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REMOVING THE ANGST FROM STATISTICS

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Abstract. *This paper presents the results of a case study investigating the use of video resources in teaching statistics proven to have their impact on student learning outcomes which positively affect the student understanding of topics and reduce students' anxiety. A two-way ANOVA is utilized to analyze the sample data from forty post-graduate students in the Health Informatics at University of Wollongong. The findings from the study show that male students are significantly more confident in their understanding of statistics topics e.g. writing meaningful paragraphs about variables (p=0.014, F=6.684), producing and interpreting scatter plots and correlations (p=0.007, F=8.388); and less anxious in working with numbers (p=0.014, F=6.691) than female students. International students are also significantly more confident in their understanding of statistics topics e.g. determining probabilities from tables (p=0.037, F=4.689), producing and using regression output (p=0.008, F=7.835); and less anxious in several aspects compared to domestic students. There is a significant difference between male and female respondents in the scale of video resources impact on making students feel more anxious or comfortable such as taking the subject that involves mathematics (p=0.029, F=5.269) and computing (p=0.016, F=6.482). However, no significant interaction was found between gender (male versus female) and location of students (international versus domestic) on student perceived competency with the statistics topics, changed in perspective after completing the subject, and video resources impact.*

1 Introduction

For many students statistics is perhaps the most anxiety-provoking subject within their courses of study (Blalock, 1987; Schacht & Stewart, 1990; Zeidner, 1991). As with mathematics anxiety, students anxious about statistics have been found to be low ability in mathematics, suffering from fear of negative evaluation, dislike of tests, and low self-esteem (Zeidner, 1991). According to Onwuegbuzie (2004) statistics anxiety can develop during the process of learning and applying statistics in a formal setting. However, they noted that statistics anxiety could occur earlier indeed often prior to enrolling the statistics subject. Furthermore, Onwuegbuzie and Wilson (2003) stated the feeling of anxiety occurs when students are having problems of any kind with any level of knowledge that deals with statistics. Statistics anxiety is not only due to lack of training skills but may due to misperceptions about statistics and negative experiences in statistics classes (Pan & Tang, 2005) and even in mathematics classes (Preis & Biggs, 2001).

Many students say that the statistics subjects are "killer subjects". Consequently, students often delay taking this subject until the end of their studies and this may also lead to a failure to complete their studies on time (Onwuegbuzie, 2004; Onwuegbuzie, Daros et al., 1997; Rodarte-Luna & Sherry, 2008). Additionally, many researchers suggested that the level of difficulty of learning statistics is as similar as learning a foreign language (Lalonde & Gardner, 1993; Lazar, 1990; Onwuegbuzie, 2003; Schacht & Stewart, 1990). With up to 80% of the graduate students experiencing uncomfortable levels of statistics anxiety (Onwuegbuzie, Slate et al., 2000; Onwuegbuzie & Wilson, 2003; Pan & Tang, 2004). It is important for the instructors to find ways on how to deal with the anxiety as to learn and understand better in statistics subject. However, only a few researchers have investigated ways of reducing anxiety among students in learning statistics (Onwuegbuzie & Wilson, 2003; Pan & Tang, 2004; Pan & Tang, 2005; Song & Slate, 2006). Song and Slate (2006) have investigated a case in their study that demonstrates how technology use and instructor attitudes can reduce students' statistics anxiety and positively impact on student motivation.

The aim of the study was to determine how to improve and best develop the resources so that student learning and comfort in learning statistics can be improved. More specifically, the purpose of this study was to identify the impact of technology in the form of video resources on student learning outcomes. A cohort of sixty-six on-campus and twenty distance postgraduate health students were obtained via the E-learning website. Outcomes from the use of resources reporting students' improved understanding of topics and reduced anxiety.

2 Methods

2.1 Participants

The participants were forty post-graduate students who enrolled in a subject on Statistics in Health Research which offered by the School of Mathematics and Applied Statistics at a Wollongong University. There were thirteen distance students and twenty-seven on-campus students. Seventeen students were male, twenty-one were female, and two students not providing gender information. Twenty-two of the students were international students, seventeen were domestic students, and one student not providing information.

