

Prior Knowledge, Sex and Students' Attitude towards Statistics: A Study on Postgraduate Education Students

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Abstract A vast range of studies for undergraduate students showed that, students have different attitudes towards statistics according to their sex and prior knowledge of statistics. In this study, the researcher tried to find out postgraduate students' attitudes towards statistics according to sex and level of prior experience of statistics. Two different groups of students from two different postgraduate degrees were chosen as a sample of the study. SATS-28 tool was used as an instrument. The study reveals that, the attitudes of postgraduate students towards statistics significantly differed by their sex and prior knowledge. The researcher also found a poor association between value and difficulty domain of SATS- 28 in this study. As a recommendation for future study, the research suggested to include more levels in prior experience variable to see in which stage the students actually assimilate their attitude towards statistics.

Keywords: *Prior knowledge, Sex, Students' Attitude, Statistics, Postgraduate students*

Cite This Article: Sumaiya Khanam Chowdhury, "Prior Knowledge, Sex and Students' Attitude towards Statistics: A Study on Postgraduate Education Students." *American Journal of Educational Research*, vol. 6, no. 3 (2018): 270-276. doi: 10.12691/education-6-3-14.

Joseph Stevens, Thomas L, Daphne and Ann Del Vecchio in 1995.

1. Introduction

According to Onwuegbuzie and Wilson (2003), as a need, the application of statistical techniques has increased over the year. So many college students are required to enroll in statistics courses as a necessary part of their degree [1]. But what happens when a student says, "I was terrified when I learned that I would have to take statistics, because I have always had a mental block dealing with mathematical formulas" [2]. Onwuegbuzie [1] said 'The level of statistical anxiety experienced by students can be so great that undertaking statistics classes have come to be regarded by many as extremely negative threat to attain their degrees'. Moreover, this negative attitude can impede learning of statistics, or hinder the extent to which students will develop useful statistical intuitions and apply what they have learned outside the classroom [3]. However, the attitudes towards statistics of students are not always same. Among many variables, mathematics experiences, level of a statistics course, previous statistics experiences, grade point average, and gender are some of the most common variables related to attitude towards statistics [4]. In this study, the researcher tried to find out the impact of "prior knowledge of statistics" and "gender" variables on postgraduate students' attitude towards statistics. Readers will also find a search for correlation within the sub domains of attitudes towards statistics of postgraduate students. For measuring the attitude the researcher used SATS-28 (Survey of Attitude Towards Statistics) which was developed by Canadians Schau,

2. Literature Review

According to Field [5] "Since time immemorial, social science students have despised statistics." The dread of statistics courses has also been reported for social work students and for education and sociology students [5]. Not only by subjects, statistical anxiety or attitudes sometimes tried to be seen by gender. Mills (2004) [6], on his examination of the cross tabulations of the gender variable found that, males were more likely to report that they were not scared of statistics, that they can learn statistics, and they felt confident mastering statistics material. Moreover, women were more likely to agree with the statement "Statistics make me anxious" [7]. Cruise and Wilkins (1980) [8] also related sex with algebra abilities and showed that there is significant difference in result upon gender. However, Cherian & Glencros (1997) [9] revealed that, gender differences were not significantly related to attitude toward statistics in a Bachelor of education students, and no significant evidence were found about the relationship with gender and statistical attitude [10,11,12]. But, again Roberts and Saxe (1982) [13] proclaimed, males did tend to have a higher SAS score, than did females, and in clusters of similar variable, higher SAS score were associated with having had more previous mathematics skills, more previous statistics knowledge and higher grades in present statistical course. About prior knowledge or previous statistical knowledge, research

showed that there was a relationship between STATS end and statistics pre knowledge. The correlation analysis tended to indicate that between the two variables there were a significant positive correlation [1,3,10,13,14]. Moreover, prior statistics and math knowledge tended to be important in helping to understand the concepts of introduction to statistics class [15]. Furthermore, Ismail, Mahmud and Kassim (2008) [16] also revealed same positive correlation with prior knowledge and positive attitudes towards statistics.

