A COMPARISON OF STUDENTS' ATTITUDES TOWARD STATISTICS: ONLINE VERSUS FACE-TO-FACE

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1. Background

With the increasing need for statistical literacy, more and more undergraduate majors require one semester of statistics (Bond, Perkins, & Ramirez, 2012; Chew & Dillion, 2014). However, empirical evidence have shown that many students face anxiety while learning statistics ((Hamid & Sulaiman, 2014; William 2010; Maat, Zakaria, & Rosli, 2016; Ben-Zvi & Garfield 1999). This aroused a wide concern among statistics educators and researchers. In the past two decades, many studies were conducted to investigate students' anxiety toward statistics. Bond, Perkins, & Ramirez (2012) examined the relationship between students' perceptions of statistics and attitudes toward statistics. Many studies found that statistics anxiety has a significant effect on students' performance (Zanakis & Valenzi, 1997; Keeley, Zayac, & Correia, 2008; Onwuegbuzie, & Seaman, 1995; Schou, 2006; Zare, Rastegar, & Hosseini, 2011; Macher, Paechter, Papousek, & Ruggeri, 2012).

2. Introduction

As the growing popularity of internet, online college education have boomed since last decade. More and more institutions offer statistics online. Do online statistics students have anxiety compared to their fellows in face-to-face statistics classes? Gundla, Richards, Nelsen, and Levesque-Bristol (2015) compared student's attitudes

toward statistics in three different formats: traditional, online, and hybrid. They found that traditional students had most significant changes in their attitudes. The study was conducted in a large coed university. Do their findings apply to students in small college? To answer this question, a study was conducted in a private 4 year all-women's college in Midwest to examine and compare students' attitude toward statistics between in face-to-face and online statistics course. Researchers have been developing surveys to measure students' attitude toward statistics since 1950s. There are many instruments available now. Survey of Attitude toward Statistics–36 (SATS-36) was used in this study due to its strong evidence of construct validity and internal consistency (Nolan, Beran, & Hecker, 2012).

3. Method

A semester-long elementary statistics is required for most of majors in that private all-women's college. This course is offered in both face-to-face and online formats. Face-to-face students have a total of 150 minutes of class meet per week. Day section meets twice a week and night section meets once a week. There is no lab or recitation hours. Online students have no class meet. All their lectures are delivered online through instructor recorded videos. This study was conducted in fall 2017. Since the night section was taught by a different instructor, only students enrolled in the day section or the online section were included. In the first week of the semester, a link of SATS-36 pre-survey was sent to all students enrolled in both sections. In the last week of the semester, a link of SATS-36 post-survey was sent to the same students. Students had one week to complete each of the survey. The results of both surveys were compared. Both face-to-face and online sections were taught by the researcher. The

two sections also had similar settings such as textbook, course schedule, office hours, PowerPoint lecture, homework, course project, quizzes, and exams. However, the face-to-face section has an extra formative assessment piece. Questions were asked in almost every class meet. Students' responses were collected by Plickers (a free app) and count toward their in-class participation points.

Both SATS-36 pre-survey and SATS-36 post-survey have 36 items. These 36 items can be grouped into 6 attitude components: affect, cognitive competence, value, difficulty, interest, and effort (Vanhoof, Kuppens, Sotos, Verschaffel, & Onghena, 2011). To allow anonymity, no identifying information were included.

5. Sample

There were 21 students enrolled in the online section and 34 students enrolled in the face-to-face section in fall 2017. At the end of the semester, 34 students (13 online and 21 face-to-face) completed both pre-survey and post-survey. Only these 34 students were included in this study.

6. Data Analysis

6.1 Internal consistency

The internal consistency of the results in the form of Cronbach's α was calculated and compared with Schau's results (Schau, 2003) in Table 1. The results of this study were in the same range reported by the author of SATS-36.

