest score in both day and evening programs. This indicates that students think that statistics are not useful in personal and professional life.

It is important to note that the results of this Work-In-Progress study are limited to the one year assessed and should not be generalized to draw broader conclusions. Further data collection and analysis is warranted over the next few offerings before conclusions can be made.

For future research, it would be beneficial to give the students both a pre- and post-survey to assess how their attitude changes about statistics and assess the gains in conceptual understanding of statistical topics as a result of various pedagogical techniques used.

References

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Appendix

The statements below are designed to identify your attitudes towards statistics. Each item has 7 possible responses. The responses range from 1 (strongly disagree) through 4 (neither disagree nor agree) to 7 (strongly agree). If you have no opinion, choose 4. Mark the one response that most clearly represents your degree of agreement or disagreement. Please respond to all statements.

Survey of Attitude Toward Statistics Adapted from Schaun 2003	Strongly disagree			Neither disagree nor agree			Strongly agree
1. I plan to complete all my statistics assignments.	1	2	3	4	5	6	7
2. I plan to work hard in my statistics course.	1	2	3	4	5	6	7
3. I will like statistics.	1	2	3	4	5	6	7
4. Statistics should be a required part of my professional training.	1	2	3	4	5	6	7
5. Statistics is not useful to the typical professional.	1	2	3	4	5	6	7
6. I am interested in using statistics.	1	2	3	4	5	6	7
7. Statistics is a subject quickly learned by most people.	1	2	3	4	5	6	7
8. I am interested in understanding statistical information.	1	2	3	4	5	6	7
9. Learning statistics requires a great deal of discipline.	1	2	3	4	5	6	7
10. I will make a lot of math errors in statistics.	1	2	3	4	5	6	7
11. I am scared by statistics.	1	2	3	4	5	6	7
12. I can learn statistics	1	2	3	4	5	6	7