A Comparison of Student Characteristics in Traditional and Web-Based College Science Courses

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A COMPARISON OF STUDENT CHARACTERISTICS
IN TRADITIONAL AND WEB-BASED COLLEGE SCIENCE COURSES

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A COMPARISON OF STUDENT CHARACTERISTICS IN TRADITIONAL AND WEB-BASED COLLEGE SCIENCE COURSES
MEGHAN ANDRIKANICH

ABSTRACT

Distance learning options at colleges and universities are increasing dramatically (e.g., National Center for Educational Statistics [NCES], 1998; NCES, 2001). Web-based courses create an interesting learning environment for study (e.g., Dupin-Bryant, 2004; Maki & Maki, 2003). Because science is a topic that induces anxiety for many students (e.g., Brownlow, et al., 2000; Greenburg & Mallow, 1982), and test anxiety has been linked to reduced academic performance (e.g., Bruch, 1981; Spielberger, 1979), the intersection of course format, science, and test anxiety is an area in need of research.

This study used an explanatory mixed method design. One hundred and seven web-based science students and 110 students enrolled in traditional courses completed a questionnaire regarding demographic and personal factors, the Reduced Reaction to Tests (RTT) (Benson & Bandalos, 1992) and the Locus of Control of Behavior Scale (Craig, Franklin, & Andrews, 1984). Ten students participated in a follow-up interview.

Quantitative results found no significant difference between age, racial/ethnic background, student status (full-time or part-time), or degree program being pursued between traditional and web-based science courses. Significantly more females, more students employed full-time, and with an external locus of control enrolled in web-based courses. Students in traditional courses experienced more test anxiety due to test-irrelevant thoughts. Traditional students experienced more anxiety in traditional science courses, while non-traditional students experienced more anxiety in web-based science courses. Expected course grade and locus of control predicted test anxiety in traditional courses, and previous web experience, expected grade, and locus of control predicted test anxiety for web-based courses.
Qualitative data indicated that students in both formats expressed opinions regarding course format, studying and test preparation methods, test-taking, communication with instructors in general, and specifically related to testing. Opinions indicated students prefer a comfortable course environment, whether that involves technology or not.

Several recommendations can be made. A continued increase in the type and variety of web-based courses will allow students continued flexibility in course scheduling. Multiple-choice tests should be considered to reduce student anxiety. Instructors should strive towards creating comfortable classroom environments and communicate clearly with their students.
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CHAPTER I
INTRODUCTION

Specific Aims

The availability of web-based courses in colleges and universities is expanding at an amazing rate (McGreal, 1997; National Center for Educational Statistics [NCES], 1998; NCES, 2001). Enrollment in web-based courses increased from 2.3 million in fall of 2004 to 3.2 million in fall of 2005 (Sloan Consortium, 2006). As course offerings increase, many questions arise regarding how this format is similar to and different from the traditional classroom for students and instructors. While there is a large amount of literature on the role of test anxiety in the traditional classroom, a search of databases revealed no primary research addressing the intersection of these two areas.

There is a similar dearth of research that focuses on test anxiety of students in college science classes. Science is a discipline that, in itself, can cause anxiety in students (e.g., Brownlow, Jacobi, & Rogers, 2000; Greenburg & Mallow, 1982). This may be due to stereotyping of science and scientists in addition to gender and racial stereotyping (Greenburg & Mallow, 1982), or due to a narrow definition of science (Barton, 1998). Although the causes of science anxiety are beyond the scope of this study, understanding that there are specific preconceptions about science and likely heightened anxiety surrounding science is important background to the current research.
Consequently, understanding the impact of class format on test anxiety in science classes is an important area of study. A science course, often including a lab, is a requirement for many degree programs, including most liberal arts programs, as well as courses for pre-health professionals such as nursing and physician’s assistant programs. This makes science a relevant discipline to investigate the relationship between course format and test anxiety. This study will build on the existing information about test anxiety by comparing students in traditional and web-based college science courses.