Table 1 Internal Consistency Comparison

Survey Components	**Cronbach's α**	**Cronbach's α reported by Schau**
Affect	0.87	0.80 – 0.89
Cognitive competence	0.86	0.77 – 0.88
Difficulty	0.64	0.64 – 0.81
Value	0.90	0.74 – 0.90

Interest	0.89	New component
Effort	0.83	New component

6.2 Pre-survey analysis

Since students chose delivery format of the course, we would wonder that students enrolled in different sections may have different attitudes toward statistics before they took this course. Therefore, the results of SATS-36 pre-survey were analyzed first. The results are showed in Table 2. There are some positively worded questions and some negatively worded questions in the original SATS-36 pre- and post-surveys. In the data analysis part, all negative worded questions are re-coded and a higher score means a student has a more positive attitude.

Table 2 SATS-36 Pre-Survey Results

Survey Components	**Face to face section**		**Online section**	
	Mean	**SD**	**Mean**	**SD**
Affect*	3.62	1.19	4.50	1.02
Cognitive competence*	4.37	1.02	5.35	0.90
Difficulty	3.39	0.55	3.67	0.54
Value	4.85	1.12	5.32	0.81
Interest	4.61	1.36	5.37	0.85
Effort	6.81	0.29	6.40	0.50

Online students have significantly more positive attitudes in affect and cognitive competence components than face-to-face students have. Both differences have large effect size. Compared to face-to-face students, online students were more confident in their intellectual knowledge and skills when applied to statistics and less concerned about statistics before they took this course. The side-by-side box plots of these two components are showed in Figure 1.

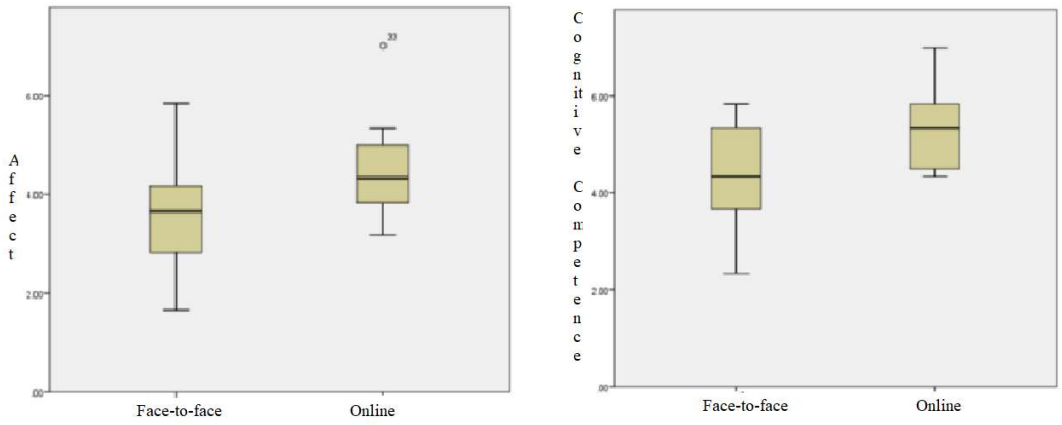

Figure 1 Affect and Cognitive Competence Components Results in SATS-36 Pre-survey

6.3 Post-survey analysis

After students took this course, their attitudes toward statistics were measured again by SATSA-36 post-survey. We first analyzed the results of SATS-36 post-survey to compare different sections' students. The results are showed in Table 3. Although online students had more positive attitudes toward statistics than face-to-face students at the beginning of the semester, there is no significant difference in students' attitude toward statistics between these two sections at the end of the semester. This is a surprise to us.

Table 3 SATS-36 Post-Survey Results

Survey Components	**Face to face section**		**Online section**	
	Mean	**SD**	**Mean**	**SD**
Affect	4.56	1.49	4.58	1.10
Cognitive competence	5.07	1.23	5.40	0.91
Difficulty	3.83	0.89	3.78	0.43
Value	4.93	1.00	5.37	1.12
Interest	4.61	1.14	4.92	1.12
Effort	6.37	0.80	6.60	0.35

6.4 Pre-survey and Post-survey comparison

In this part, we compared students' responses in the pre-survey with their responses in the post-survey to find if there were changes in students' attitudes toward statistics after taking this course. Table 4 showed the differences between students' responses in the post-survey and corresponding responses in the pre-survey.