2.1. Review of Tool

The Survey of Attitudes Toward Statistics (SATS) was designed for use in both research and instruction [17]. In their survey they states that [18], "Our survey contains 28 items grouped into four components identified through our development process: Affect, Cognitive Competence, Value, and Difficulty. The possible range of scores for each component is between 1 and 7. Using the 7-point response scale, higher scores, then correspond to more positive attitudes". The examples of these four attitudes are [19]:

1. *Affect*: Students' feelings concerning statistics.
2. *Cognitive Competence*: Students' attitudes about their intellectual knowledge and skills when applied to statistics.
3. *Value*: Students' attitudes about the usefulness, relevance, and worth of statistics in personal and professional life.
4. *Difficulty*: Students' attitudes about the difficulty of statistics as a subject.

While developing the SATS-28 all estimated correlations among the four latent variables were also found to be significant. With the exception of the correlation of the Value and Difficulty factor, $r=.085$ [17].

3. Statement of Purpose

In the above literature, some debate could be found about the impact of sex on students' attitudes towards statistics. Moreover, a clear idea also found about the relation of prior knowledge and students' attitudes towards statistics from all above undergraduate studies but not about post graduate students. So in this study, the researcher tried to find out the difference of students' attitude, according to their sex and their prior knowledge of statistics at postgraduate level and also wanted to evaluate whether the exceptional result of correlation (Value and Difficulty factor, $r=.085$) from the study of Schau, et. al 1995 [17] was also working for this study. This study will help the instructors of the postgraduate level to fix their teaching, learning method in statistics subject, and also can help the students to reduce the negative view about statistics.

4. Research Question

The research questions and hypotheses were generated from the above literature. These are:

1. Is there any difference in attitudes towards statistics according to students' sex in postgraduate level?

2. Is there any difference in attitudes towards statistics according to the level of prior knowledge of statistics at postgraduate level?
3. To what extent the Difficulty sub scale is correlated with value sub scale in postgraduate level?

4.1. Hypothesis

Research Hypothesis 1: There is a significant difference in attitudes towards statistics between male and female postgraduate students.

Null Hypothesis: There is no significant difference in attitudes towards statistics between male and female postgraduate students.

Research Hypothesis 2: There is a significant difference in attitudes towards statistics among students according to their prior knowledge of statistics.

Null Hypothesis: There is no significant difference in attitudes towards statistics among students according to their prior knowledge of statistics.

Research Hypothesis 3: A significant correlation will be found in Value and Difficulty factor in this study.

Null Hypothesis: No significant correlation will be found in Value and Difficulty factor in this study.

5. Study Methodology

In this survey study, the data has been collected by the tutor from two different master's programs among several different modules. The data were collected by distributing the questionnaire (the SATS-28 tool with some socio- demographic data) among the students of M.Ed psychology (38.7%) and Msc. Educational Research (12.7%) of University of Manchester on their first lesson of statistics course. The questionnaire was also distributed among the students who were not enrolled in the statistics course that time (48.6%).

The SATS tool consists 28 positive and negative statements regarding affect domain (6 statements), Cognitive competence domain (6 statements), value, domain (9 statements) and difficulty domain (7 statements). The SATS-28 instrument was chosen because it represents important attitudes related to the student's achievement and Statistics [20]. Moreover, while measuring the reliability of this tool, the reliability of all items was found much higher (Cronbach's Alpha.929) and for each domain as well (Affect: .90, Cognitive competence: .87, value: .80 and Difficulty: .80). For analysis perspective, the negative statements were transformed and recoded into positive statements.

6. Results

The demographic descriptive results of this study showed that among the total number of samples (N=142) male was 35.2% and female was 63.4% and missing 1.4%. 7% were less than 18 years old, 60.6% are 18-30 years, 16.9% were 31-40 years, 12% were 41-50 and 9.9% were above 50 years old. Moreover, 14.8% students never done statistics before, 5.6% did statistics on GCSE level, 7% in

A level, 39.4% in graduate level, 34.4% in another postgraduate degree level, and .7% were missing.

