WHEN DO STUDENTS' ATTITUDES CHANGE? INVESTIGATING STUDENT ATTITUDES AT MIDTERM

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ABSTRACT

Statistics educators have been investigating how students' attitudes change in the introductory statistics course for many years. Typically, an overall decrease in mean attitudes over the course has been noted. However, when and how do students' attitudes change during the term? Do they steadily decrease or is there a point when students' attitudes might actually be increasing? If so, can instructors use this to their advantage? This research introduced a mid-semester survey of attitudes. We found that students' attitudes are not necessarily strictly declining from the beginning to the end of the semester. We also found it might be advantageous to follow individual student attitude trends throughout the semester instead of just looking at aggregate mean scores for the different surveys.

Keywords: *Statistics education research; Survey of Students' Attitudes Towards Statistics (SATS-36)*

1. INTRODUCTION

Ramirez, Schau, and Emmioğlu (2012) identify that as most students only take one statistics course in their undergraduate career that educators may only have one chance to motivate students to learn the statistical skills they will need in their professional and personal lives. Therefore, students' attitudes are an important piece to a successful introductory statistics experience. A lot of research has been conducted that examine students' attitudes in the undergraduate introductory statistics course (e.g., Bond, Perkins, & Ramirez, 2012; Evans, 2007; Schau & Emmioğlu, 2012). Most of the research conducted has found that students' attitudes in many areas tend to decrease from the beginning to the end of the semester. However, we wondered whether this decrease was strictly linear, or if there was a point of increase during the semester. Discussion at a Statistics Education session of the Join Statistical Meetings (JSM) in 2013 indicated that this indeed was a gap in the current literature. This question is of interest because if there is a point that attitudes are on the rise, instructors may be able to use this to their advantage in their teaching in order to try and maintain this increase in attitudes. This paper looks at how students' attitudes change not only from pre- to post-test, but also by considering a mid-semester test as well.

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2. LITERATURE REVIEW

2.1. BACKGROUND ON SURVEY OF ATTITUDES TOWARDS STATISTICS

The Survey of Attitudes Towards Statistics (SATS) (Schau, 2003) has been widely used as a tool for assessing students' attitudes in an introductory statistics course. There are two versions of the SATS, 28 and 36, which is attributed to the number of questions on the survey, in addition to how many components are being measured. The instrument consists of a set of Likert scale questions where 1 = "strongly disagree" and 7 = "strongly agree." As some of the questions are positively worded and some are negatively worded, the negatively worded questions are reverse coded before scoring. The SATS-36 has questions which target the following six areas:

- Affect – a measure of students' positive and negative feelings concerning statistics
- Cognitive Competence – a measure of students' attitudes about their intellectual knowledge and skills when applied to statistics
- Value – a measure of students' attitudes about the usefulness, relevance, and worth of statistics in their personal and professional life
- Difficulty – a measure of students' attitudes about the difficulty of statistics as a subject
- Interest – a measure of students' level of individual interest in statistics
- Effort – a measure of the amount of work the student expends to learn statistics

Historically, the SATS-36 has been given as a pre- and post-assessment at the beginning and end of the semester. These two assessments both include 36 questions that are used to measure students' attitudes but differ in the verb tense used, such as "I plan to…" vs "I tried to…" on some of the questions. Schau and Emmioğlu reported the following SATS results in their 2012 paper (p. 91).

Table 1. Student-based means and standard deviations for pretest, posttest, and change scores by attitude component (Reprinted with permission of the authors.)

Component		Pretest		Posttest		Change	
	n	Mean	*SD*	Mean	*SD*	Mean	*SD*
Affect	2209	4.16	1.12	4.30	1.32	0.13	1.23
Cognitive Competence	2192	4.94	1.04	5.03	1.16	0.10	1.06
Value	2186	5.04	0.99	4.72	1.12	-0.32	0.96
Difficulty	2204	3.75	0.81	3.90	0.96	0.15	0.84
Interest	2219	4.51	1.27	4.00	1.44	-0.50	1.25
Effort	2246	6.32	0.90	5.84	1.09	-0.48	1.14

Schau and Emmioğlu also indicate that a difference of ½ point or more is considered to be an important finding. As can be seen in Table 1, the Interest component has a negative change of ½ point from beginning to the end of the semester. Additionally, Effort and Value also have "large" negative differences.

