ASSOCIATION OF COURSE PERFORMANCE WITH STUDENT BELIEFS: AN ANALYSIS BY GENDER AND INSTRUCTIONAL SOFTWARE ENVIRONMENT

J. RICHARD ALLDREDGE
Washington State University
alldredg@wsu.edu

GARY R. BROWN
Washington State University
browng@wsu.edu

ABSTRACT

The effect of educational technologies on learning is an area of active interest. We conducted an experiment to compare the impact of instructional software on student performance. We hypothesize that some of the impact on student performance may reflect the influence of the technology on student subject-related beliefs and that those beliefs may differ by gender. We desired to assess how course performance may be associated with student beliefs, and how the association may differ depending on instructional software environment and gender.

Keywords: *Statistics education research; Instructional software; Student beliefs; Gender*

1. INTRODUCTION

1.1. BACKGROUND

An experiment in an algebra-based introductory statistical methods course presented an opportunity to assess the influence of an instructional software environment on the association between student beliefs and subsequent course performance. The influence of student gender on the connections between belief, performance and software environment is also of interest. The motivation for this investigation is stated by Gal, Ginsburg, and Schau (1997), “Lastly, in order to make the learning of statistics less frustrating, less fearful, and more effective, especially among college students but also at earlier stages, further attention by statistics educators should be focused on the attitudes and beliefs students bring into statistics education experiences, how they develop and change during their educational experiences, and the impact they have on students’ achievement, persistence, and eventual application of their new knowledge and skills.” In this study, beliefs about quantitative confidence, general academic confidence, quantitative background, and the importance of quantitative skill to future success were measured with a pre-course self-assessment (Appendix). Here beliefs are defined as individually held ideas about statistics, about oneself as a learner of statistics, and about the social context of learning statistics (Gal et al., 1997). Among the questions of interest are: 1) is there an association between pre-course beliefs and course performance? 2) does evidence of association remain stable throughout the course? 3) does the association

Statistics Education Research Journal, 5(1), 64-77, http://www.stat.auckland.ac.nz/serj

differ for females and males? 4) does the association depend on the instructional software package used? The answers to these questions have implications for designing intervention strategies for improving the teaching and learning of statistics.

1.2. PREVIOUS WORK

Research investigating student beliefs about science, mathematics, and statistics has been conducted by a number of authors (Gal & Ginsburg, 1994; Shamos, 1995; Seymour & Hewitt, 1997; Wisenbaker & Scott, 1998). Much of this work suggests that capable students are overtly discouraged from their interest or potential interests in science and mathematics. Negative beliefs can impede learning, hinder development of useful intuitions, and reduce application outside the classroom (Gal & Ginsburg, 1994). Most theories on academic motivation involve the premise that lack of self-confidence leads to a reluctance to try (Cross & Steadman, 1996). Rouse (1995) notes many negative beliefs among students about mathematics, including a lack of confidence in their ability to do mathematics. Also students' understanding, retention, and application of what is taught, and their motivation to learn, depends upon their sense of why this subject is necessary or useful. Moore (1997) states that the first topic within the course must be motivational for students, that is, an explanation of why students need to understand the material. Although distinctions can be made about the influence of negative beliefs in science education, mathematics education and statistics education, Gal et al. (1997) note that beliefs, achievement, and persistence influence each other in statistics education in ways similar to mathematics and other areas. There are differences as well. Huang and Brainard (2001) found female students' self-determinants of mathematics self-confidence to be different from factors that determine science self-confidence. Sax (1994) notes that traditional predictions of mathematics confidence operate differently for males and females and for science and nonscience fields at college entrance. Clark (1994) examined the effect of context on performance, for example, the teaching of statistics to first year university males who have a nonphysical sciences interest.

