

Effects of Implementing Projects in an Elementary Statistics Class

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Abstract

In hopes of reducing the percent of students receiving non-passing grades in elementary statistics classes, interactive hands-on projects were implemented in the classes. These projects gave students the opportunity to use personal data, discuss statistical concepts with each other, and strengthen the students' understanding, mastery and appreciation of the material covered in an elementary statistics class. Although no decrease in the percent of non-passing grades was observed and no noticeable shift in the overall grades occurred, there was a statistically significant increase in the students' perception of the teacher's ability to teach the course and the students' perception of the teacher's interest in the success of the students. Through further investigation, partial justification for the lack of significant change in non-passing grades was attributed to circumstances in students' personal lives that are beyond the control of the teacher and would not be affected by any change in teaching style.

Introduction and Background

Implementing activity learning such as hands-on activities or projects in an elementary statistics class is highly recommended and has been shown to help students grasp important concepts and ideas as well as lead to student success. (Garfield, 1993; Gnanadesikan, Scheaffer, Watkins, & Witmer 1997; Ledolter, 1995; Smith, 1998). The percent of students not passing the elementary statistics class at our university was above acceptable levels, however, no such hands-on projects were being utilized at that time. This research was funded by an NSF-PRISM grant (#AR2005FA-04) and transpired at a medium sized liberal arts university with approximately 6,500 students. The elementary statistics class of concern is a service course for many majors, mostly in the Health Sciences (Radiology, Nursing etc.), but is also a gateway course for research methods courses in such majors as Criminal Justice, Biology, and Psychology. At our university, the elementary statistics class is a 2000 level course and typically covers the basic topics of descriptive statistics, graphs, simple linear regression, probability, confidence intervals, tests of significance, and Chi-square tests. It is not an overly demanding course as it does not cover topics of ANOVA or multiple regression, which students tend to find more difficult. The class was offered numerous times each semester and generally met for three 50 minute time periods for standard lecture.

Through an inspection of grade distributions of previous years for this class, a long term trend was revealed. A larger than expected proportion of

students were retaking the course in order to satisfy the requirements of their major. Approximately 33% of students were finishing the elementary statistics class with a grade of D, F or W (withdraw). During a recent school year, 889 students attempted the elementary statistics class at our university, resulting in almost 300 D, F and W grades. Almost all majors requiring statistics at the university expect a grade of C or better, hence most students receiving a grade of D would be required to retake the course along with all students receiving F or W grades, excluding those who drop out of school or change their major to one not requiring statistics (which, for some students, is the reason for changing majors). Upon examination of the grade distributions across the rest of the campus, we found other 2000 level courses typically awarded grades of D, F or W to only 23% of the students.

The purpose of this research project was to strengthen the students' understanding, mastery and appreciation of the material covered in an elementary statistics class by including five hands-on projects throughout the semester thereby reducing the proportion of students who retake the course.

Implementing Projects into the Class

Throughout the semester, five in-class projects were implemented. For each project the students assembled into small groups and carried out various hands-on tasks that facilitated the utilization of their knowledge of the current material. Most of the projects also introduced a new minor topic or concept that the students discovered by completing the project. For example, the large effects that different outliers can have on correlation coefficients and regression equations are left for the students to discover as they complete the project on regression and correlation.

Increasing the proportion of students who pass the course on the first attempt was the main goal and was attempted by specifying particular characteristics to the projects. The projects were graded, hence students were more apt to prepare for them by studying and doing some recent homework assignments. This additional in-class-directed student study time between tests was presumed to be beneficial. Numerous doses of studying and practicing new knowledge usually results in better student comprehension and retention than a few large cram sessions just prior to test day. (Donovan and Radosevich, 1999). Collaborative work provides students with a better chance of understanding the material and obtaining correct answers. This tends to lead to an increase in the students' confidence in obtaining correct answers that in turn motivates students' study habits (Pajares, 1996). Collaborative work can also pressure students into understanding the material so they do not appear unknowledgeable of the current material when discussing the issues with their peers.

Data Collection

Some of the most pertinent data collected were the grade distributions from the classes used in this study. These distributions vary naturally and a

change during a single semester may give a false sense of success or failure, therefore, data was collected over a two year time period during fall, spring, and summer semesters. The grade distributions of classes in which projects were employed were compared to the grade distributions of classes in which no projects were used. Extreme care was taken to minimize additional variability between the classes with projects and the classes without projects. The classes with and without projects were all taught by the same instructor, during the same times of day, the same course content was covered using the same lecture notes (except for the minor concepts unveiled during the projects), and the same format and types of questions were used on tests. Throughout the two year duration of this experiment, five classes were taught without the projects and eight classes were taught with the projects.

A second set of data collected was student comments regarding the projects. After each project, students were asked to anonymously write any positive or negative comments regarding any aspect of the projects.

Results

After the completion of the study, it was determined that there was no significant decrease in the overall percent of D's, F's and W's in the classes with projects compared to the classes without projects. The Chi-square test used to look for a change in the proportion of passing grades (A, Bs and C's) and non-passing grades (D's, F's and W's) resulted in a test statistic of 0.218 with 1 degree of freedom and a p-value of 0.64.

Additionally, a Chi-square test was used to determine if the implementation of projects affected any part of the grade distributions of A, B, C, D, F and W's. With a test statistic of 2.83 and 5 degrees of freedom, a p-value of 0.725 was obtained indicating no significant change to any part of the overall grade distribution.