About thirty-eight percent of participants reported completing between nine and eleven hours per week (most frequently cited time spent) in the subject. Twenty-five percent of participants reported doing five hours or less of work per week. The participants were also asked to anticipate their grades to provide some indication as to the performance of students responding. Anticipated grades ranged from the lowest fail grade through to high distinction, but the majority of these students expected either a credit (thirty percent) or distinction grade (twenty-five percent).

2.2 Instruments

A survey questionnaire was used to collect the information on students' background, usefulness of learning resources, accessing and playing the video resources, students' perceived competency with the statistics topics, changed in perspective after completing the subject, impact of video resources, and suggestions for the improvement of the subject. Responses on the usefulness of learning resources were obtained on a 4-point scale ranging from 1 (not applicable or rarely used) to 4 (extremely useful), perceived competency with the statistics topics obtained on a 4-point scale ranging from 1 (not at all) to 4 (could do this), changed in perspective after completing the subject obtained on a 5-point scale ranging from 1 (much more anxious) to 5 (much more comfortable), and the impact of video resources obtained on a 6-point scale ranging from 1 (no videos to help) to 6 (much more comfortable). This study reported a reliability coefficient of 0.96 for the 51-item scales and nine open-ended questions were also included in the instrument.

2.3 Procedures

At the end of the weeks of final examination, students were asked to volunteer to fill out a set of questionnaire via online in the E-learning website. The approach of using an online survey has been shown to increase disclosure (Locke & Gilbert, 1995; Rodarte-Luna & Sherry, 2008; Turner, Ku et al., 1998) and could produce a higher response rate. The students were approached initially and informed about the purpose of the study which an information sheet delivered via email. In addition to the information sheet supplied to the students, they were asked to provide a return email or completion of an online permission slip giving their consent to participate in the study. The students were told that their participation is voluntary and that they were free to refuse to participate and to withdraw from the study at any time. The students would not be penalized for not participating in the study and they were informed that the outcome of the study should be beneficial for future students.

3 Results

3.1 Usefulness of video resources

In terms of usefulness of video resources, the participants had mean score of 3.72 with a standard deviation of 0.51 on a 4-point scale which were: 1=not applicable or rarely used, 2=little use, 3=moderately useful, and 4=extremely useful. As can be seen in Table 1, about ninety-five percent of the students found the video resources were useful in helping them to learn and understand the subject.

Table 1. Value of video resources for helping students learning and understanding

	Moderately Useful %	Extremely Useful %	Total %
Video resources (where available)	22.5	72.5	95.0

2.5% not answered

These results are supported by student comments to “How and what ways were the videos useful (or not)” which eighty percent of the students responded the videos were useful in a variety of ways, five percent of students responded the videos were not useful, and fifteen percent of students not responded (see Table 2). The video resources were found to be helpful by almost all students in their understanding and learning the subject including topics, calculations or workings, lectures and labs, using statistical software (JMP), applying statistical theory and concepts, and clarifying information outside the lectures; increase their confidence to complete tasks such as assignments, lab works, quizzes, and final examination; and provide better teaching methods and learning tools.

Table 2. Student comments to “How and what ways were the videos useful (or not)?”

The videos were useful	
• Easier to see how calculations were done. • Helpful to understand and apply the theory. • Made you feel as you are being taught one to one. • It gave better understanding about the steps to follow while performing a test or calculating. • The videos were fantastic learning tools. • It helpful in giving a step by step explanation. • The videos were very visual tool. • It helped to refresh memory outside the lectures. • They were very useful for a distance student that does not have face-to-face interaction with lecturers/tutors or other students. • They helped explain concepts that were difficult to interpret in the textbook or readings. • They were very useful in explaining concepts and allowing you to work through at your own pace. • Visual and verbal explanations are fantastic. • They provided the visual education that was lacking from distance learning… • The videos about the JMP are useful. • Could understand the subject much better by looking at the videos. • The videos were helpful for me to do the assignments. • They gave a visual/auditory learning to the subject. • Helpful to understand the most difficult points in each topic. • They were helpful in understanding the points that could not be understood in lectures and labs. • It was like having a personal tutor for oneself. • They helped to clarify the information in the lectures. • It showed the calculations or workings appropriately. • Could see the video to get more appropriate understanding.	• The videos to be of assistance as I was a distance student and this is the only opportunity for classroom instruction. • Help to understand the lecture and use JMP. • It is useful for some knowledge which is hard to understand in book. • They enabled me to understand better …really good stuff. • It was well demonstrated and the sound was good and was to the topic point. • In all the way it was useful. • Able to review specific topics in at one’s learning pace. • They are extremely important. ..Many students will benefit from this efficacious strategic teaching. • To use JMP software. • Being able to see the learning process involved in the statistical applications we were learning, and also having the lab environment within which to ask question.... • After lectures they provide a better understanding. • Giving more confidence for future assignment. • It helps in understanding the procedure to solve the problem using JMP, and it was full of information. • The videos were useful in making me understand the things I was a bit confused about. It made me clearer. • Videos were useful to understand the course of statistics and to sit in quiz and final exam as well. • They were good… I liked them because they were short and I could stop and start them easily to get the info down.
The videos were not useful	
• Reading statistical studies were not useful in the video actually. • I don’t like videos teaching, I have to spend time in downloading the videos, I prefer traditional paper study.	