In addition to potential differences in the association between beliefs and course performance due to gender differences, field of interest differences, or science, mathematics, and statistics focus, there may be differences due to instructional materials employed. Shaughnessy (1992) suggested using computer software to change student beliefs. Moore (1997) proposes that video may be used to change the beliefs of viewers at a subconscious level so instructional software that includes carefully constructed video components may be more effective at changing beliefs than software without video clips. Harwood and McMahon (1997) concluded that integrated video media curriculum intervention can positively affect achievement and attitudes among high school chemistry students. Nevertheless, as Forbes (1996) notes, it is unlikely that any one technique will suit all learners. Adaptive technologies are frequently cited as an important way to address this challenge and others associated with improving instruction (National Science Foundation, 1996; Derry, 1992; McCalla, 1992). In addition to presentation of learning content in these technologies, much attention has been placed on the importance of the design, particularly focused on the user interface and ease of use (Nielsen, 2000; Reigeluth, 1999; Shneiderman, 1998; Ware, 2000). Finally, in contrast to the clamor associated with the arrival of technologies in education Zemsky and Massy (2004) counter with sobering evidence and argument that technology does little to revolutionize education, further suggesting that pedagogy and implementation are the only salient variables.

Based on this previous work we hypothesized that different instructional software environments that reflect different pedagogies would influence the association between student beliefs and student course performance in different ways. Furthermore, we hypothesized that the impact of the instructional software environment on the association would be different for females and males.

2. MATERIALS AND METHODS

2.1. THE EXPERIMENT

The experiment was implemented in an introductory algebra-based statistical methods course. This course satisfied a general education requirement for mathematics proficiency at Washington State University and satisfied a requirement of many departments. Students could enroll in the course with either a Math or Stat prefix, depending on their department's policy. Course content included material concerning methods for producing data, summarizing data graphically and numerically, describing and quantifying relationships between variables, measuring uncertainty with probability, sampling distributions, confidence interval estimation and hypothesis testing for proportions and means, and analysis of count data. The students came from broad backgrounds of previous mathematical and statistical knowledge and current academic interests. Two-thirds of the 172 students were female and 95 percent were between the ages of 18 and 24. One-third of the students had undeclared majors so student interest as evidenced by major was not included in analyses.

The course consisted of three hours of lecture instruction per week and a two-hour weekly laboratory session. There were two lecture sections of the course. One section was divided into three laboratory sections and the other larger lecture class was divided into six laboratory sections. Each laboratory section was assigned one of two instructional software packages to be used in the laboratory for the entire semester. To reduce instructor influence on overall differences among the beliefs and performances of students, a single instructor volunteered to teach both lecture sections of the course. The same textbook was used for both lecture sections. All three teaching assistants were assigned two laboratory sections from one instructional software package and one laboratory section for the other software package. All students in a laboratory section used the same instructional package. Students individually selected a lecture section and a laboratory section associated with that lecture section prior to the beginning of the term. For administrative convenience the three laboratory sections associated with the smaller lecture class used one package and the six sections associated with the larger lecture class used the other. Therefore there is a potential confounding effect of lecture and package even though the same instructor taught both lecture sections. No students switched lecture sections and hence software package associated with different laboratory sections during the term. Because the treatments were applied to laboratory sections, rather than to individual students, the nine laboratory sections were considered the experimental units for comparing instructional packages.

Two instructional software packages, ActivStats® and CyberStats™, were the treatments used in this study. ActivStats presents an introductory statistics course by integrating video, simulation, animation, narration, text, interactive experiments, and a statistics package into a learning environment (Addison Wesley Interactive, 1998). Product information accompanying ActivStats claims that students will experience real world examples, learn key statistics concepts through specially designed simulations, and practice with interactive experiments. CyberStats is a Web based textbook for an introductory statistical methods course that features learning through interaction (CyberGnostics, 2004). Students interact with simulation and calculation applets. On the CyberStats web page the following principles are listed: learning by activity and discovery, real data in real-world settings, and a stress on conceptual understanding. Each package contains its own version of a computational statistics program that both interfaces with the topical lessons, and is available for use independently of the instructional activities. CyberStats is a world-wide-web based program. Students pay a fee for a password that gave them access to the material CyberStats for the duration of the academic term while students in the other treatment group purchased ActivStats on a CD-ROM. The cost for each package was approximately the same. These packages were chosen because we agree with Lee (1998) that introductory statistics should be taught using real world data, student activities, and computer technology. The decision not to use a formal control group with no instructional software treatment is consistent with an approach that assumes that there will be impacts and they will be different for the different instructional methods.