2.2. RESEARCH ON STUDENT ATTITUDES

As the SATS has been evaluated for validity and reliability multiple times and has generally performed consistently well in these evaluations, the SATS has been widely utilized for assessing student attitudes in statistics in multiple ways. Some of the examples of how SATS has been used in the literature are presented below.

Research on attitudes for given populations The primary audience that the SATS has been used with in the literature is the algebra-based introductory statistics course. Schau and Emmioğlu (2012) investigated whether the introductory statistics course in the United States improved the students' attitudes towards statistics. After looking at over 2000 students' SATS results, they found that, overall, generally students' attitudes stayed about the same (Affect, Cognitive Competence, Difficulty) or decreased (Value, Interest, Effort). In our study, we comment on the variability amongst the data and recommend more investigation with more complete data (about instructors and institutions) as well as more work involving what is at the root of the students' attitudes. We highlight three examples below.

Evans (2007) looked into the relationships between students' attitudes, their conceptions, and their achievement in the course. They found a significant correlation between attitude and achievement (both at the beginning and end of the course) as well as a lower, yet significant, correlation between attitudes and conceptions.

Leavy, Hannigan, and Fitzmaurice (2013) investigated why future secondary mathematics teachers' find statistics difficult. More specifically, they investigated their attitudes using the SATS post-test in addition to CAOS (Comprehensive Assessment of Outcomes in a First Statistics Course) which was developed by delMas, Garfield, Ooms, and Chance (2007). We were most interested in why the participants found statistics difficult. As their population of students generally took the calculus-based statistics course (which is really Probability and Statistics at most universities), one of the major reasons behind the difficulty was related to the probability component instead of the statistics component. Another key factor in students' difficulty was that the topics were a different way of thinking than mathematics.

Griffith et al. (2012) investigated the attitudes across different disciplines (business, criminal justice, and psychology). Although the researchers found that business students were more likely to have positive attitudes, the researchers did not use the SATS nor did they do a pre- and post-test to measure how the attitudes changed.

Research on a modification in curriculum or delivery method Another area where the SATS is often used is to help measure the impact of students' attitudes due to a change in curriculum or delivery method. Gundlach, Richards, Nelson, and Levesque-Bristol (2015) compared attitudes in statistics courses across different delivery methods including web-augmented traditional, fully-online, and flipped classrooms. Their study found similar results discussed in Section 2.1; however, they did find that students in the traditional class had a larger positive change (or a smaller negative change) than the online or flipped classrooms. DeVaney (2010) investigated anxiety and attitudes about statistics for students of a graduate-level educational statistics course. More specifically, the researcher compared attitudes of online versus on-campus students. They found that online students had higher levels of anxiety and generally more negative attitudes toward statistics. Whereas these two papers looked at delivery methods, another looked at change in attitudes (using SATS) based on an active learning workbook approach (Carlson & Winquist, 2011). The researchers found that although the students using the active learning workbook found the class more difficult than their comparison group, they liked statistics more and had more positive changes in Affect and Cognitive Competence.

Research on timing of SATS More recently, some research has been conducted on the timing of the SATS administration. Posner (2014) investigated the timing of the administration of the pre-test for SATS. More specifically, he questioned the importance of the first day of class on the results of the SATS. In his randomized experiment, some

students took the pre-test before the first day of class while others took it after the first day of class. He did find that those who took it after the first day generally had better attitudes than those that took it before the first day.

On the other end of the spectrum, Millar and White (2014) investigated whether the post-test was really a good measure of the students' attitudes towards statistics if it is given at the end of the course when they are under a much higher stress load (due to finals, projects, etc.). They collected data to measure how students' post-test SATS scores changed from the end of the first statistics class to the beginning of the second statistics class. Although they found only one significant mean change from December to January (in Effort), they also discovered the importance of absolute mean gain (for example, mean gain in Affect was 0.04, but absolute mean gain was 0.66). This is important because with the way the current analysis is done, a negative change in a component score by one student cancels out a positive change in the same component by another student, whereas an absolute mean gain would measure whether the attitudes were changing at all.

