A COMPARISON OF ATTITUDES BETWEEN TRADITIONAL AND HANDS-ON CLASSES IN AN INTRODUCTORY STATISTICS COURSE

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In this paper we present a comparison study of students' attitudes toward statistics. We administered attitude surveys to three sections of an introductory statistics course. Two of these sections were small classes, taught by a "traditional" lecture based format. The third section was a large class, taught using a "hands-on" active-learning approach. The surveys collected responses on factors such as Learning Styles, Affect, Cognitive Competence, Value and Difficulty. The survey responses were used to compare students' attitude towards statistics between the two class formats.

INTRODUCTION:

Statistics is one of the few required courses taken by students from a wide spectrum of majors. In fact it is hard to imagine any discipline that does not require some level of statistics. However many students lack enthusiasm for statistics and perceive it as an obstacle to be overcome for a career in medicine, business, education, engineering, etc. As such, a large number of students lack competency in understanding and applying statistical concepts to solve real world problems. We mention here two factors that have been identified for low performance in statistics: negative attitude and pedagogical approaches.

It has been shown that students' performance in statistics is related to cognitive and demographic factors such as gender, prior knowledge, mathematical ability and spatial ability (Chiesi, F & Primi, 2010, Elmore & Vasu, 1986). Affective and attitudinal factors can also have impact on students' performance in statistics (Mills, 2004). There is evidence that there is a two sided relation between attitude towards statistics and performance. On one side, there are studies that show direct relation between attitudes toward statistics and the development of statistical thinking skills, the ability to apply statistics outside of the classroom, enrollment and persistence in statistics related courses and achievement (e.g. Gal, Ginsburg, & Schau, 1997). On the other side, negative attitudes toward statistics have been linked to poor performance in class (e.g. Waters, Martelli, Zakrajsek, & Popovich, 1988). Hence, creating a positive attitude towards statistics and reducing the fear of statistics by promoting the value of statistics in the classroom can be the first step instructors should take to help students in statistics courses (Garfield & Ben-Zvi, 2007). Even though research shows that positive attitude helps students' performance, the question of which factors influence students' attitudes towards statistics the most is not fully understood. Students' experience with statistics prior to college, their perception of what statistics means based on their out of school lives, their belief that statistics is mathematics, and even their disciplinary major can have influence on their attitude towards statistics. Our goal in this paper is to study the effect of pedagogical approach used in the classroom on students' attitude towards statistics. Research shows that pedagogical approaches that engage students in the learning process have positive impact on students' understanding of statistical concepts (GAISE, http://www.amstat.org/education/gaise/). In this regard, we present a comparison of attitudes between students taught by a traditional lecture format method and those taught by a hands-on active learning approach. We administered a survey similar to the *Survey of Attitudes Toward Statistics (SATS) (*SATS-28; Schau, 1992) to collect students' responses on attitudes towards statistics.

BACKGROUND

This study was conducted on three sections of an introductory statistics class (STA 282) at Central Michigan University. The students enrolled in this class, by far, major in the social sciences and take the course to fulfill a quantitative course requirement for graduation. Two sections of this

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course (about 45 students in each section) were taught by a traditional lecture format approach, while one large section (about 80 students) was taught by a hands-on active learning approach. The students from the active learning approach were engaged in data production and analysis through various in-class activities. In all classes surveys were administered to measure students' attitudes towards statistics based on factors such as *learning styles, affect, cognitive competence, value* and *difficulty*. Table 1 gives demographic information collected from the surveys.

Table 1: Demographic information of student respondents from the two classes

	Female	Male	Freshman	Sophomore	Junior	Senior	Graduate
Traditional	31	53	27	28	24	4	1
	(36.9%)	(63.1%)	(32.1%)	(33.3%)	(28.6%)	(4.8%)	(1.2%)
Hands-On	29	38	34	23	8	1	1
	(43.3%)	(56.7%)	(50.7%)	(34.3%)	(12%)	(1.5%)	(1.5%)

Note that 84 of the traditional class and 67 of the hands-on class responses were recorded. It is worth mentioning that in addition to different class formats, students' class standing may have some impact on the responses to the survey questions.