Despite similarities in the two software packages they reflect two distinct instructional strategies. ActivStats embodies design principles that reflect assumptions that learners benefit from a greater contextualization of the problems, a contextualization that situates the learning of statistics in word problems, and it places a conspicuous emphasis on organizing the learning of statistics around the primacy of broad concepts. The interface, consistent with those assumptions, provides links to videos that explore the context in which the statistical analysis will be provided, and the statistics are organized around concepts like “understanding data, understanding relationships, and generating data.” For instance, instead of introducing the concept of regression, the organization subordinates the statistical methods to the umbrella concepts of relationships between things, and it presents videos. For example, a short video on the plight of the manatee is used to introduce the relationship of the animal to human incursions in the Everglades. In this context, regression is introduced as a tool to examine the relationships between human incursion and a declining animal population.

The CyberStats package reflects principles that hold the importance of the mathematical underpinnings of statistics. The different statistical methods shape the organization of the material, moving from the more basic principles to the more complex. The interface is designed to present the information about the statistical concept sequentially, including definition of terms. It then presents opportunities to practice the procedure. In addition, the package integrates the mathematical and statistical concepts with interactive models that demonstrate the graphical representation of the concept.

Students were directed to use selected material from their assigned software package during each laboratory session. They were also instructed to do selected laboratory homework exercises from their assigned package. The laboratory homework exercises counted toward their course grade. The selected material related to lecture topics presented during the class meetings prior to the scheduled laboratory.

2.2. INSTRUMENTS

At the first laboratory session, the students completed a questionnaire with 39 questions addressing issues of quantitative, verbal, and academic confidence. The questionnaire also addressed computer proficiency and students’ feelings considering applications of statistics and general academic study to their future. The survey was modeled, with permission, after the Teaching Goals Inventory (Angelo & Cross, 1993). Angelo and Cross drew in particular on work by Kulik (1976) and Bowen (1977) to shape their work on students' reactions to instructions. The aspects of the Teaching Goals Inventory that focused on attribution of responsibility for learning were particularly useful in our adaptation of the instrument. In addition to extracting and adapting questions from the Teaching Goals Inventory, we focused questions specifically on issues of general confidence and beliefs toward learning and toward confidence in mathematics and statistics in particular. We focused several questions about students' confidence, in order to explore issues that research suggests are promising for improving student performance, though there are also indicators in that work that improving confidence alone may not improve student performance. (Leder, Pehkonen, & Törner, 2002).

The pre-course questionnaire is presented in the Appendix. A similar questionnaire was given during the final laboratory session. In addition to questions about confidence and future applications of statistics the post-course questionnaire asked students to evaluate the instructional package they used during the course. An analysis of the difference between post and pre-class responses due to educational software treatment may be found in Alldredge and Som (2002).

Assessment of student learning included two mid-semester tests and a final examination based on topics covered in both the lecture and laboratory portions of the class. Mid-semester tests consisted of short answer and multiple-choice questions and were administered in lectures. Students in one lecture section had 50 minutes to complete the tests while students in the other lecture section had 75 minutes to complete a longer test. Several questions asked students to comment on or explain their results in words. Students were allowed use of calculators, statistical tables, and one sheet of self-prepared notes. The take-home final test consisted of story problems where computer assisted calculations were necessary, as well as short answer and multiple-choice questions. The take-home final test was untimed, open book, and unsupervised. Students were instructed to work independently and had one week to complete the final test. An additional assessment of student learning used total course points including all tests, final test, scores compiled from in-class and laboratory activities, lecture and laboratory homework assignments, and two class projects. The projects, although containing statistical analysis, were largely written works and graded for pertinent statistical content and quality of writing. Course grade, based on total points, was also used in analyses. Students' pre-course quantitative and verbal skills were assessed through SAT (formerly known as Scholastic Aptitude Test) verbal score, SAT mathematics score, and SAT total score. The SAT is a three-hour test that measures verbal and mathematical reasoning skills that is administered to secondary school students. Many colleges and universities use the SAT as one indicator of a student's readiness to do college-level work (SAT I, CollegeBoard.com).