This lack of significant differences in the grade distributions was unexpected since other researchers have found improvements, in some cases substantial improvements, in the grade distributions of classes that utilize active learning (Keeler & Steinhorst, 1995; Smith, 1998).

Although this series of projects did not have a significant effect on the percent of students who will probably have to retake the course, it is believed that the students enjoyed attending class more and were more enthusiastic about the subject matter than the students in the classes without projects. These suppositions came from reading the comments regarding the projects that the students wrote throughout the study. While a very small proportion of the students' comments pertained to group size and length of projects, an overwhelming majority of the students' comments were enthusiastically positive. Some of the more pertinent comments pertained to how much better the students claimed to understand the current material after completing the project and how much they enjoyed the class when projects were used. Similar results of students enjoying a mathematically based course more but not improving their overall understanding was also found in the 2003 Trends

in International Mathematics and Science Study as reported by The Associated Press (Ben Feller, 2006).

With the overwhelming positive comments regarding the projects, but no change in the grade distribution, especially in the D-F-W percent, the research team thought this series of projects might be influencing the students' perception of the teacher. Therefore, teacher evaluations completed by the students for the given time period of this study were examined.

Teacher evaluations consist of ten statements regarding the course and instructor along with one statement rating the overall quality of instruction. Four of the ten statements are related to the instructor's ability to teach the course and may be directly affected by changing the delivery of the course, i.e. implementing projects into the course. They are: "The instructor was effective in creating the educational experience", "The instructor demonstrated interest in the academic achievement of students", "The instructor presented the material clearly and gave understandable explanations" and "Time spent in course activities was related to the subject matter of the course". The statement regarding overall quality of instruction was also included. These five statements will be summarized respectively as Effect, Interest, Explain, Discuss, and Overall. Table 1 gives the mean evaluation results for the five statements, differentiating between those classes taught with projects and those taught without projects along with corresponding standard deviations, standard errors and sample sizes.

Effectiveness, Interest, Explanation and Discussion are on four-point scales while Overall is based on a five-point scale. For all statements, larger values indicate more favorable results. By implementing projects into the standard lecture, the researchers were looking for increases in the means of these evaluation statements. Since the scales are four point and five point scales and the mean ratings without projects for all five statements are already close to their maximum values, there is little room for improvement. This brings forth the point that even small improvements may be difficult to attain. Yet, the table shows small increases in all five means when the projects were utilized versus when no projects were utilized. These means were analyzed using MANOVA and took into consideration which semester the classes occurred, the time of the day the classes were offered and whether or not projects were utilized. Although the increases in means were small, the analysis signified that there were significant differences in the mean vector. Follow up tests revealed statistical significant increases in the means of the Interest statement and the Overall statement (p-values of .042 and .035 respectively).

During the last term of this research project, it was becoming obvious that the percents of D's, F's and W's were not decreasing. This was perplexing given the students' comments claiming how much better they understood the material after completing the projects. Therefore, the primary researcher attempted to determine additional reasons for the continually high percentages of D's, F's, and W's. During the last summer term 13 students received non-passing grades: five students received D's, three students received F's, and five students received W's. Of the five receiving W's, one student moved away, one

withdrew because she was missing class to be with her sick grandmother, one student was doing quite well in the class but decided to withdraw because he needed to concentrate on classes more pertinent to his major, and two, it was assumed since no other reason was given, withdrew because of poor grades. Two of the three who received F's, attended class so infrequently (less than 25% of classes attended), they not only struggled with the class material but did not know when the tests were given and, hence, missed tests. Of the thirteen previously mentioned students who received non-passing grades, five of the students would have received non-passing grades regardless of the types of class activities. Since no other reason was apparent, it is assumed the remaining students who received non-passing grades received them for no other reason than poor comprehension of the material. If this last semester can be regarded as a typical semester, it is an indication that almost 40% of the non-passing grades result from circumstances in the students' lives that are beyond the control of the teacher. Hence a certain proportion of failing grades can be expected regardless of the methods used to teach the course.

Conclusions

In conclusion, the projects implemented into the regular lecture format did not statistically reduce the percentage of students who will retake elementary statistics in order to obtain a college degree. They also did not significantly improve or change the grade distribution of students taking elementary statistics. The results of this study did however bring to light the idea that an instructor may be able to improve students' perception of the instructor's effectiveness and their appreciation of the topic of statistics through implementation of such projects.

Although the percents of D's, F's and W's did not significantly diminish, it may be that the original problem being addressed, high percentage of D's, F's and W's, is at least partially attributed to problems that were not addressed by this research. A large portion of the students receiving D's, F's and W's might be, at least as evidenced by one semester, receiving them for reasons that cannot be remedied through classroom activities.

Table I
Descriptive statistics from teacher evaluations for selected questions

		Effect	Interest	Explain	Discuss	Overall
Without projects n = 5	Mean	3.68	3.57	3.64	3.78	4.34
	Std. Dev.	0.053	0.07	0.138	0.053	0.134
	Std. Err.	0.0237	0.0313	0.0617	0.0237	0.0599
With projects n = 8	Mean	3.72	3.65	3.72	3.81	4.54
	Std. Dev.	0.094	0.104	0.084	0.079	0.216
	Std. Err.	0.0332	0.0368	0.0297	0.0279	0.0764

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