Posner's research on the timing of the pre-test (showing just what the first day impact can be on students' attitudes) and Millar and White's research on the concern of the post-test during a stressful time led to our research questions:

1. When do students attitudes change during the semester?
2. How do individual student attitudes change (rather than focusing only on the mean change in the class)?

3. RESEARCH METHODOLOGY

3.1. PARTICIPANTS

Students at the authors' academic institutions took part in this research. These institutions are both primarily four-year undergraduate institutions (with few graduate programs) with somewhat similar enrollments. However, one campus is more of a residential campus whereas the other serves a larger commuter student population. Each course in which this research was implemented was an algebra-based introductory statistics course with primarily traditional inference methods, such as *t*-tests.

3.2. RESEARCH INSTRUMENT

The Survey of Attitudes Towards Statistics (SATS) was the instrument used in this study, and the background on this instrument was given in Section 2.1. For all analyses conducted, the SATS-36 version was used so all references to SATS will refer to this version. Before any analyses were conducted, tests were done on the pre-test mean scores to see whether the students' attitudes from the two schools were significantly different from one another entering the course. These results were not statistically significant, so the data was collapsed across school and analyzed in this format.

3.3. DATA COLLECTION

Data collection took place from Spring 2013–Spring 2015 (excluding summer terms; only full-length semesters were included). Although the two academic institutions differed in the ordering of the statistical content covered—One school introduced inference from the onset of the course, with some randomization-based methods, whereas the other school introduced inference about a third of the way through the course (which was before the

mid-assessment)—all of the SATS tests were given at similar times in the semester and at each of these administrations, each school had covered similar topics.

Students completed the pre-SATS test within the first week of the course, after the first day. At the midpoint of the semester, as well as during the last week of the course, the post-SATS was given. Demographic information was collected only during the pre-SATS administration.

Instruments were then scored according to the standard SATS ratings. Each student receives an average rating for each of the six components for each of the three SATS administrations. Only students who took all three (pre-, mid-, post-) were included in the results due to the goal of the SATS being to compare how student attitudes change. This resulted in about 25% of the students being excluded (some of who had withdrawn from the course as well).

All of the survey completions were counted as low-stakes assignments for the course (to increase completion rate) but all students filled out a consent form that either allowed or refused to allow their data for research purposes. Only those students who provided consent are included in the results summarized from this study. In addition, all surveys were taken via an online survey program outside of class (as to not interrupt class time, as well as to get the most honest results)

3.4. ANALYSIS METHODS

We investigated means and standard deviations for each component, in order to compare to previous SATS reports, as well as how the scores were changing over time—are the scores consistently decreasing throughout the semester or at some point are students' scores increasing, before ultimately decreasing overall? The differences of more than ½ point for the first half of the semester (Mid – Pre) and the second half of the semester (Post – Mid) were compared.

A repeated measures analysis was conducted to determine whether there was a significant time effect—that is, does time have an effect on the scores recorded. An ANOVA was run for each of the six SATS components separately using the software package JMP® Pro 12.2 (SAS Institute, Inc., 2015) to run the analyses.

3.5. COMPARISON TO HISTORICAL SATS

The means (and standard deviations) for each component in our study are summarized in Table 2. Looking at how the pretest and posttest results compared to the historical SATS data (Table 1), the only substantial difference is in the Effort component. The students involved in this study consistently believed they would and did put more effort into the course. Looking solely at the means, Affect, Value, and Interest all appeared to make their big change during the first half of the course and stayed relatively stable during the second half of the course. Affect had a positive change during the first half whereas Value and Interest had negative changes (just like the historical SATS data). Cognitive Competence and Difficulty had positive changes during both the first half and the second half of the course. This means that students (on average) began to be more confident in their abilities and thus, found the class easier as the course progressed. The final component, Effort, had negative changes during both the first half and second half of the course.