Significance

Recent advances in technology have created many new learning and testing options. Students now have choices between traditional classrooms, telecourses, and on-line courses, as well as other hybrid formats combining course delivery methods. For instructors and institutions to best meet the needs of students approaching courses through alternative formats, it is important to understand their experiences and the factors that led them to this format, including academic and personal scheduling issues. Students who enroll in web-based courses are more likely to be Caucasian, part-time students, and further advanced in their academic careers (Halsne & Gatta, 2002). Previously identified characteristics of students who are successful in web-based courses include being female (Cheung & Kan, 2002), being later in their academic careers (Dupin-Bryant, 2004; Maki & Maki, 2003), and having higher self-efficacy regarding course completion (Wang & Newlin, 2002). Further investigation into differences between enrollment and achievement in web-based courses is an important area to aid in course advising, to ensure that students are enrolling in the format that matches their individual learning style.

Some academic subjects elicit higher levels of discipline-specific anxiety, which is often associated with higher levels of test anxiety. This is a common occurrence in the fields of science (e. g., Brownlow et al., 2000; Greenburg & Mallow 1982), as well as mathematics (e. g., Cooper & Robinson, 1989; Haynes, Mullins, & Stein, 2004), and statistics (e. g., Onweugbuzie, 1998, 2000, 2004). The interaction between discipline specific anxiety and
test anxiety is worthy of further attention, so the relevance of science anxiety will be addressed.

Brownlow et al. (2000) examined the relationship between science anxiety, parental occupation, ownership of science-related paraphernalia (e.g., telescopes, chemistry sets), and gender. Results indicated that men and women had similar levels of science anxiety, and there was no relationship between anxiety and parental occupation or ownership of science paraphernalia. However, students with higher levels of science anxiety reported having ineffective high school science teachers, avoided science in college, and had lower quantitative SAT scores. This illustrates the importance of instructors to the experience of student anxiety, and the relationship between anxiety and course selection. A later study found non-science (or general) anxiety, gender (being female), and choice of a non-science major to be significant predictors of science anxiety (Udo, Ramsey, & Mallow, 2004).

Although test anxiety is most noticeable during evaluative situations, students with test anxiety experience classes and process information differently than their non-anxious counterparts. Some students with higher levels of anxiety may begin to study early in an attempt to improve performance because they are aware of examination performance deficits (Rost & Schermer, 1989). In contrast, other test-anxious students procrastinate because they feel that more preparation will not benefit their performance (Kalechstein, Hocevar, Zimmer, & Kalechstein, 1989). These and other studies (e.g., Kondo, 1997; Pekrun, 1985; Udo et al., 2004) have primarily focused on traditional classroom settings, where courses are formatted and meetings are regularly scheduled. Study and test-taking habits of students in a web-based course may be very different, as there is often more scheduling flexibility and independent direction through the course material.

A student’s perception of control over the outcome of a learning experience can also impact his or her level of anxiety in a course. Students with an external locus of control may experience higher levels of test anxiety because of the perception that academic performance is based more on chance or on the difficulty level of the exam than individual preparation
It is possible that the more flexible testing options allowed in web-based courses reduces test anxiety as students perceive more control over the learning and testing process. One study found that students enrolled in a web-based course were more likely to report an external locus of control, but that those students with an internal locus of control performed better (Wang & Newlin, 2002). It is possible that more students with an external locus of control enroll in web-based courses because they feel that course outcome depends more on luck or on the course being easy. However, once in the course, students with an internal locus of control may be more likely to succeed due to additional effort put into the course. Directly associating locus of control with test anxiety in web-based or traditional classes may also explain factors of student performance.

Besides the short-term effects of test anxiety on one particular exam or course, there are long-term consequences associated with untreated test anxiety. Unfortunately, the experience and effects of test anxiety begin in grade school. Covington (1985) found that already anxious grade-school students who experienced failure believed they had lower ability, leading to increased perception of threat from exams and further increased levels of anxiety. These students also showed higher levels of self-handicapping and procrastination. It is likely that these students would avoid higher-risk activities (and possibly coursework) that would lead to higher rates of failure. More generally, it is possible that increases in anxiety lead to decreased levels of curiosity and exploration of the world in general (Voss, 1984). Test anxious students may miss out on a wide array of information and experiences if these concerns are accurate.

Test anxiety also impacts factors outside the classroom. College admission frequently relies on testing. Students with higher levels of test anxiety score lower on the SAT (Zeidner & Nevo, 1992), thus decreasing available educational opportunities. A longitudinal study by Spielberger (1979) found higher levels of academic failure for high-test anxious students. Academic failure included students being dismissed from a university because of unsatisfactory academic performance, or leaving with a GPA too low for graduation. Keiffer,
Cronin, and Gawet (2006) determined that college students with higher levels of test anxiety were more likely to drink to reduce tension than for social camaraderie or for mood enhancement. Rates were also higher for female students than for male students. Based on the above research, test anxiety will not only affect an individual’s class experience, but can have far-reaching consequences for a student’s academic, professional, and personal life as well.