Table 4 SATS-36 Post-Survey responses - Pre-Survey Results

Survey Components	**Face to face section**		**Online section**	
	Mean	**SD**	**Mean**	**SD**
Affect	0.94*	1.55	0.08	0.66
Cognitive competence	0.70*	1.02	0.05	0.57
Difficulty	0.435	0.98	0.11	0.53
Value	0.07	0.99	0.04	0.87
Interest	0.00	1.29	-0.44*	0.61
Effort	-0.44*	0.78	0.19	0.38

Face-to-face students became significantly more positive in affect and cognitive competence components after taking this course. Meanwhile, they felt that they need less effort on this course than what they expected after they took this course. All effect sizes are medium. On the contrary, online students did not show significant difference in all components except the interest component. They became less interested in statistics after they took this course. But the change in interest component has a small effect size. The side-by-side box plots of the four significant changes existing components are showed in Figure 2.

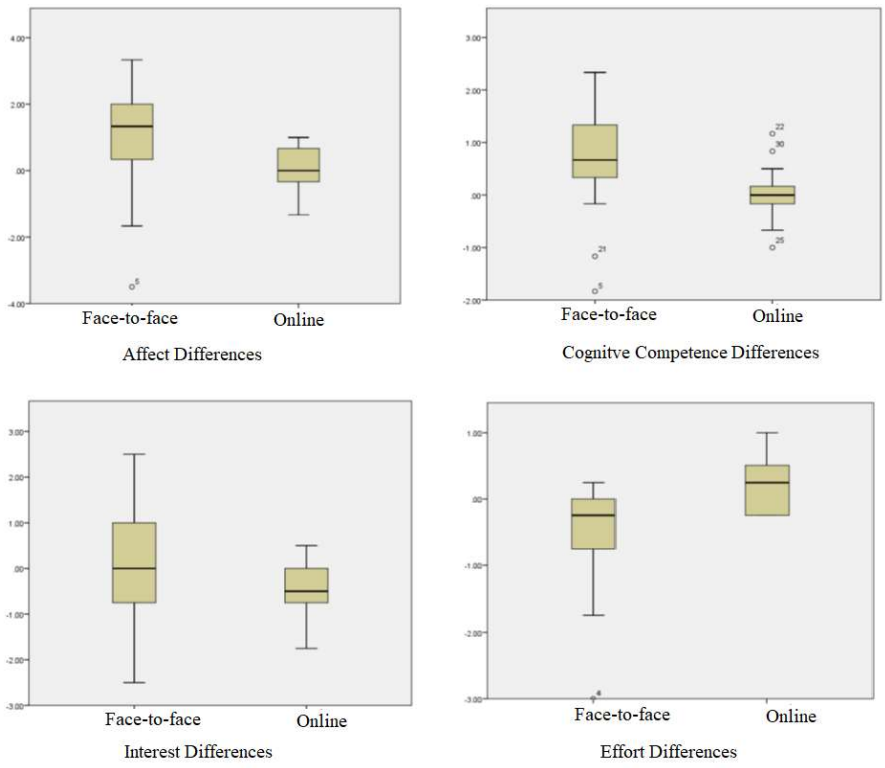

Figure 2 Pairwise Comparison of Affect, Cognitive Competence, Interest, and Effort Components: Post-survey results – Pre-survey results

7. Summary

We found face-to-face and online students have different attitudes toward statistics in affect and cognitive competence components before they took this course. It is not surprised to find that online students felt more confident in statistics at the beginning of the semester in general. We often heard face-to-face students talked about reasons of not taking this course online. Lack of confidence in statistics is the most frequent reason we heard. After took this course, face-to-face students became more confident and there was no significant difference in their attitude toward statistics compared to their online peers. This finding could be an indication of effective teaching in face-to-

face section. Face-to-face students did not show attitudes change in value, effort, and interest components. On the other side, online students did not become more positive at the end of the semester in all components. Instead, they became less interested in statistics in the post-survey. Compared to the face-to-face section, online section did not have the in-class work piece and students did not have interactive opportunity with the instructor and other students. We think this is the part we need to work on in future teaching. All the findings were based on one semester. We will need to collect more data in the future.