After screening and checking any abnormality of data (higher or lower than the maximum and minimum value). Table 1 shows the mean score, standard deviation, skewness and kurtosis of Affect, Cognitive competence, value and difficulty domain. All the domain along with the SATS score are seen normally distributed except the value domain. Value domain has 45.45 mean score which is slightly negative skewed (-.54) as well as cognitive competence (-.45)

Table 1. Mean, Std. Deviation, Skewness and Kurtosis of Affect, Cognitive Competence, Value, Difficulty and SATS score

	Mean	Std. deviation	Skewness	Kurtosis
Affect	24.89	8.58	-0.11	-0.6
Cognitive competence	29.03	7.15	-0.45	-0.01
Value	45.45	8.48	-0.54	-0.18
Difficulty	23.52	7.03	0.02	-0.34
SATS Score	123.27	25.42	-0.2	-0.29

By the summary of the descriptive nature of the data, for conducting the inferential statistics, the researcher assumed that, the homogeneity of variance of our population were equal. Though it seemed slight skewness in value domain, but overall the data were normally distributed as the SATS score was seen in the above table normally distributed. Moreover, one extreme score was found in SATS score data. For maintaining the assumptions of the parametric test the extreme score was removed. After manipulating the extreme score the total number of participants was (N=141). As parametric test, to find out the gender difference in students' attitudes towards statistics, the researcher did Independent sample t-test.

Table 2. Two Tailed Independent Sample t-test of Sex and SATS score

	Variable	Mean score	t-score	Sig (2-tailed)
SATS Score	Male	130	2.203	.029
	Female	119.97		

Overall the mean value of SATS score of male (130) and female (119.97) shows that, there is a difference among students according to their gender. The t-test $t(123) = 2.203$, $p < .05$ with .42 effect size indicates that, the difference is significant (See appendix A).

One way ANOVA was used to examine the difference in SATS score in groups according to their prior knowledge of statistics, for an overall $F(4,121) = 4.907$, $p < .05$ and .13 effect size was found (See appendix B). Though the difference between Never before group and Undergraduate (sig .005, $p < .05$) as well as Never before group and Postgraduate group (sig .003, $p < .05$) found significant, however, the difference with the groups GCSE and A level was found not significant. The significant differences are given below:

Table 3. Significant Difference in Attitudes towards Statistics (SATS score) According to Students Prior Knowledge

	Never before	GCSE	A level	Undergrad	Postgraduate
Never before	-	-	-	sig .005, $p < .05$	sig .003, $p < .05$
GCSE	-	-	-	-	-
A Level	-	-	-	-	-

To find out the correlation between the value domain and the difficulty domain both Pearson correlation and Spearman rho was conducted. In both the cases a very weak positive but significant correlation was found. For the Pearson correlation ($r(131) = .232$, $p < .05$) was found and for Spearman rho the correlation was ($r(131) = .217$, $p < .05$) (See appendix C). The correlation of value domain and difficulty domain is given below:

Table 4. The Pearson and Spearman rho Correlation of Value and Difficulty Domain

	Value	Difficulty	Sig. (2-tailed)
Pearson	1	0.23	0.01
	0.23	1	
Spearman rho	1	0.22	0.01
	0.22	1	

All the above tests in this study had missing values. Only one extreme value from this study was excluded. The missing values were also found very few in numbers. As a whole although SATS score had 15 missing values, individually Affect domain had 3 missing values, Cognitive competences had 1 missing value, Value domain had the most, 10 missing values and Difficulty domain had 5 missing values. Within value domain, "Statistics is worthless" and "Statistics conclusions are rarely presented in everyday life" were mostly unanswered.

6.1. Summary of Major Findings and Interpretation

The study was about finding out the postgraduate students' attitudes towards statistics according to their sex and prior knowledge of statistics. Also the researcher tried to find out relationship pattern between value and difficulty domain in this postgraduate students' study. Some major findings were found after doing the descriptive and inferential statistics. The major findings of this research according to the research questions are given below:

6.1.1. Research Question-1

Is there any difference in attitudes towards statistics according to students' sex in post graduate level?