The information above includes many personal and academic factors associated with test anxiety, as well as the impact of test anxiety on many areas of the student experience besides testing. However, the research is primarily based on the student experience in traditional classes. Research on test anxiety in web-based courses is necessary to keep up with advances in course offerings. In addition, a deeper understanding of how students and instructors interact regarding test anxiety in both course formats of the course may add insight to differences in test anxiety between the two course formats.

**Purpose of the Study**

Web-based courses are being offered at an increasing rate. The interactions between the options offered by colleges and the unusual demands of diverse student populations require more research if educational goals by colleges and students are to be adequately met. There is currently a void in the research dealing with test anxiety and web-based courses. The collection of quantitative data on levels of student anxiety in web-based courses during this study will begin to fill this void, and attempt to define factors that predict test anxiety. Through qualitative methods, this study will also explore possible differences in the student experience in traditional and web-based science courses.

**Research Questions**

Although extensive studies and experiments have been performed in several areas of test anxiety, the role of course format associated with classes that elicit a high level of anxiety has not been investigated. The present study seeks to fill this void. The research questions are:
1. Are there differences in demographics or personal factors between students enrolled in traditional or web-based science courses? Demographics include age, race/ethnicity, and gender. Personal factors include number of credit hours being taken, number of hours worked per week, program being pursued, and locus of control.

2. Are there differences in components of text anxiety (levels of worry, tension, bodily symptoms, or test-irrelevant thinking) between students enrolled in traditional or web-based science courses?

3. Is total level of test anxiety impacted by age, gender, course format, or locus of control?

4. Do student characteristics of locus of control, expected course grade, or previous course experience (both previous science courses and previous web-based courses) significantly predict level of total test anxiety in traditional or web-based science classes?

5. Are there associations between student experience of test anxiety, experience in science or web-based courses, or their communication with their instructors? Do student perceptions influence their experience of test anxiety?

**Definitions**

**Full-time student.** These are students who are enrolled in 12 or more credit hours per semester.

**Part-time student.** These are students who are enrolled in 11 or fewer credit hours per semester.

**Test-anxiety.** For the purposes of this study, test-anxiety refers to the debilitating experiences of heightened worry, emotionality, bodily symptoms, and distracting thoughts during evaluative settings.

**Traditional classes.** These are courses that meet as a whole in one classroom. Web resources may be available to the class, but regular attendance is required for in-person discussion, lectures, and test-taking. A regularly scheduled laboratory session may be included.
Science course. For this study, this will include undergraduate college courses in chemical (such as general or biological chemistry), biological (such as microbiology or physiology), or health sciences (such as nursing or medical terminology).

Web-based courses. Web-based courses are administered solely on-line. A one-time course orientation may be offered, but students will receive all course materials and information through a classroom web site. Testing may be administered through the course web-site, or require on-campus meetings for tests, as a group or in another proctored environment. Laboratory requirements, either at home or through individually scheduled group activity, may be included.

Locus of control. Locus of control refers to the way an individual assigns responsibility for his or her actions. A more external locus of control of behavior means the individual attributes outcomes to chance or luck rather than to individual effort. In contrast, someone with a more internal locus of control of behavior means the individual attributes outcomes to individual effort.

Assumptions

The following assumptions have been made prior to the research:

1. Course delivery and instructor interaction are different in traditional and web-based courses. Students taking on-line courses have more flexible schedules relating to course time, duration spent receiving course material, and scheduling of exams within a given period.

2. Science is a subject that elicits anxiety in many students. Students may avoid science courses as long as possible in order to reduce individual anxiety.

Delimitations

Participants in this study were students enrolled in a community college in northeast Ohio. This institution is also involved in a University Partnership, so some participants may be pursuing a Baccalaureate degree. This institution is open-enrollment, so admissions
requirements or placement testing into a specific level are not required in most cases. Results of this study may only be generalized to other open-enrollment institutions offering web-based science courses.

Limitations

The limitations of this research study are as follows:

1. Limited generalizability. Participants are participating in science courses, and will represent a specific subset of the academic population. Participation will be voluntary. Traditional students will be provided with a paper questionnaire. Students who are given class time to complete the questionnaire are more likely to participate than those asked to return the questionnaire independently.