References

Ben-Zvi, D. & Garfield, J. (1999). Statistical literacy, reasoning, and thinking: goals, definitions, and challenges.

Bond, M., Perkins, S., & Ramirez, C. (2012). Students' perceptions of statistics: an exploration of attitudes, conceptualizations, and content knowledges of statistics. Statistics Education Research Journal, 11(2), 6 – 25.

Callister, R. & Love, M. (2016). A comparison of learning outcomes in skills-based courses: online versus face-to-face formats. Decision Sciences Journal of Innovative Education, 14(2), 243 – 256.

Chew, P. & Dillion, D. (2014). Statistics anxiety update: refining the construct and recommendations for a new research agenda. Perspectives on Psychological Science, 9(2), 196 – 208.

Hamid, H., Sulaiman, M. (2014). Statistics Anxiety and Achievement in a Statistics Course among Psychology Students. Journal of Behavioral Science, 9(1), 55 – 66.

Hernandez-Julian, R. & Peters, C. (2012). Does the medium matter? Online versus paper coursework. Southern Economic Journal, 78(4), 1333-1345.

Liu, S., Onwuegbuzie, A., & Meng, L. (2011). Examination of the score reliability and validity of the statistics anxiety rating scale in a Chinese population: comparisons of statistics anxiety between Chinese college students and their Western counterparts. Journal of Educational Enquiry, 11(1), 29 – 42.

Keeley, J., Zayac, R., & Correia, C. (2008). Curvilinear relationships between statistics anxiety and performance among undergraduate students: evidence for optimal anxiety. Statistics Education Research Journal, 7(1), 4 – 15.

Khavenson, T., Orel, E., & Tryakshina, M. (2012). Adaptation of survey of attitude towards statistics (SATS 36) for Russian sample. Procedia - Social and Behavioral Science, 46, 2126 – 2129.

Maat, S., Zakaria, E., & Rosli, R. (2016). Descriptive study on students' anxiety towards statistics. Indian Journal of Science and Technology, 9(48), 1- 6.

Macher, D., Paechter, M., Papousek, I., & Ruggeri, K. (2012). Statistics anxiety, trait anxiety, learning behavior, and academic performance. European Journal of Psychology of Education, 27(4), 483–498.

Nolan, M., Beran, T., & Hecker, K. (2012). Surveys assessing students' attitudes toward statistics: a systematic review of validity and reliability. Statistical Education Research Journal, 11(2), 103 – 123.

Onwuegbuzie, A. & Seaman, M. (1995). The effect of time constraints and statistics test anxiety on test performance in a statistics course. Journal of Experimental Education, 63(2), 115-124.

Schau, C., Stevens, J., Dauphinee, T., & Del Vecchio, A. (1995). The development and validation of the Survey of Antitudes toward Statistics. Educational and Psychological Measurement, 55, 868-875.

Schau, C. (2003). Statistics meetings, San Francisco. [Online: http://evaluationandstatistics.com].

Schou, S. (2006). A study of student attitudes and performance in an online introductory business statistics class. Electronic Journal for the Integration of Technology in Education, 6, 71 – 78.

Vanhoof, S., Kuppens, S., Sotos, A., 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.

Warren, L. & Holloman, H. (2005). On-line Instruction: Are the Outcomes the Same? Journal of Instructional Psychology, 32(2).

Williams, A. (2010). Statistics Anxiety and Instructor Immediacy. Journal of Statistics Education, 18(2), retrieved from http://www.amstat.org/publications/jse/v18n2/williams.pdf .

Zanakis, S. & Valenzi, E. (1997). Student Anxiety and Attitudes in Business Statistics. Journal of Education for Business, 73(1), 10 - 16.

Zare, H., Rastegar, A., & Hosseini, S. (2011). The relation among achievement goals and academic achievement in statistics: the mediating role of statistics anxiety and statistics self-efficacy. Procedia - Social and Behavioral Sciences, 30, 1166–1172.