2.3.STATISTICAL METHODS

In order to reduce the dimensionality of the questionnaire and identify the underlying patterns of variation in the data set, a multivariate principal component analysis (PCA) was conducted. A mixed model analysis of variance was used to explore the association between course performance and student pre-course beliefs. Specifically, analysis of variance and covariance were used to test for association between factor scores identified by the PCA and course performance, while considering the effect of instructional package used and gender. SAT mathematics, SAT verbal, or SAT total scores were used as covariates in the mixed model analysis of variance. Spearman correlation coefficients were computed for the ActivStats and CyberStats laboratory sections to measure the strength of the monotonic relationship between factor scores and course performance

(Hays, 1973, p. 787). We also tested the association between pre-course questionnaire item responses and overall course grade with the Jonckheere-Terpstra (JT) statistic (Hollander & Wolfe, 1973) for all laboratory sections combined and for the ActivStats and CyberStats laboratory sections separately. This statistic allowed testing a directional hypothesis between each item on the pre-course questionnaire and the final course grade. All analyses were completed for females and males separately to explore gender differences in the associations.

3. RESULTS

The principal component analyses produced a pattern and size of coefficients in the varimax rotated factor pattern that allowed three new variables that were linear combinations of the original response variables to be identified with labels. One of the linear combinations identified was composed of questionnaire items 3, 4, 6, 8, 12, 19, and 20 that are related to the student's self-reported concern about their ability to do mathematics (Mathematics Concern). A second factor, consisting of questionnaire items 1, 2, 17, was related to feelings of general confidence by students in their ability to do well in school (General Confidence). The third linear combination identified by the principal component analyses involved items 9, 11, 13, 15, 18, 22, and 24 that relate to past help and the applicability of mathematics, statistics and computer skills to their future careers (Math Commitment).

The presence of significant interactions in the mixed model analysis of variance indicated there were differences in the association between principal component factors and course performance measures depending on the educational treatment. Inclusion of SAT mathematics, SAT verbal, or SAT total scores as covariates in the mixed model analysis of variance usually markedly reduced the level of significance between a principal factor and the course performance score. This results from the highly significant correlation between SAT scores and the Mathematics Concern and General Confidence factors. Separate analyses for females and males showed different associations between principal component factors and some course performance measures prompting a separate consideration of the associations for each of the four instructional package-gender situations. That is, associations between pre-course beliefs and course performance are presented and compared for each of the groups: ActivStats-Female; ActivStats-Male; CyberStats-Female; CyberStats-Male. The number of students in each group having complete data for this analysis was 38, 21, 68, and 29, respectively.

Spearman correlation coefficients between the Mathematics Concern factor and test performance were negative throughout the course for all groups except the CyberStats-Male group (Table 1). That is, students who expressed more concern with their ability to do mathematics tended to have lower scores on all tests with the exception of the male CyberStats group. In the ActivStats group, this negative association was stronger for males than for females. The CyberStats-Female group had a significant negative association between all performance scores and Mathematics Concern while CyberStats-Male group had non-significant associations that were positive except for test 1. We note that Spearman's correlation coefficient does not provide information about independence of variables but rather is used here to provide a measure of association, namely, the direction and strength of the monotonic relationship between variables.

Correlation coefficients between General Confidence factor scores and test performance were significantly negative for the ActivStats-Female group (Table 1). In contrast the correlations were significantly positive for the ActivStats-Male group for all performance scores with the exception of the final test. In fact, the strength of the association decreased throughout the course. Females in the CyberStats group had a significant positive relationship between General Confidence and test performance for tests 1 and 2 but the correlation decreased to 0.067 for the final test. Males in the CyberStats group had a non-significant association between test performance and General Confidence throughout the course.

The correlation coefficients for the Math Commitment factor with scores on all tests, as well as total course points, was generally negative, but not significant, for both males and females (Table 1).

The Jonckheere-Terpstra test revealed associations between several items on the pre-course questionnaire and final course grade. Some associations were consistent for both males and females for both instructional packages, while others indicated differences in significance depending on gender and instructional package. Table 2 shows the type of association found between final course grade and selected questionnaire items related to the three factors identified above. Notice that items 12 and 17 that relate to General Confidence had significant associations with course grade for ActivStats-Male group but not for the CyberStats-Male group (Table 2). For females, items 1 and 17 were significantly associated with final course grade for the CyberStats treatment group but not for the ActivStats group. Items 4, 6, and 19 that relate to Mathematics Concern all had significant associations with course grade for the CyberStats-Female but not for the ActivStats-Female group (Table 2). For males, item 4 had a significant association with final grade for the CyberStats group and a significant association for the ActivStats group. Like the females, males showed an association between item 6 and final grade for the CyberStats group. There were only a few items identified as being strongly related to Math Commitment that had a significant association with course grade (Table 2).