15% not answered

3.2 Perceived comfort with topics

The students were asked to indicate how confident they were in relation to each of the topics on a 4-point scale which were: 1=not at all, 2=might have a little difficulty, 3=moderately confident, and 4=could do this. In regard to student perceived competency with the statistics topics, the results of two-way ANOVA shown significant differences in several topics between gender (male versus female) and location of students (international versus domestic). Male students reported higher confidence compared to female students as shown in Table 3.

Table 3. Differences on perceived comfort with topics between genders

How confident are you now that you can solve problems involving	F value	p value (Main effect)	Male	Female
1. Using JMP	6.744	0.014	Mean=3.41 S.Deviation=0.712	Mean=2.86 S.Deviation=0.655
2. Writing meaningful paragraphs about variables	6.684	0.014	Mean=3.47 S.Deviation=0.624	Mean=2.86 S.Deviation=0.655
3. Producing and interpreting scatterplots and correlations	8.388	0.007	Mean=3.71 S.Deviation=0.470	Mean=2.90 S.Deviation=0.768
4. Normal Models	5.157	0.030	Mean=3.41 S.Deviation=0.618	Mean=2.70 S.Deviation=0.979

As can be seen in Table 4, international students also reported higher confidence compared to domestic students. However, there was no significant interaction between gender and location on student perceived competency with the statistics topics.

Table 4. Differences on perceived comfort with topics between locations

How confident are you now that you can solve problems involving	F value	p value (Main effect)	International	Domestic
1. Producing and using regression output	7.835	0.008	Mean=3.50 S.Deviation=0.512	Mean=2.59 S.Deviation=0.939
2. Determining probabilities from tables	4.689	0.037	Mean=3.45 S.Deviation=0.596	Mean=2.82 S.Deviation=1.131
3. Producing and using Pearson's Chi Square	4.451	0.042	Mean=3.45 S.Deviation=0.596	Mean=2.65 S.Deviation=1.057

3.3 Change in perspective after completing the subject

The students were asked to report their change in perspective after completing the subject on a 5-point scale which were: 1=much more anxious, 2=a little anxious, 3=not more anxious or comfortable, 4=a little comfortable, and 5=much more comfortable. Several significant differences were observed when comparing the scale of change that students have nearly completed the subject. Table 5 shows male students were more comfortable or less anxious in working with numbers than female students.

Table 5. Difference on student changed in perspective after completing the subject between genders

How much more anxious or comfortable are you now that you have nearly completed the subject	F value	p value (Main effect)	Male	Female
Working with numbers	6.691	0.014	Mean=4.47 S.Deviation=0.717	Mean=3.48 S.Deviation=1.030

International students were also more comfortable or less anxious compared to domestic students in several aspects as shown in Table 6. There was no significant interaction between gender and location on student changed in perspective after completing the subject.