COMPARISON OF SOME ATTITUDE SURVEY QUESTIONS

In this section we present a comparison of students' responses to selected survey questions listed in Table 2. Students' responses were recorded on a scale of 1 to 5 (1 = Strongly Agree, 2= Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly Disagree). The survey data are transformed into three categories: "Strongly Agree and Agree", "Neutral" and "Strongly Disagree and Disagree". This is done to prevent small cell frequency (< 5) occurring for the Chi-square test. A Chi-square test is conducted to compare the results between Traditional class and Hands-on class. Table 2 reports the percent responses of "Strongly Agree and Agree" along with the p-values of the Chi-square test statistics.

Table 2: Percent responses of "Strongly Agree" or "Agree" for selected survey questions

	T	H	p-value
1. Statistics is too complicated	10.6	14.9	0.435
2. Mathematical formula intimidate me	12.9	29.9	0.03*
3. Statistics, like math, has lots of formulae	50.6	37.8	0.105
4. This statistics course is useful for solving real world problems	74.1	69.7	0.002**
5. I believe I can learn statistics	78.8	81.9	0.862
6. Statistics is worthwhile part of my study	51.8	52.2	0.571
7. Statistics deals with concepts different from math	54.8	69.7	0.05*

There are some interesting results one can read from Table 2. No significant difference was found between the percentages of students that value statistics (Question 6) and its level of difficulty (Question 1). The significant difference between the percentages of students who are intimidated by mathematical formulae (Question 2) can be explained by the fact that students in the Hands-on class had more experience working on conceptual problems. Emphasis was made on interpretation of statistical results and drawing conclusions. Computer software was used to generate results, and students had little or no experience working directly with mathematical formulae. The highly significant difference observed in question 4 is surprising. Even though students in the Hands-on class worked primarily on conceptual, application oriented problems, the percentage of these students that see the use of statistics to solve real world problems is significantly smaller than those in the Traditional class. One possible explanation for this is due to a big difference in percentage of "Neutral" responses between the two class formats (not reported). It is worth revisiting this issue in the future to find out that this has not happened by chance. The results to question 3 and 7 are interesting. While the difference between the percentages of students

who think statistics, like math, has many formulae is not significant, significantly more students from the Hands-on class view statistics to have concepts that are different than math .

PRELIMINARY COMPARISON OF THREE TYPES OF FACTORS BETWEEN TRADITIONAL AND HANDS-ON CLASSES

In this section, we present, for each class, results from three types of questions: learning styles, affects and motivations, and opinion and belief. We choose to use the t-test, instead of Chi-square test for the reason that the cell frequencies are often smaller than 5, which makes the Chi-square test results less valid.

Table 3: Learning Style: Traditional (T, N = 82) versus Hands-On (H, N = 67) Class

Question	Mean (T)	Std. dev (T)	Mean (H)	Std dev (H)	p-value
Learn better with step by step instruction	1.62	0.748	1.40	0.524	0.0438*
Learn better in cooperative group work	2.60	1.041	2.51	0.927	0.5823
Learn better with lots of quizzes	2.40	0.873	2.97	0.984	0.0003**
Learn better with real world projects	2.85	0.877	2.97	1.044	0.447
Learn better with lots of homework	2.62	1.050	2.57	0.908	0.759

Students from both classes have no significant difference in terms of learning through cooperative work, real world projects and lots of homework. Significantly more students from the Traditional class benefit from step by step instruction, and significantly more of these students view taking lots of quizzes help them learn the material better. Since the Hands-on class did not have in-class quizzes on a regular basis, it is not surprising to see a significantly lower number of these students report “quiz taking” as beneficial to their learning.