4. DISCUSSION

The findings related to gender, confidence, and preparation reported in the previous section suggest that there are complex associations between pre-course beliefs and course performance, but a more compelling finding is that associations between beliefs and course performance are not necessarily stable throughout the course. The implications of construct instability, therefore, underscore the complexity of the gender differences in the associations between pre-course beliefs and course performance. This complexity suggests that using technological interventions to mediate learning requires insights into how, and when, students absorb information provided by instructional technology.

The software packages—or the contexts of learning represented in the different designs of these two software packages—influence the associations between beliefs and learning outcomes differently. Specifically, ActivStats seems more effective in ameliorating the effect of Mathematics Concern on course performance compared to CyberStats for females. It may be that ActivStats, with its greater focus on contextualizing the presentation of statistical concepts, may better amend the negative attitudes females have towards mathematics than CyberStats. In contrast, for males it appears that ActivStats allows the negative association between Mathematics Concern and performance to persist while CyberStats may alter the negative association. Males may find that the more direct, linear format of CyberStats alleviates their concerns about their ability to do mathematics.

Table 1. Spearman correlation (p-values) between factor scores and course performance

ActivStats-Female			
Item	Mathematics Concern	General Confidence	Math Commitment
Test1	-0.333	-0.306	0.007
	(0.047)	(0.070)	(0.969)
Test2	-0.401	-0.321	-0088
	(0.015)	(0.057)	(0.609)
Final test	-0.170	-0.295	-0.038
	(0.323)	(0.081)	(0.827)
Total	-0.361	-0.320	-0.038
	(0.030)	(0.057)	(0.827)
Grade	-0.244	-0.353	-0.184
	(0.151)	(0.035)	(0.283)
ActivStats-Male			
Item	Mathematics Concern	General Confidence	Math Commitment
Test1	-0.544	0.504	-0.323
	(0.013)	(0.024)	(0.165)
Final	-0.406	0.304	-0.131
	(0.076)	(0.192)	(0.582)
Total	-0.496	0.436	-0.164
	(0.026)	(0.055)	(0.490)
Grade	-0.514	0.470	-0.068
	(0.020)	(0.037)	(0.775)
CyberStats-Female			
Item	Mathematics Concern	General Confidence	Math Commitment
Test1	-0.291	0.401	-0.033
	(0.023)	(0.001)	(0.799)
Test2	-0.352	0.246	-0.047
	(0.005)	(0.056)	(0.219)
Final test	-0.291	0.067	0.047
	(0.023)	(0.607)	(0.715)
Total	-0.398	0.239	-0.015
	(0.002)	(0.064)	(0.910)
Grade	-0.358	0.203	-0.035
	(0.005)	(0.117)	(0.788)
CyberStats-Male			
Item	Mathematics Concern	General Confidence	Math Commitment
Test1	-0.165	0.083	-0.235
	(0.410)	(0.681)	(0.238)
Test2	0.136	0.207	-0.071
	(0.499)	(0.299)	(0.726)
Final	0.170	-0.186	-0.283
test	(0.396)	(0.352)	(0.152)
Total	0.139	0.048	-0.206
	(0.489)	(0.814)	(0.303)
Grade	0.087	0.066	-0.357
	(0.665)	(0.744)	(0.068)

*Table 2. Direction and significance(*p≤0.10) of association between final course grade and questionnaire items*

	ActivStats		CyberStats	
Factor/Questionnaire Item	Female	Male	Female	Male
General Confidence				
1. I have confidence in my ability to do well on exams	+	+*	+*	+
2. I have confidence in my ability to write well	–*	+*	+	–*
17. When I apply myself, I do well in school	–*	+*	+*	+
Math Concern				
4. Math formulas confuse me	–	–*	–*	+*
6. My previous instruction in math was poor	–	–	–*	–
19. When I struggle with math I feel unintelligent	+	–	–*	+
Math Commitment				
11. I usually study math with friends	–	–	+	–*
13. My previous instructors are responsible for my attitude toward statistics	–*	+	–	–
15. Stat skills are essential to my future career	–	+*	–	–*
22. I spend a lot of time studying math	+	–*	+*	+
24. Computer skills are essential for my future success	–	+	–*	–*