The result of t-test shows, t-test $t(123) = 2.203$, $p < .05$ with .42 effect for the mean difference of male (130) and female (119.97). That means the difference is significant with medium effect. So the researcher rejected the null hypothesis, which was, there is no significant difference in

attitudes towards statistics between male and female postgraduate students, and accepted the positive hypothesis. In this case, it can be said that, the sex of postgraduate students have impact on their attitude towards statistics. Male postgraduate students have more positive attitude towards statistics than female postgraduate students.

6.1.2. Research question- 2

Is there any difference in attitudes towards statistics according to the level of prior knowledge of statistics in post graduate level?

The result of ANOVA shows, ($F(4,121) = 4.907, p < .05$) with .13 effect size for the mean difference of groups, which are divided by the variable "prior knowledge of statistics". Overall the result was significant though had small effect, the researcher rejected the null hypothesis and accepted the positive hypothesis which was, There is significant difference in attitudes towards statistics among students according to their prior knowledge of statistics. However, though the overall result was significant, there were no significant result found in relation with GCSE and A level group with Never before group, undergraduate group, and postgraduate group. This study can only say that, the students who had statistics in their undergraduate or in another postgraduate degree level have much more positive attitudes towards statistics than the students who did not do statistics before.

6.1.3. Research question-3

To what extent the Difficulty sub scale is correlated with value sub scale in post graduate level?

The result of both Pearson ($r(131) = .232, p < .05$) and Spearman Rho ($r(131) = .217, p < .05$) test revealed very weak positive correlation, but significant between Value domain and Difficulty domain also for postgraduate students. Though the correlation was very poor as it was significant, the researcher rejected the null hypothesis and accepted the positive hypothesis, which was a significant correlation will be found in Value and Difficulty factor in this study. That means, if value increase then the difficulty level sometimes also increase.

7. Discussion

The study found that, because of sex difference the attitudes towards statistics get changes in postgraduate level, which also supported the results from Mills (2004) [6] and Fullerton & Umphrey, (2001) [7]. According to them, males were more likely to report that they were not scared of statistics, and that they can learn statistics, and they felt confident mastering statistics material, and women were more likely to agree with the statement "Statistics makes me anxious". However, this study disagrees with Cherian and Glencros (1997) [9] that, gender differences were not significantly related to attitude toward statistics. The result also indicates the social environment, as an example, 21% of girls say their parents encourage them to become an actress, while 10% of girls say their parents have encouraged them to think about an engineering career [21]. Moreover, the result about prior knowledge of statistics found similar with the study results of Schutz, et al (1998) [15] and Ismail,

Mahmud and Kassim (2008) [16], which found significant positive relation between prior knowledge of statistics and attitudes towards statistics. However, this study also revealed that, there is no significant difference attitudes of students who had statistics in their GCSE level, and A level students who had statistics in undergraduate and postgraduate level. This may be concluded that, the students who had statistics once in their academic life have gained different attitude towards statistics rather than who didn't have. The third result of this study is slightly different from the result of Schau, et. al (1995) [17]. Where the estimated correlations between Value and Difficulty factor, $r = .085$ but not significant, here in this study the correlation was very poor but the result was significant.

7.1. Limitation of the Study

As limitation of this study, first of all the data which was given to the researcher is from two sets of class. The sample was not randomly selected. As in survey research the randomization is necessary to offer protection against bias in the selection of the sample member [22] and also for parametric tests. The second limitation of this study was the variance of the population was assumed but not tested. Moreover, the value domain did not present a totally symmetric graph though the normality was needed for parametric tests. Overall, the research didn't present any in-depth study which could be done by adding some qualitative tool or didn't use SATS-36 though it is an upgraded version of SATS-28. The most important limitation of this study was related to the SATS score calculation. As according to Schau (2008) [23] "A total attitude score never should be calculated. Students do not possess an attitude toward statistics but rather a set of interrelated components that comprise attitudes toward statistics."

