COMPARING ATTITUDES TOWARD STATISTICS AMONG STUDENTS ENROLLED IN PROJECT-BASED AND HYBRID STATISTICS COURSES

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Considerable research has been devoted to how students learn statistics, such as through data analysis projects, simulations, online learning courses, and traditional lecture. This study analyzes the differences in attitudes towards statistics among introductory statistics students experiencing two different learning environments: a project based statistics course versus a mix of traditional and online learning course (hybrid course). The Survey of Attitudes Toward Statistics (SATS-36) is used to compare the attitudes of college students from a small liberal arts college enrolled in an introductory statistics course during the Fall 2012 and Spring 2013 semesters. This study suggests that an examination of these environments is needed to better understand students' attitudes.

INTRODUCTION

Over the past few decades, the relationship between students' attitudes and various learning environments has been discussed in the statistics education literature. Attitudes are often measured through a survey, such as the Survey of Attitudes Toward Statistics (SATS-36, Copyright © C. Schau, 1996, 2003), which has six attitudinal components: *Affect, Cognitive Competence, Value, Difficulty, Interest and Effort*. This survey instrument has been used in statistics education research due to its reliability, validity and well-known psychometric properties (Hilton, Schau, & Olsen, 2004; Tempelaar, Schim van der Loeff, & Gijselaers, 2007; Vanhoof, Kuppens, Sotos, Verschaffel, & Onghena, 2011). For more information, visit the website www.evaluationandstatistics.com (Schau, 2005).

Statistics education researchers have compared the attitudes of students in a project based course versus a traditional course (a control group). For example, Chadjipadelis and Andreadis (2006) used the SATS-36 and found that the students who were in a project-based course had statistically significant higher attitude scores than those in the control group, with the exception of the *Difficulty* component. Yet, Carnell (2008) found no significant difference in students' attitudes, from all six components of the SATS-36. Similarly, Spence and Sinn (2009) did not find a statistically significant difference between the two groups, as measured by their own instrument called the Statistics Self-beliefs Survey. They also developed the Perceived Usefulness Survey and found that the students in the project group scored significantly higher than those in the control group. Harlow, Burkholder and Morrow (2002) also developed their own pre and post survey instrument called Quantitative Attitudes. They found that students who conducted applied projects "significantly reduced their quantitative anxiety and significantly increased their quantitative self-efficacy over the course of a semester" (p. 423).

Researchers in statistics education also compared the attitudes of students in hybrid versus traditional statistics courses. Utts, Sommer, Acredolo, Maher, and Matthews (2003) reported that the control group had higher satisfaction ratings than the hybrid group, based on student evaluations. However, Ward (2004) found higher ratings from the hybrid group. DeVaney (2010) compared the attitudes of graduate students in an online course versus a traditional (in-class) course, using the SATS-28, and found that the students' scores on the *Affect* and *Difficulty* subscales were significantly different between the two groups. That is, based on the two subscales, students in the traditional course responded more positively than the ones in the online course.

The primary aim of this study is to compare the attitudes of statistics students from two learning environments: (1) a project-based learning course, and a (2) hybrid course consisting of a traditional lecture and online learning. We used the SATS-36 to measure attitudes of students at the beginning and at the end of the semester. This study also provided the opportunity to explore the additional questions from the SATS that are not often reported in the research literature. Furthermore, this study also served to examine the implications of various learning environments on students' attitudes, as well as in enhancing sustainability and learning capacity of students.

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METHODOLOGY

Participants and Contexts

Participants were 212 students from a small liberal arts college enrolled in an introductory statistics course. The students were not randomly assigned; rather, they self-selected to enroll in the course without prior knowledge of the learning environment. Majority of the students were females at 75.1% (148 out of 197). In the Fall 2012 semester, the project-based learning course, 59 (77%) were females and 18 (23%) were males out of 77 who answered the question. In the hybrid course, Spring 2013, 89 (74%) were females and 31 (26%) were males out of the 120 who answered the question. Both courses were taught by the same instructor, covered the same course material, and all students were required to take exams in class.