The associations between General Confidence and course performance are different than those for Mathematics Concern and course performance. CyberStats appears to allow a stronger relationship between General Confidence and course performance than ActivStats for females while the opposite is true for males. For females the association is persistently negative for the ActivStats treatment group while for the CyberStats group the General Confidence relationship with course performance is positive, although it does decrease during the semester. For males ActivStats may encourage a more positive association between General Confidence and course performance than CyberStats. It may be that the focus on context in ActivStats provides connections to general feelings of confidence for males but not for females. For example, the links to videos that depict context, such as the plight of the manatee due to increased boat traffic, are used to introduce statistical methods of analysis. It may be that videos of real world problems, and effective statistical solutions, bolster confidence in males more so than in females.

The implications of the complex relationship between strategies that encourage confidence and those that improve performance emphasize a critical distinction: confidence and performance are not at all the same, especially for women. As Fennema (1996) notes, we do not know how confidence influences learning, but it has long been assumed that lower confidence contributes to gender differences in learning mathematics.

This raises serious issues about the efficacy of educational measures, tests, and instructional strategies that merit additional research. The complexity is underscored by the findings that although females had a significantly lower score on questionnaire item 3 (I have confidence in my ability to do math) they scored significantly higher than males on all exams except the first, and achieved more total course points. These results are consistent with other research (Rosser, 1989) indicating that even when females do well on exams they have a lower perception of their mathematics ability than do males. Further, it should be noted again that the combined scores for male and female students in laboratories that used ActivStats had significantly higher mean scores for all exams as well as total course points compared to students in the CyberStats laboratories (Alldredge & Som, 2002). Despite these generalizations, it appears that there are complex differences between males and females in the influence of differently designed software packages on the association between their beliefs and course performance. The technology that was designed to expand the context of statistics and that emphasized the methods of statistics through use of video components as ways to examine the context was more effective in terms of course performance for many students than was the technology that placed a more immediate focus on statistical methods, though the latter used examples as well. The distinction might be simplified. The more effective approach focused on statistics as a set of tools useful for examining the world; the less effective approach focused on statistics as an end, as content to be learned. However, the results obtained in this study indicate that in the realm of beliefs the effectiveness of the packages varied depending on student gender and dimension of belief.

What emerges is that persistent skepticism about the efficacy of technology as a way to improve learning is misdirected, and the findings in this study contribute to the growing body of research that argues that point. Researchers need to move beyond the simple question, "Does information technology work?" and examine instead the complex nuances of instructional design and the underlying strategies associated with that design, with or without technology. The differential findings in this study illuminate this point. Based on previous work (Zemsky & Massy, 2004) that identifies the salience of various pedagogical designs and implementation rather than the generic and more common tendency to lump all technologies into binary pronouncements, future research on intervention strategies to improve learning will benefit from attention to the complexity of the association between student beliefs and student achievement.

It is clear that more study is necessary. We have only part of the story here concerning how to change future practice. Perhaps combining the insights gained here with learning styles information would support recommendations about the future for use of instructional software.

ACKNOWLEDGEMENTS

We would like to thank the graduate teaching assistants as well as the students who participated in the experiment. In addition we would like to express our appreciation to the editor and referees for their insightful suggestions for improvement.

REFERENCES

Addison Wesley Interactive. (1998). ActivStats. Reading, MA: Addison Wesley [Online: www.aw-bc.com]

Alldredge, J.R., & Som, N.A. (2002). Comparison of multimedia educational materials used in an introductory statistical methods course. In B. Phillips (Ed.), *Proceedings of* *the Sixth International Conference on Teaching Statistics*. Voorburg, The Netherlands: International Statistical Institute.

Angelo, T., & Cross, K. P. (1993). *Classroom assessment techniques: A handbook for college teachers*. San Francisco: Jossey-Bass.

Bowen, H. R. (1977). *Investment in learning: The individual and social value of american higher education*. San Francisco: Jossey-Bass.