Table 2. SATS results

Component	Pretest		Midtest		Posttest	
	Mean	*SD*	Mean	*SD*	Mean	*SD*
Affect	4.15	1.09	4.39	1.23	4.37	1.16
Cognitive Competence	4.79	1.00	4.95	1.05	5.14	1.04
Value	4.90	0.99	4.66	0.98	4.75	1.04
Difficulty	3.78	0.90	3.93	0.97	4.09	1.03
Interest	4.57	1.19	4.06	1.32	4.11	1.32
Effort	6.61	0.67	6.39	0.76	6.26	0.94

3.6. REPEATED MEASURES ANALYSIS

All the assumptions for the repeated measures analyses were satisfied. Table 3 summarizes the results of the analysis.

Table 3. Repeated measures results

	Overall		Multiple Comparisons		
Component	*F* Ratio	*p*-value	Pre-Mid *p*-value	Pre-Post *p*-value	Mid-Post *p*-value
Affect	3.8068	0.0226	0.0355	0.0580	0.9799
Cog Comp	8.4083	0.0002*	0.1736	0.0001**	0.0563
Value	5.6507	0.0036*	0.0103**	0.0103**	1.0000
Difficulty	7.7120	0.0005*	0.1416	0.0003**	0.1046
Interest	13.8379	< 0.0001*	< 0.0001**	< 0.0001**	0.8668
Effort	14.4392	< 0.0001*	0.0032**	< 0.0001**	0.0984

* denotes significance at the Bonferroni adjusted alpha level of 0.008.
** denotes significance at the Bonferroni adjusted alpha level of 0.0167.

The repeated measures analysis found, after a Bonferroni adjustment, that the Cognitive Competence (*p*-value = 0.0002), Difficulty (*p*-value = 0.0005), Effort (*p*-value < 0.0001), Interest (*p*-value < 0.0001), and Value (*p*-value = 0.00363) components had a significant time effect on the mean score. After further investigation, it was found that the mean post and pre-scores were significantly different for the Cognitive Competence and Difficulty components, but neither was significantly different from the mid scores. Whereas for the Effort, Interest, and Value components, the mean pre-scores were significantly different from both the mean mid and post scores, but mid and post were not significantly different. Therefore, it appears that something is happening in the first half of the semester to impact students' (mean) attitudes in the introductory course.

3.7. DESCRIPTIVE ANALYSIS OF INDIVIDUALS

We were also interested in looking at how individual students' attitudes changed across the semester for the different components. We specifically wanted to focus on the Affect, Value, and Interest components due to the fact that these are the areas where the teacher can have the most impact. The results provided in the tables below (Tables 4–6) look at the direction of change for a student during a given half of the semester. In order to classify students into different direction of change categories, we were first interested in determining what a "large" change would be. We decided to use ½ point change in the student's mean score, which is also roughly half a standard deviation. Thus, a "Decrease"

is classified as the student's mean component score decreasing at least ½ point (either from pre to mid or from mid to post), and an "Increase" is classified as the student's mean component score increasing by at least ½ point, and a "None" would be for students whose change did not fall into the "Decrease" or "Increase" categories.

Table 4 summarizes the Affect component for the three SATS administrations. It can be seen that a total of 61.99% (181/292) of the students had some type of positive change (i.e., one or two increases (↑) in Affect score, possibly accompanied by a negative change) during the semester, whereas a total of 50.34% (147/292) had some type of negative change (i.e., one or two decreases (↓) in Affect score, possibly accompanied by a positive change). Of the group of students with some type of positive change, 16.02% (29/181, referencing the ↓↑ cell) of them had a negative change during the first half of the course followed by a positive change in the second half, and 26.52% (48/181, referencing the ↑↓ cell) of them followed a positive change in the first half with a negative change during the second half of the course. Overall, during the course of the semester 44.52% (230/292) had a positive change in Affect during the first half of the course (↑+) and only 26.03% had a positive change in Affect during the second half of the course (+↑). Only 14.04% (41/292) of the students showed no change (··) in Affect at all during the semester. A total of 77 (48+29) or 26.37% were flip-floppers during the semester (↑↓ or ↓↑).