The project-based learning course required the students to conduct their own survey research and analyze their own data using descriptive and inferential statistics. There were four major writing assignments with the following goals: (1) to develop their own research questions; (2) to write their own survey questionnaire and describe how they plan to collect their own data; (3) to analyze the results; and (4) to write the final report and present their findings in class. The students worked as a group consisting of 2-3 members per group. This course did not include a graded homework. The project was worth 20% of the final grade for the course.

The students in the hybrid learning course were required to do their homework online through the textbook publisher's website. They paid approximately $75 to register in the website in order to access the homework problems, examples, and an electronic version of the textbook. The homework grade was worth 20% of the final grade. The two courses are similar in content and structure, except that there is a project requirement in one course, while the other has an online homework component.

Measurement and Analysis

We used the Survey of Attitudes Toward Statistics (SATS-36) to measure attitudes of students. We used t-tests to examine the differences in the mean SATS scores between the two learning environments. Descriptive statistics and Chi-square test of independence were also obtained to explore the additional questions from the SATS. The participants took the SATS-36 online survey at the beginning and at the end of the semester.

RESULTS

Table 1. SATS Subscales for the Pre-Scores

	Affect	Cognitive Competence	Value	Difficulty	Interest	Effort
Project-based						
Mean	4.26	4.95	4.90	3.74	4.70	6.37
SD	1.06	0.99	1.11	0.75	1.16	1.09
n	75	75	76	74	75	78
Hybrid Course						
Mean	4.06	4.77	4.67	3.64	4.47	6.46
SD	1.04	0.90	0.99	0.67	1.21	0.88
n	118	118	115	118	118	119

SATS-36 Pre and Post

A visual comparison between project-based and hybrid course shows that the two courses are similar among the six SATS attitude components in both the pre- (Table 1) and post- (Table 2) subscores. It appears that in the pre-SATS, the students in the project-based course had slightly higher attitude components than the hybrid course, with the exception of the *Effort* subscale. Responses in the post-SATS, however, showed that the students in the hybrid course had slightly higher values in the *Affect* and *Cognitive Competence* than the project-based course, while the *Effort* subscale was slightly higher in the project-based course. Note that the sample sizes (n) in the

tables vary due to missing values from students' responses. This is because in order to get a subscale score, students need to answer the group of questions completely.

Table 2. SATS Subscales for the Post-Scores

	Affect	Cognitive Competence	Value	Difficulty	Interest	Effort
Project-based						
Mean	3.96	4.62	4.41	3.75	3.69	5.94
SD	1.31	1.25	0.96	1.05	1.34	1.13
n	63	63	63	61	60	63
Hybrid Course						
Mean	4.03	4.86	4.34	3.71	3.47	5.76
SD	1.20	1.18	0.93	0.99	1.31	1.16
n	105	108	109	108	108	109

Table 3. SATS Subscales for the Mean Change (Post – Pre)

	Affect	Cognitive Competence	Value	Difficulty	Interest	Effort
Project-based						
Mean	-0.38	-0.39	-0.51	0.06	-1.13	-0.53
SD	1.25	1.25	0.88	0.90	1.32	1.31
n	59	59	60	56	56	61
Hybrid Course						
Mean	0.01	0.06	-0.27	0.05	-0.93	-0.68
SD	1.03	0.97	0.93	0.87	1.31	1.32
n	93	96	94	96	95	97
Independent t-test (assuming unequal variances; two-tailed tests)						
t	-1.969	-2.328	-1.591	0.088	-0.915	0.683
df	106	101	132	111	115	128
p-value	0.052	0.022	0.114	0.930	0.362	0.496

Table 3 shows the mean change or the paired differences after subtracting the pre-scores from the post-scores. Results from the independent t-test between the two learning environments show a significant difference in the *Cognitive Competence* of students in the project-based as compared to the hybrid course (*t = -2.328; df = 101; p =.022*). This shows that students' cognitive competence in the project-based course dropped from pre to post (-.39), while the students in the hybrid course had a small increase (.06) but might be considered negligible. We did not find significant differences in the remaining components.