Clark, M. (1994). The effect of context on the teaching of statistics at first year university level. In L. Brunelli & G. Cicchitelli (Eds.), *IASE, Proceedings of the First Scientific Meeting* (pp. 105-113). Perugia, Italy: University of Perugia.

Cross, K. P., & Steadman, M. H. (1996). *Classroom research: Implementing the scholarship of teaching*, San Francisco: Jossey-Bass.

CyberGnostics. (2004). CyberStats. [Online: www.cyberk.com]

Derry, S. (1992). Metacognitive models of learning and instructional systems design. In M. Jones & P. Winne (Eds.) *Adaptive learning environments: Foundations and frontiers* (pp. 257-286). Berlin: Springer-Verlag.

Fennema, E. (1996). Mathematics, gender, and research. In G. Hanna (Ed.), *Towards gender equity in mathematics education* (pp. 9-26). Dordrecht: Kluwer Academic Publishers.

Forbes, S. D. (1996). Curriculum and assessment: hitting girls twice. In G. Hanna (Ed.), *Towards gender equity in mathematics education* (pp. 71-79). Dordrecht: Kluwer Academic Publishers.

Gal, I., & Ginsburg, L. (1994). The role of beliefs and attitudes in learning statistics: toward an assessment framework. *Journal of Statistics Education*, *2*(2). [Online: www.amstat.org/publications/jse/v2n2/gal.html]

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 and the International Statistical Institute.

Harwood, W. S., & McMahon, M. M. (1997). Effects of integrated video media on student achievement and attitudes in high school chemistry. *Journal of Research in Science Teaching*, *34*, 617-631.

Hays, W. L. (1973). *Statistics for the social sciences* (2^{nd} edition). New York: Holt, Rinehart & Winston.

Hollander, M., & Wolfe, D. A. (1973). *Nonparametric statistical methods*. New York: John Wiley & Sons, Inc.

Huang, P. M., & Brainard, S. G. (2001). Identifying determinants of academic self confidence among science, math, engineering and technology students. *Journal of Women and Minorities in Science and Engineering*, *7*, 315-337.

Kulik, J. (1976). Student reactions to instruction: Memo to the faculty. Ann Arbor: University of Michigan.

Leder, G. C., Pehkonen, E. & Törner, G. (2002). *Beliefs: A hidden variable in mathematics education*. Hingham, MA: Kluwer.

Lee, C. (1998). An assessment of the PACE strategy for an introductory statistics course. In L. Pereira-Mendoza, L. S. Kea, T. W. Kee, & W-K. Wong (Eds.), *Proceedings of the Fifth International Conference on Teaching Statistics* (pp. 1215-1222). Voorburg, The Netherlands: International Statistical Institute.

McCalla, G. (1992). The search for adaptability, flexibility, and individualization: Approaches to curriculum in intelligent tutoring systems. In M. Jones & P. Winne (Eds.), *Adaptive learning environments: Foundations and frontiers* (pp. 91-122). Berlin: Springer-Verlag.

Moore, D. S. (1997). New pedagogy and new content: the case of statistics. *International Statistical Review*, *65*, 123-165.

National Science Foundation. (1996). *Shaping the future: New expectations for undergraduate education in science, mathematics, and technology*. Washington, D.C: Government Printing Office.

Nielsen, J. (2000). *Designing web usability*. Indianapolis: New Riders Publishing.

Reigeluth, C. (Ed.) (1999). *Instructional-design theories and models: A new paradigm of instructional theory*. Mahwah, NJ: Lawrence Erlbaum Associates.

Rosser, P. (1989). *The SAT gender gap: Identifying the causes*. Washington D.C.: Center for Women Policy Studies.

Rouse, L. P. (1995). Women and minorities in a social statistics course. *Journal of Women and Minorities in Science and Engineering*, *2*, 181-192.

SAT I, CollegeBoard (2004). [Online:http://www.collegeboard.com/student/testing/sat/about/SATI.html]

Sax, L. J. (1994). Predicting gender and major-field differences in mathematical self-concept during college. *Journal of Women and Minorities in Science and Engineering*, *1*, 291-307.

Shneiderman, B. (1998). *Designing the user interface: Strategies for effective human-computer interaction*. Reading, MA: Addison Wesley.

Seymour, E., & Hewitt, N. (1997). *Talking about leaving: Why undergraduates leave the sciences*. Boulder, CO: Westview Press.