8. Recommendation for Future Research

This research study tried to suggest two future research study to the other researchers. These are:

- Research about finding out the factors related to the sex variable, which are considering sex as an impact factor for attitudes towards statistics.
- In-depth research study about why GCSE level and A level statistics couldn't make differences in attitudes towards statistics than never before level attitudes.

9. Conclusion

Measuring attitudes towards statistics is now a mandatory issue for the teachers who are teaching or want to teach statistics. Without knowing the perception or attitudes of students, any steps of teaching could go wrong. Through this study, the researcher tried to draw light on two important variable, "sex" and "prior knowledge" which are significantly related to the issue of attitude towards statistics of postgraduate students. So that, in future the teachers of statistics can draw a hypothesis by seeing the class or from the background of the student to make a proper lesson.

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Appendix

Appendix A: t-test

Group Statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
SATS_Score	Male	45	130.0000	21.89853	3.26444
	Female	80	119.9750	25.71803	2.87536

Independent Samples Test

	Levene's Test for Equality of Variances	t-test for Equality of Means							
		Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper	
SATS_Score	Equal variances assumed	.305	2.203	123	.029	10.02500	4.55048	1.01761	19.03239
	Equal variances not assumed		2.304	103.919	.023	10.02500	4.35020	1.39830	18.65170

Appendix B: ANOVA

ANOVA

SATS_Score	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	10746.396	4	2686.599	4.907	.001
Within Groups	66245.644	121	547.485		
Total	76992.040	125			

Multiple Comparisons

Dependent Variable: SATS_Score

Tukey HSD

(I) Prior_experience	(J) Prior_experience	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Never Before	GCSE	-18.45714	10.27552	.381	-46.9136	9.9993
	A Level	-3.30000	9.06216	.996	-28.3962	21.7962
	Undergraduate course	-21.94000*	6.19063	.005	-39.0840	-4.7960
	Postgraduate course	-23.93333*	6.43524	.003	-41.7547	-6.1119
GCSE	Never Before	18.45714	10.27552	.381	-9.9993	46.9136
	A Level	15.15714	11.53085	.683	-16.7757	47.0900
	Undergraduate course	-3.48286	9.44255	.996	-29.6325	22.6668
	Postgraduate course	-5.47619	9.60469	.979	-32.0749	21.1225
A Level	Never Before	3.30000	9.06216	.996	-21.7962	28.3962
	GCSE	-15.15714	11.53085	.683	-47.0900	16.7757
	Undergraduate course	-18.64000	8.10544	.152	-41.0867	3.8067
	Postgraduate course	-20.63333	8.29376	.100	-43.6016	2.3349
Undergraduate course	Never Before	21.94000*	6.19063	.005	4.7960	39.0840
	GCSE	3.48286	9.44255	.996	-22.6668	29.6325
	A Level	18.64000	8.10544	.152	-3.8067	41.0867
	Postgraduate course	-1.99333	4.99878	.995	-15.8367	11.8500
Postgraduate course	Never Before	23.93333*	6.43524	.003	6.1119	41.7547
	GCSE	5.47619	9.60469	.979	-21.1225	32.0749
	A Level	20.63333	8.29376	.100	-2.3349	43.6016
	Undergraduate course	1.99333	4.99878	.995	-11.8500	15.8367

*. The mean difference is significant at the 0.05 level.

Appendix C: Correlation

Correlations

		Value	Difficulty
Value	Pearson Correlation	1	.232**
	Sig. (2-tailed)		.008
	N	131	129
Difficulty	Pearson Correlation	.232**	1
	Sig. (2-tailed)	.008	
	N	129	136

** . Correlation is significant at the 0.01 level (2-tailed).

Correlations

		Value	Difficulty
Spearman's rho	Value	1.000	.217*
	Correlation Coefficient	.	.013
	Sig. (2-tailed)	131	129
Difficulty	Difficulty	.217*	1.000
	Correlation Coefficient	.013	.
	Sig. (2-tailed)	129	136
	N		

*. Correlation is significant at the 0.05 level (2-tailed).