2. The data collection method involves administering self-report questionnaires. Self-report data may be influenced by many factors, including amount of time available or presence of an instructor.
CHAPTER II
REVIEW OF LITERATURE

Introduction to Test Anxiety

Over thirty years ago, Liebert and Morris (1967) classified test anxiety as a situation-specific personality trait, which means that an anxious response occurs when an individual with test anxiety is placed in an evaluative setting. While it is normal for most people to experience some level of anxiety in an evaluative setting, individuals considered to be “test anxious” experience a debilitating form of anxiety often leading to lowered examination performance. By contrast, individuals who are low in test anxiety experience a facilitating form of anxiety, leading to greater attention and focus on the task at hand (Spielberger, Anton, & Bedell, 1976). In Liebert and Morris’s early designation, two components of test anxiety were defined: worry and emotionality. Worry refers to distracting thoughts relating to performance that occur during the test, while emotionality refers to the physiological responses (such as increased heart rate) that occur during the test. Since then, the two factor model has been expanded into a four-factor model, including worry, bodily symptoms (awareness of physiological changes), test-irrelevant thinking (distraction due to environmental factors), and tension (experience of anxiety during a test) (Sarason, 1984).

Despite relative agreement on a definition of test anxiety, research on test anxiety has included many forms, dimensions, and variables over the years. The following review of the literature will first discuss the effects of test anxiety throughout the learning cycle, then
consider individual characteristics of test anxious individuals, and finally discuss test anxiety as it relates to web-based courses.

**Test Anxiety Across the Learning Cycle**

Test anxiety is believed to impact the entire learning experience. Covington (1985) states that the learning cycle includes test anticipation (becoming aware of upcoming examinations), test preparation (active study or other preparation methods), test taking, and test reaction (receiving feedback about examination performance). Within each of these phases, students can be impacted by test anxiety. In addition, students’ interactions with the instructor and other students in the classroom can impact the test anticipation and test preparation phases.

*Test Anticipation*

In the first phase of the learning cycle, test anticipation, students evaluate their overall probability of success or failure on an upcoming exam (Covington, 1985). Students experiencing test anxiety utilize different coping strategies, suggesting test anxiety affects the way information is processed before the actual threat of exam performance occurs. Prior experience of failure on early exams (or in previous courses) may also lead to lower estimation of potential performance in the course (Hodapp, 1983; Mandler & Sarason, 1952a), leading students to anticipate reduced performance and increase anxiety. Students with higher levels of test anxiety and low academic performance are more likely to criticize themselves due to worry about upcoming examinations (Spielberger, 1979). This means that as students experience distracting thoughts during their studies, they blame themselves for the inability to focus.

High-test anxious individuals are more likely to view the possibility of success as low and focus on the avoidance of failure. Students with higher levels of test anxiety are more likely to predict lower performance than students with low-test anxiety (Miesner & Maki, 2007). Hagtvet and Benson (1997) hypothesized that the more a student worries about avoiding failure, the greater amount of test anxiety that student will experience. To test this
hypothesis, graduate students completed questionnaires evaluating their motivation to avoid failure and their level of test anxiety. The study was not directly linked to an actual evaluative setting in order to avoid unnecessary increases in anxiety. Instead, subjects were asked generally how they felt in exam settings. The authors found that test anxiety increased as the motive to avoid failure increased.

While a student may initially have some tendency towards becoming test anxious, environmental stimuli and interactions with instructors can influence the overall level of anxiety a student experiences. For example, threatening or punishing interactions with a teacher increase test anxiety, while more understanding and helpful environments decrease test anxiety (Hancock, 2001; Pekrun, 1985). Other instructor and classroom characteristics that influence test anxiety include teacher pressure towards student achievement, a chaotic classroom atmosphere, increased competition between students (Pekrun, 1985), fear of embarrassment within a classroom, and uncertainty of course demands (Rost & Schermer, 1989). Taken together, these studies indicate the importance of teacher involvement in creating an organized, non-threatening atmosphere in order to decrease test anxiety in the classroom. In the field of science in particular, where anxiety is potentially heightened due to the discipline itself, it has been suggested that student anxiety may be increased due to a mismatch between a professional scientist acting as an instructor and a non-science student taking the course (Udo et al., 2004).