Table 4. SATS Affect results

		Post – Mid			
Direction of Change		Decrease ↓	None ·	Increase ↑	Total
Mid – Pre	Decrease ↓	13 (↓↓) (4.45%)	29 (↓·) (9.93%)	29 (↓↑) (9.93%)	71 (↓+) (24.32%)
	None ·	28 (·↓) (9.59%)	41 (··) (14.04%)	22 (·↑) (7.53%)	91 (·+) (31.16%)
	Increase ↑	48 (↑↓) (16.44%)	57 (↑·) (19.52%)	25 (↑↑) (8.56%)	130 (↑+) (44.52%)
	Total	89 (+↓) (30.48%)	127 (+·) (43.49%)	76 (+↑) (26.03%)	292 (100%)

The Value component is summarized in Table 5. It can be seen that about half of the students (45.89%, 55.82%) had no change in Value during one half of the semester (+· or ·+), while 28.42% had no change in Value for the duration of the course. Here, 35.96% of students had a negative change in Value during the first half of the semester (↓+) compared

Table 5. SATS Value results

		Post – Mid			
Direction of Change		Decrease ↓	None ·	Increase ↑	Total
Mid – Pre	Decrease ↓	16 (↓↓) (5.48%)	49 (↓·) (16.78%)	40 (↓↑) (13.70%)	105 (↓+) (35.96%)
	None ·	20 (·↓) (6.85%)	83 (··) (28.42%)	31 (·↑) (10.62%)	134 (·+) (45.89%)
	Increase ↑	17 (↑↓) (5.82%)	31 (↑·) (10.62%)	5 (↑↑) (1.71%)	53 (↑+) (18.15%)
	Total	53 (+↓) (18.15%)	163 (+·) (55.82%)	76 (+↑) (26.03%)	292 (100%)

to only 18.15% during the second half of the semester (+↓). In the Value category, 42.47% (124/292) had some type of positive change (at least one ↑) during the semester, much less than compared to the Affect category.

Finally, the Interest component is summarized in Table 6. It can be seen that about half of the students (50.68%) had a negative change in Interest during the first half of the semester (↓+), whereas only 18.49% had a positive change (↑+) over this same period. During the second half of the semester, students were relatively split equally among all three categories of negative change (31.16% +↓), no change (37.33% +·), and positive change (31.51% (+↑), Goodness of Fit p-value = 0.3495). Interest also shows us our largest group of flip-floppers (one positive change, one negative change) of 31.16% (9.59% ↑↓ or 21.58% ↓↑).

Table 6. SATS Interest results

		Post – Mid			
Direction of Change		Decrease ↓	None ·	Increase ↑	Total
Mid – Pre	Decrease ↓	37 (↓↓) (12.67%)	48 (↓·) (16.44%)	63 (↓↑) (21.58%)	148 (↓+) (50.68%)
	None ·	26 (·↓) (8.90%)	45 (··) (15.41%)	19 (·↑) (6.51%)	90 (·+) (30.82%)
	Increase ↑	28 (↑↓) (9.59%)	16 (↑·) (5.48%)	10 (↑↑) (3.42%)	54 (↑+) (18.49%)
	Total	91 (+↓) (31.16%)	109 (+·) (37.33%)	92 (+↑) (31.51%)	292 (100%)

4. DISCUSSION

The overall mean results (Table 2) show a similar story with respect to mean pre-test and post-test scores as shown from the historical SATS data (Section 2.1). In addition to the information from this table and taking into account the mid-semester test, it would be believed that for the components of Affect, Value, and Interest, the changes in attitudes are occurring only during the first half of the semester (both Value and Interest were significant at the 0.0083 (0.05/6) level, whereas Affect was only marginally significant at the same level (p-value = 0.0226)). Oddly though, their change in the Affect (their positive and negative feelings toward statistics) attitude component improves, whereas at the same time that their Value and Interest attitude components worsen. However, when we investigate the individual students' change (instead of just looking at the mean change), the results show a slightly different story. The means, as well as the repeated measures analysis, would lead us to believe that there is not much change in these three components during the second-half of the semester, and thus, the results in Tables 4–6 should then have the students having no change ("None") for the Post-Mid scores. As we can see from these tables, this is definitely not the case; more specifically, only about 43% (Affect), 56% (Value), and 37% (Interest) of students' attitudes did not change during the second half of the course.