Shamos, M. H. (1995). *The myth of scientific literacy*. New Brunswick: Rutgers Press.

Shaughnessy, J. M. (1992). Research on probability and statistics: Reflections and directions. In D.A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 465-494). New York: Macmillan.

Ware, C. (2000). *Information visualization: Perception for design*. San Francisco: Morgan Kaufman.

Wisenbaker, J., & Scott, J. S. (1998). A multicultural exploration of the interrelationships among attitudes about and achievement in introductory statistics. In L. Pereira-Mendoza, L. S. Kea, T. W. Kee, & W-K. Wong (Eds.), *Proceedings of the Fifth International Conference on Teaching Statistics* (pp. 709-710). Voorburg, The Netherlands: International Statistical Institute.

Zemsky, R., & Massy, W. F. (2004). Thwarted innovation: What happened to eLearning and why. A Final Report for The Weatherstation Project of The Learning Alliance at the University of Pennsylvania in cooperation with the Thomson Corporation.

J. RICHARD ALLDREDGE
Department of Statistics
Washington State University
Pullman, WA 99164-3144
USA

APPENDIX: Pre-course questionnaire

Your feedback preceding this course will provide important and useful information for the course developers, the department, and the university. Please read the instructions carefully before giving your answers. Thank you for participating in this project.

Student ID #	Gender: M F
Your TA's name:	Your Major:
Year in School:	Minor (if applicable):

Part I: Background

Indicate how strongly you agree or disagree with each of the following statements:
(mark the appropriate circle, select only one response per question)

		Strongly agree	agree	somewhat	disagree	strongly disagree
1.	I have confidence in my ability to do well on exams.					
2.	I have confidence in my ability to write well.					
3.	I have confidence in my ability to do math.					
4.	Math formulas confuse me.					
5.	I have a good background in statistics.					
6.	My previous instruction in math was poor.					
7.	I am usually systematic in my approach to problem solving.					
8.	I am usually well prepared for math exams.					
9.	Math skills are essential to my academic success.					
10.	I am generally good at visualizing concepts.					
11.	I usually study math with friends.					
12.	Math requires extensive mental discipline.					
13.	My previous instructors are responsible for my attitude toward statistics.					
14.	My family are pretty good in math.					
15.	Stat skills are essential to my future career.					
16.	People who are exceptionally good in math are often perceived as odd.					
17.	When I apply myself, I do well in school.					
18.	In the past, I have generally gotten help in math from family or friends.					
19.	When I struggle with math I feel unintelligent.					
20.	Most of my friends are better at math than I am.					
21.	It is important to get to know students who are different from me in their cultural and socio-economic backgrounds.					
22.	I spend a lot of time studying math.					
23.	I am good in music.					
24.	Computer skills are essential for my future success.					

Part II: Technological Background

Rate your ability to do each of the following: (Circle the appropriate number from 1 – no knowledge/ability to 5 - expert user. Circle only one)						
		no knowledge/ ability				expert user
25.	send and receive voice mail	1	2	3	4	5
26.	create a word processed document on a computer	1	2	3	4	5
27.	program a VCR	1	2	3	4	5
28.	send and receive documents on a fax machine	1	2	3	4	5
29.	use a video camera	1	2	3	4	5
30.	use a spreadsheet or database program on a computer	1	2	3	4	5
31.	send and receive e-mail	1	2	3	4	5
32.	search for information on the Internet/World Wide Web	1	2	3	4	5
33.	program a computer using a programming language (such as Fortran, C, C++, or a database language such as Foxpro or Oracle, etc.)	1	2	3	4	5
34.	program a computer using a database language (such as Foxpro or Oracle, etc.)	1	2	3	4	5
35.	Create or edit a World Wide Web site (using such programs as html, java, etc.)	1	2	3	4	5
36.	electronically send and receive files by way of the computer (over a modem, the Internet/WWW etc.)	1	2	3	4	5

What type of computer do you use? (mark all that apply)

		Mac	Dos/ Windows	Windows/NT	Unix	Other (Please specify)	N/A
37.	at home?					________________	
38.	at work?					________________	
39.	in a university computer lab					________________	

Part III: *In the space below, please answer the following question:*
What is the most important thing you hope to learn in this course?