Value, Interest and *Effort* had negative mean change scores, showing that attitude components that got worse over the course of the semester because the pre-scores were higher than the post-scores. It appears that the students from the project-based course had the worst mean change score for the *Interest* component at -1.13, followed by the students from the hybrid course at -.93, for the *Interest* component as well. Schau and Emmioglu (2012) suggested that when analyzing attitude changes from pre to post scores, a difference of ½ point or more can be considered important even if it is not statistically significant. The results in this study show that the changes in the *Interest* and *Effort* components are important to note in both groups. However, the *Difficulty* component can be interpreted as no change because of positive mean change scores that were close to zero (i.e., .06 and .05 for project-based and hybrid course, respectively).

SATS-36 Additional Questions

There are several additional questions on the SATS which deserve analyzing because these are often disregarded in the analysis, and that these additional questions can enrich our understanding of students' attitudes. Table 4 contains these questions for the Pre-SATS, and Table

5 contains the questions for the Post-SATS. The chi-square test compared the responses to the question between the two learning environments. Using $\alpha = 0.05$, we found two questions that showed significant differences between the learning environments. Both of these questions were given on the Pre-SATS.

Table 4. Additional Questions on the Pre-SATS

Question	Likert Scale	Chi – Square Test
How well did you do in mathematics courses you have taken in the past?	1 = Very poorly 7 = Very well	$X^2 = 9.749, df = 6$ *p-value = 0.136*
If the choice had been yours, how likely is it that you would have chosen to take any course in statistics?	1 = Not at all likely 7 = Very Likely	$X^2 = 22.182, df = 6$ *p-value = 0.001*
How good at mathematics are you?	1 = Very poor 7 = Very good	$X^2 = 12.627, df = 6$ *p-value = 0.049*
In the field in which you hope to be employed when you finish school, how much will you use statistics?	1 = Not at all 7 = Great deal	$X^2 = 3.486, df = 6$ *p-value = 0.746*
How confident are you that you can master introductory statistics material?	1 = Not at all confident 7 = Very confident	Test not valid

Table 5. Additional Questions on the Post-SATS

Question	Likert Scale	Chi – Square Test
As you complete the remainder of your degree program, how much will you use statistics?	1 = Not at all 7 = Great deal	$X^2 = 1.358, df = 6$ *p-value = 0.960*
If you could, how likely is it that you would choose to take another course in statistics?	1 = Not at all likely 7 = Very Likely	Test not valid
How difficult for you is the material currently being covered in this course?	1 = Very easy 7 = Very difficult	$X^2 = 5.487, df = 6$ *p-value = 0.476*
How good at mathematics are you?	1 = Very poor 7 = Very good	$X^2 = 6.577, df = 6$ *p-value = 0.362*
In the field in which you hope to be employed when you finish school, how much will you use statistics?	1 = Not at all 7 = Great deal	$X^2 = 5.883, df = 6$ *p-value = 0.436*
How confident are you that you have mastered introductory statistics material?	1 = Not at all confident 7 = Very confident	$X^2 = 5.057, df = 6$ *p-value = 0.536*

The second question in the Pre-SATS shows that whether one would take a course in statistics is associated with the learning environment ($p = .001$). It was interesting to see that after combining the frequency counts in the two lower end of the Likert scale (1 and 2 choices, "not at all likely"), 59% of the students (69 out of 116) in the hybrid course were not likely to take a course in statistics. Only 28% of the students (22 out of 78) in the project-based course had a similar response. This same question was asked in the Post-SATS, but the Chi-square test of independence was not obtained due to the low expected values. For the project-based course Post-SATS, 66% of the students (42 out of 64) were not likely to take a course in statistics after this course, and 65% of the students (72 out of 111) in the hybrid course were not likely to take a course in statistics after the course. Figure 1 shows the histogram of the Pre and Post SATS for the combined data (hybrid and project-based courses). This shows an increase in the responses in the "not likely" to take statistics category from pre to post.