Table 4: Affects and Motivations: Traditional (T, N = 84) versus Hands-On (H, N = 65) Class

Question	Mean (T)	Std. dev (T)	Mean (H)	Std dev (H)	p-value
Statistics is too complicated	3.71	0.844	3.57	0.935	0.3397
Statistics is worthwhile part of my field of study	2.65	0.885	2.65	0.991	1.0
Like to take more statistics course	3.60	0.920	3.85	0.972	0.11
Statistics, like mathematics, is with lots of formulae	2.65	0.857	2.91	0.964	0.0842
Statistics is computationally intensive	2.70	0.724	2.63	0.821	0.5818
Statistics is different from mathematics.	2.68	0.971	2.45	0.884	0.1382

No significant difference between the Traditional and Hands-on class formats was found in terms of Affects and Motivations.

Table 5: Opinions and Belief: Traditional (T, N = 84) versus Hands-On (H, N = 66) Class

Question	Mean(T)	Std.dev (T)	Mean (H)	Std dev (H)	p-value
This statistics course requires a lot of memorization	3.05	0.844	2.62	1.019	0.0054**
This statistics course deals only with formulas and few concepts	2.62	0.904	2.36	0.955	0.0902
This statistics course is only useful to people whose careers are science related	3.49	0.925	3.29	1.004	0.2075
This statistics course is difficult.	2.99	1.047	2.52	0.980	0.0057**
This statistics course is useless for me.	3.80	0.833	3.73	1.016	0.6436
I can learn statistics	2.08	0.625	2.05	0.618	0.7697

For questions "This statistics requires a lot of memorization" and "This statistics course is difficult", highly significant differences between the Traditional and Hands-on classes were observed. This difference is not surprising as the Hands-on class put more emphasis on conceptual understanding, and less on correctly applying mathematical formulae. Students used on regular basis computer software and necessary formulae were provided to the students for tests and quizzes. The need to memorize and use mathematical formulae in the Traditional class may have impact on students' perception of "Statistics is difficult".

CONCLUSION

A comparison of students' attitudes towards statistics based on two class formats (Traditional and Hands-on) is presented. Students from both classes recognize the value of statistics and its importance to both science and non-science majors. Moreover, no significant difference was found between the number of students who think that statistics is too complicated and computationally intensive. It is encouraging to see that this perception did not make a significant difference on students' attitudes on their confidence to learn statistics and their desire to take more advanced statistics classes. While the class formats did not make a significant difference on students' attitude that statistics involves lots of mathematical formulae, a significant difference was found between the two classes when it comes to viewing that statistics as a subject that deals with concepts different from mathematics. Moreover, a significant difference was found between the two class formats on the role of statistics to solving real world problems. As attitude towards statistics is one factor that affects students' persistence in statistics, more work must be done in instructional activities for both class formats to narrow the difference in attitude among students of both class formats.

REFERENCES

Chiesi, F & Primi, C (2010). Cognitive and non-cognitive factors related to students' statistics achievement. *Statistics Education research Journal*, *9*(1), 6–26.

Elmore, P. B., & Vasu, E. S. (1986). A model of statistics achievement using spatial ability, feminist attitudes and mathematics-related variables as predictors. *Educational and Psychological* Measurement, *46*(1), 215–222.

GAISE Report (2005). At http://www.amstat.org/education/gaise/

Gal, I., Ginsburg, L., & Schau, C. (1997). Monitoring attitudes and beliefs in statistics education. In I. Gal & J. B. Garfield (Eds.), *The assessment challenge in statistics education* (pp. 37–51). Amsterdam: IOS Press.

Garfield, J., & Ben–Zvi, D. (2007). How students learn statistics revisited: A current review of research on teaching and learning statistics. *International Statistical Review, 75*(3), 372–396.

Mills, J. D. (2004). Students' attitudes toward statistics: Implications for the future. *College Student Journal*, *38*(3), 349–361.

Schau, C. (1992). *Survey of Attitudes Toward Statistics (SATS-28)*, http://evaluationandstatistics.com

Waters, L. K., Martelli, T. A., Zakrajsek, T., & Popovich, P. M. (1988). Attitudes toward statistics: An evaluation of multiple measures. *Educational and Psychological Measurement, 48*(2), 513–516.