Table 6. Differences on student changed in perspective after completing the subject between locations

How much more anxious or comfortable are you now that you have nearly completed the subject	F value	p value (Main effect)	International	Domestic
1. Taking the subject that involves mathematics	11.942	0.001	Mean=4.36 S.Deviation=0.848	Mean=3.00 S.Deviation=1.225
2. Taking the subject that involves computing	4.895	0.034	Mean=4.27 S.Deviation=0.935	Mean=3.12 S.Deviation=1.269
3. Working with problems that involves mathematics	8.903	0.005	Mean=4.36 S.Deviation=0.953	Mean=3.24 S.Deviation=1.147

3.3 Impact of video resources

The students were asked to indicate the impact of video resources on making them feel more anxious or comfortable on a 6-point scale which were: 1=no videos to help, 2=much more anxious, 3=a little anxious, 4=not more anxious or comfortable, 5=a little comfortable, and 6=much more comfortable. The results shown significant differences in the scale of taking the subject that involves mathematics and computing which male students had greater video resources impact than female students (refer to Table 7). However, no significant differences in the scale of video resources impact were found between international and domestic students. Also, there was no significant interaction between gender and location on the impact of video resources.

Table 7. Differences on the impact of video resources between genders

What impact did the video resources on making you feel more anxious or comfortable	**F value**	**p value (Main effect)**	**Male**	**Female**
1. Taking the subject that involves mathematics	5.269	0.029	Mean=5.53 S.Deviation=0.624	Mean=4.67 S.Deviation=1.372
2. Taking the subject that involves computing	6.482	0.016	Mean=5.53 S.Deviation=0.717	Mean=4.53 S.Deviation=1.349

4 Discussion

Statistics is a required subject for many courses offered in colleges and universities today. Interestingly, these requirements produce a stressful condition for many students who experienced statistics anxiety. Over the past 20 years, many research have been focuses on measurement of and factors affecting statistics anxiety. Unfortunately, only few studies have been conducted investigating ways or techniques to reduce student statistics anxiety (Onwuegbuzie & Wilson, 2003; Song & Slate, 2006) in particular among post-graduate students.

This study examined how the video resources can be used and improved to help the student understanding and comfort in learning statistics. More specifically, this study used the resources as to assist students reducing their anxiety and to learn statistics more effectively. The findings revealed that the use of resources improved the students' understanding of topics and reduced anxiety. In responding to the usefulness of video resources, the participants consistently favored the teaching methods that using the videos as learning tools in helping them to understand and learn better i.e. calculations and workings of the statistical formulas, labs and using the statistics software (JMP). In regard to technological tools of teaching, software packages e.g. JMP, Minitab, SPSS enable the students in handling data such as organizing, analyzing, and computing statistics which it can lessen their time needed to manually calculate them (Forte, 1995). As the labs, video resources offered student understanding in interpretations of the computed statistics.

Many studies have frequently shown gender differences in anxiety particularly among students in statistics subject (Baloglu, 2003; Hembree, 1990; Hong & Karstensson, 2002; Meece, Parsons et al., 1982; Rodarte-Luna & Sherry, 2008; Zeidner, 1991). This study revealed significant differences between genders in student perceived competency with the statistics topics, change in perspective after completing the statistics subject, and impact of the video resources which male students reported higher than female students. However, inversely to the findings of studies conducted by Bell (1998) and Onwuegbuzie (1999), the international students reported higher in student perceived competency with the statistics topics and change in perspective after completing the statistics subject than domestic students.

Some researchers may be concerned regarding the generalizability of this study with a sample size of forty voluntary participants. Although the information was sought from the particular group of students, the purpose of this study was not to make general statement about statistics anxiety for all post-graduate students in Health Informatics. Rather, this study was to try to provide potentially useful suggestions for instructors and students to use the video resources a means of improving the understanding and learning statistics as well as reducing statistics anxiety. In further research, it would be desirable to conduct multiple groups of students from various courses of studies. The multiple groups of students would give us more complete picture of students' statistics anxiety and the use of video resources that would help them to learn statistics effectively. Because of anonymity, actual grades for the students in this study could not be associated with the questionnaire data. Thus, it would be also interesting to extent this study by looking at the relationship between the anxiety and students' performance. Major follow up issue is to look at students in subjects not designed by the author of these resources. Resources were closely aligned with perceived curriculum needs of students e.g. in meaningful paragraph.

In summary, the findings in this study agreed with the statement made by Song and Slate (2006) that "technology is a tool" and as Gunter (2001) stated "to close the teaching and learning technology gap between where we are and where we need to be in the 21st century, instructional design and curriculum should be focused on preparing the students to participate in using technologies to learn". Therefore, the technology used in the form of video resources was proven positively impact on student learning outcomes.

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