The third question in the Pre-SATS shows that students' confidence in math is related to the learning environment ($p = 0.049$). After combining the top two responses in the Likert scale (6 and 7, "very good in math"), 40% of the students (48 out of 120) in the hybrid course said that they are very good in math, while only 25% of the students (19 out of 76) in the project-based course reported a high confidence in math. This shows that there were more students in the hybrid course

who reported that they are good at math than in the project-based course. However, this same question in the Post-SATS did not show the same association ($p = 0.362$). Still, more students in the hybrid course (32% or 36 out of 111 students) had higher confidence in math than in the project-based course (19% or 12 out of 64 students).

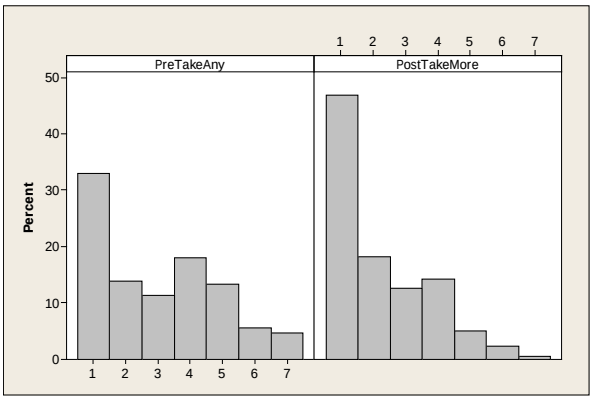

Figure 1. Histogram of Pre- and Post- Choice Been Yours Take Any or Another Statistics Course

In terms of sustainability and building capacity, we also found it interesting to investigate the question: "In the field in which you hope to be employed when you finish school, how much will you use statistics?" The Chi-square test shows that the students' response to this question is independent of the learning environment. Looking at the overall data (combined hybrid and project-based courses), the histograms on Figure 2 show no obvious change in the distribution from pre to post. In the Post-SATS, there were only 20% of students (35 out of 175) who gave a Likert value above 4 or neutral, that is, gave a 5, 6, or 7. This shows that only a small percentage of students see the usefulness of statistics in their field of employment.

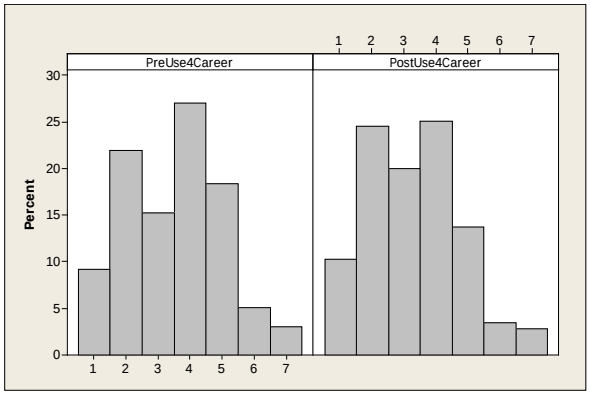

Figure 2. Histogram of Pre- and Post- Use of Statistics in Field of Employment

CONCLUSION

Although we found a significant difference between the project-based course and the hybrid course in the *Cognitive Competence* component, it appears that the students in the project based course had worse experience. This result is slightly different from previous studies that compared project-based course with traditional courses (Carnell, 2008; Chadjipadelis & Andreadis, 2006), and project-based course with online course (DeVaney, 2010). It is possible that a semester long project is not enough to bring about positive changes to students' *Cognitive Competence* and further support their attitudes. Perhaps the students in the hybrid course improved their cognitive competence because the online homework system gave them instant feedback on whether they got the answer correctly or incorrectly. On the other hand, the project based course received feedback only after submitting the written work and after presenting their project in class.

As for the students in the hybrid course, it appears that they had a neutral experience with a small change towards the positive side. This tells us that if we capitalize on students' technology skills, then we might be able to build on their attitudes and enhance their learning. Many of the

students now have laptops, tablets such as an iPad, and smart phones that have internet capabilities. Perhaps this indicates that teachers, researchers and statistics educators should consider the effect of hybrid and online courses, online homework systems, and even social media (e.g., facebook and twitter) in sustaining students' learning and promoting positive attitudes.