When it comes to the Affect component, the data show (individually as well as (marginally) with means) that the greatest positive impact is coming in the first half of the semester. However, at the same time, the largest change for Affect (Table 4) is in the increase/decrease cell. This shows that although there is a strong positive impact during the first half of the semester, there is something happening still (not necessarily good!) in the second half of the semester.

Now looking at the Value component, the data show that the first half of the semester (with respect to the mean change) is decreasing for students and then staying sort of steady during the second half of the semester. When looking more closely at the individual student results, there is still a large percentage of students (44%) having their attitudes of value change during the second half of the course. Thus, these changes during the second half seem to counter-balance each other out showing little (non-significant) mean change.

Finally looking at the Interest component, the means show a similar story as Value (decreasing the first half and staying relatively steady during the second half). Individually, a bit more than half of the students had a negative change during the first half of the course.

As can be seen from the analysis conducted, these results are similar to previous findings when investigating mean pre-test and post-test scores (an overall decrease in attitudes during the semester). However, when the mid-test was taken into account, there does seem to be a slightly different story when looking at the mean attitude scores. It appears that the overall change in mean attitudes is mostly occurring during the first half of the course. Additionally, when looking at attitudes at the student level there seems to be a large percentage of students whose attitudes do change during the second half of the course; however, most of the time this is not a favorable change. Therefore, it looks like that for how the course is currently taught, the best chance instructors have to favorably change students' attitudes is during the first half of the course. However, this means that there is room for improvement during the second half of the course and further investigation into why this pattern is happening should be conducted.

5. CONCLUSIONS

5.1. LIMITATIONS

Through the analyzing of this data, it must be noted that the timing of the administrations of the SATS is an important limitation to the study. We only gave the mid-test at the true middle of the semester. Whether or not similar patterns would occur if the mid-test was given at a slightly different time (e.g., a third of the way through the course) is unknown.

In addition, what specifically was the reason for the student's change in attitudes is unknown. Knowing what topic, activity, experience, and so forth, lead to the student's change in attitude would be useful to know.

5.2. IMPLICATIONS

Statistics educators are constantly changing how they teach certain content and are trying to inspire their students throughout the course. The results from this study suggest that students' attitudes are not only affected by the first day of class (Posner, 2014), they are fluid, as very few students' attitudes did not change during the semester. More specifically, their attitudes do not only have the ability to go down, but can go up as well throughout the semester. However, how students' attitudes change during the semester is not a consistent pattern, and thus depends upon the students themselves. This result is encouraging, as previous research has made it seem that attitudes in the areas statistics educators primarily try to change (Affect, Value, and Interest) tend to go down. Now it is known that each student may have his/her own window of opportunity and thus, the teacher needs to try to find it.

5.3. SUGGESTIONS FOR FUTURE RESEARCH

Future research on this topic would benefit from greater use of data collection at different timings of the mid-test as well as the inclusion of free response questions that prodded at what aspects going on inside (or outside) the classroom may have been the reason for the change in attitude. In addition, the research found that looking at just the mean change of a course can mask a lot of the movement of individual student's attitudes, which is similar to what Millar and White (2014) mentioned. It is suggested that future research include more individual student attitude results instead. More specifically, from the results in Tables 4-6, it would also be of future interest to look at the combination of the three components (Affect, Interest, Value) together – what are the conditions for having students' attitudes in Affect (positive/negative feelings toward statistics) improve while the Value and Interest components go down during the same part of the semester?