Of concern for statistics educators are the lack of positive responses (5, 6, or 7) on the questions involving whether a student would take more statistics courses or whether they will use statistics in his or her field. However, with this data set (combining both classes), 40% of students (78 out of 197) listed their major as "other." With the exception of one of the choices, Arts/Humanities, all of the majors listed would use statistics (Biology, Business, Chemistry, Economics, Education, Engineering, Mathematics, Medicine/Pre-Medicine, Psychology, Sociology/Social Work, Statistics). Could it be that with this set of students that they actually would not "use" statistics in their field of study? Hence, they would not believe that they have a need to take additional statistics courses. Furthermore, we wonder if the question concerning whether this course is required should be changed on the SATS. The questions reads, "Are you required to take this statistics course (or one like it) to complete your degree program?" The course could be required for two reasons, (1) to satisfy general education requirements or (2) to satisfy requirements for their major. Students' responses to the additional questions on the SATS would be affected if they were taking the course to satisfy general education requirements versus taking the course for their major, and we feel that this distinction should be made to improve the analysis of the additional questions of the SATS.

REFERENCES

Carnell, L. J. (2008). The effect of a student-designed data collection project on attitudes toward statistics. *Journal of Statistics Education, 16*(1). www.amstat.org/publications/jse.

Chadjipadelis, T., & Andreadis, I. (2006). *Use of projects for teaching social statistics: case study*. Paper presented at the Seventh International Conference on Teaching Statistics (ICOTS7), Salvador, Bahia, Brazil. http://www.stat.auckland.ac.nz/~iase/publications/17/8C3_CHAD.pdf

DeVaney, T. A. (2010). Anxiety and attitude of graduate students in on-campus vs. online statistics courses. *Journal of Statistics Education, 18*(1). www.amstat.org/publications/jse

Harlow, L. L., Burkholder, G. J., & Morrow, J. A. (2002). Evaluating attitudes, skill, and performance in a learning-enhanced quantitative methods course: A structural modeling approach. *Structural Equation Modeling, 9*(3), 413-430.

Hilton, S. C., Schau, C., & Olsen, J. A. (2004). Survey of attitudes toward statistics: Factor structure invariance by gender and by administration time. *Structural Equation Modeling, 11*(1), 92-109.

Schau, C. (2005). *Survey of Attitudes Towards Statistics Website*. www.evaluationandstatistics.com/index.html

Schau, C., & Emmioglu, E. (2012). Do introductory statistics courses in the United States improve students' attitudes? *Statistics Education Research Journal, 11*(2), 86-94. http://iase-web.org/documents/SERJ/SERJ11(2)_Schau.pdf

Spence, D. J., & Sinn, R. (2009). *Authentic discovery projects in statistics*. Paper presented at the 3rd Annual Meeting of the Georgia Association of Mathematics Teacher Educators, October 14, 2009. http://gamte.org/GAMTE_Proceedings_2009.pdf

Tempelaar, D., Schim van der Loeff, S., & Gijselaers, W. H. (2007b). A structural equation model analyzing the relationship of students' attitudes toward statistics, prior reasoning abilities, and course performance. *Statistics Education Research Journal, 6*(2), 78-102. http://www.stat.auckland.ac.nz/~iase/serj/SERJ6(2)_Tempelaar.pdf

Utts, J., Sommer, B., Acredolo, C., Maher, M. W., & Matthews, H. R. (2003). A study comparing traditional and hybrid internet-based instruction in introductory statistics classes. *Journal of Statistics Education, 11*(3). www.amstat.org/publications/jse

Vanhoof, S., Kuppens, S., Sotos, A. E. C., Verschaffel, L., & Onghena, P. (2011). Measuring statistics attitudes: Structure of the Survey of Attitudes Toward Statistics (SATS-36). *Statistics Education Research Journal, 10*(1), 35-51. www.stat.auckland.ac.nz/~iase/serj

Ward, B. (2004). The best of both worlds: A hybrid statistics course. *Journal of Statistics Education, 12*(3). www.amstat.org/publications/jse