REFERENCES

Bond, M., Perkins, S., & Ramierez, C. (2012). Students' perceptions of statistics: An exploration of attitudes, conceptualizations, and content knowledge of statistics. *Statistics Education Research Journal*, *11*(2), 6–25.
[Online: https://www.stat.auckland.ac.nz/~iase/serj/SERJ11%282%29_Bond.pdf]

Carlson, K., & Winquist, J. (2011). Evaluating an active learning approach to teaching introductory statistics: A classroom workbook approach. *Journal of Statistics Education*, *19*(1), 1–23.
[Online: http://www.amstat.org/publications/jse/v19n1/carlson.pdf]

delMas, R., Garfield, J., Ooms, A., & Chance, B. (2007). Assessing students' conceptual understanding after a first course in statistics. *Statistics Education Research Journal*, *6*(2), 28–58.
[Online: https://www.stat.auckland.ac.nz/~iase/serj/SERJ6%282%29_delMas.pdf]

DeVaney, T. (2010). Anxiety and attitude of graduate students in on-campus vs. online statistics courses. *Journal of Statistics Education*, *18*(1), 1–15.
[Online: http://www.amstat.org/publications/jse/v18n1/devaney.pdf]

Evans, B. (2007). Student attitudes, conceptions, and achievement in introductory undergraduate college statistics. *The Mathematics Educator, 17*(2), 24–30.
[Online: http://math.coe.uga.edu/tme/issues/v17n2/v17n2_Evans.pdf]

Griffith, J., Adams, L., Gu, L., Hart, C., & Nichols-Whitehead, P. (2012). Students' attitudes toward statistics across the disciplines: A mixed-methods approach. *Statistics Education Research Journal*, *11*(2), 45–56.
[Online: http://iase-web.org/documents/SERJ/SERJ11(2)_Griffith.pdf]

Gundlach, E., Richards, K., Nelson, D., & Levesque-Bristol, C. (2015). A comparison of student attitudes, statistical reasoning, performance, and perceptions for web-augmented traditional, fully online, and flipped sections of a statistical literacy class. *Journal of Statistics Education*, *23*(1), 1–33.
[Online: http://www.amstat.org/publications/jse/v23n1/gundlach.pdf]

JMP® Pro, Version 12.2. SAS Institute Inc., Cary, NC, 1989-2015.

Leavy, A., Hannigan, A., & Fitzmaurice, O. (2013). If you're doubting yourself then, what's the fun in that? An exploration of why prospective secondary mathematics teachers perceive statistics as difficult. *Journal of Statistics Education*, *21*(3), 1–26.
[Online: http://www.amstat.org/publications/jse/v21n3/leavy.pdf]

Millar, A., & White, B. (2014). How do attitudes change from one stats course to the next? In K. Makar, B. de Sousa, & R. Gould (Eds.), *Sustainability in Education. Proceedings*

of the Ninth International Conference on Teaching Statistics (ICOTS9, July 2014), Flagstaff, AZ, USA. Voorburg, The Netherlands: International Statistics Institute. [Online: http://iase-web.org/icots/9/proceedings/pdfs/ICOTS9_1F2_MILLAR.pdf]

Posner, M. (2014). A fallacy in student attitudes research: the impact of the first class. In K. Makar, B. de Sousa, & R. Gould (Eds.), *Sustainability in Education. Proceedings of the Ninth International Conference on Teaching Statistics (ICOTS9, July 2014)*, Flagstaff, AZ, USA. Voorburg, The Netherlands: International Statistics Institute. [Online: http://icots.info/9/proceedings/pdfs/ICOTS9_1F3_POSNER.pdf]

Ramirez, C., Schau, C., & Emmioğlu, E. (2012). The importance of attitudes in statistics education. *Statistics Education Research Journal*, *11*(2), 57–71. [Online: http://iase-web.org/documents/SERJ/SERJ11(2)_Ramirez.pdf]

Schau, C. (1992). *Survey of Attitudes Towards Statistics* (SATS-28). [Online: http://www.evaluationandstatistics.com]

Schau, C. (2003). *Survey of Attitudes Towards Statistics* (SATS-36). [Online: http://www.evaluationandstatistics.com]

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

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