Another environmental factor that can influence test anxiety is student-to-student interaction. Stefanou and Salisbury-Glennon (2002) observed the effects of participating in a learning community (a small group of undergraduate students enrolled in the same first-year courses) on college students’ motivation and learning strategies. This study demonstrates how positive classmate interactions can foster feelings of support, which benefit students on many levels. Results indicated that students who participated in these communities showed better organizational strategies, critical thinking skills, time management, help seeking behaviors, and were more likely to use peer learning than students who were not involved in
learning communities. Furthermore, these students demonstrated increased extrinsic motivation (due to the accountability and involvement of the close group work), increased self-efficacy, and decreased test anxiety.

In summary, test anxiety may be increased by both external and internal pressures perceived by a potentially anxious individual as soon as a course begins and exams are anticipated (Becker, 1982). Examples of external pressures include high standards set by teachers and comparison of personal achievement to that of other students in the class, while an example of internal pressure would be high (and/or sometimes unachievable) goals set by the student. Test anxious individuals may be more focused on these perceived pressures than on the actual course content, contributing to further increases in anxiety and decreases in performance. This means that before a student begins to study for one specific examination, he or she is being impacted by the general environment in the classroom.

Test Preparation

The second component of the learning cycle is the test-preparation phase, in which students begin to prepare for an upcoming exam (Covington, 1985). Students experiencing test anxiety utilize different coping strategies, suggesting test anxiety affects the way information is processed before the actual exam occurs. For example, some students may be aware of their anxiety during test taking and therefore begin studying earlier and spend more time studying the material (Rost & Schermer, 1989). In contrast, knowing that they have high-test anxiety may lead some students to use self-handicapping strategies such as procrastination or reduced effort (Kalechstein et al., 1989; Rost & Schermer, 1989).

Kondo (1997) found that test anxious students use higher rates of concentration and preparation for upcoming exams than their non-test anxious counterparts, who rely more on relaxation or positive thinking. Test-anxious individuals are more likely to worry about the exam, and spend more time preparing for the exam, but are believed to score poorly because of increased worry and distraction during the exam. Huwe, Hennig, and Netter (1998) found similar results, showing that test anxious individuals tend to review material up to the
beginning of the exam, indicating more focus on preparation. These results indicate that students with test anxiety are aware of the problems they experience during an examination, and work harder at learning the subject material in order to compensate for those difficulties.

In a study examining the interactions between test anxiety and intrinsic motivation, Fransson (1977) conducted an experiment to determine whether motivation to learn material would be higher if the material were personally relevant, and to determine how motivation and test anxiety related to information processing. The information tested on was a passage describing the examination system for the Institute of Education at a college in Sweden. Students from the college of education were assumed to have high levels of intrinsic motivation to read the passage because the material was personally relevant. Students recruited from sociology were assumed to have low levels of intrinsic motivation, because the material was not personally relevant. Results indicated high performance of some students with high levels of test anxiety and high levels of intrinsic motivation. These students also showed higher levels of deep-level processing (focused on comprehension of material) instead of surface-level processing (rote memorization). These results indicate that a student who has high levels of test anxiety, but who is intrinsically motivated to understand material, will work towards understanding the information instead of simply memorizing facts. This showed a higher degree of effort from test-anxious students, indicating more work was put in to learning the material, possibly to compensate for anticipated deficits in test-taking skills. These results are encouraging as they indicate the possibility of success for high test-anxious students, something not reported in many other studies.

An individual with poor study strategies may also experience test anxiety based on lack of preparation. Cassady (2004b) found that students with high levels of test anxiety have difficulty encoding, organizing, and storing information while studying. These difficulties may be due to distracting thoughts during preparation. This may indicate that although students begin to study earlier and report reasonable amounts of study time, they are not using the time effectively, leading to a lack of preparation. In addition, high-test anxious
students may lack organized study habits, particularly a lack of time management (Topman, Kleijn, van der Ploeg, & Masset, 1992).

In contrast, Cassady (2004a) reported that students with high levels of test anxiety reported lower study skills, found tests to be more threatening, and prepared less effective notes than their non-anxious counterparts. This may be related to the results reported by Huwe et al. (1998), indicating increased last-minute review of material by test-anxious individuals. Based on these results, it is possible that students with poor study strategies are aware that they have not successfully learned required material, and attempt to “cram” at the last minute to compensate for their lack of preparation. Students who procrastinate also showed higher levels of test anxiety (Kalechstein et al., 1989), because this often leads to “cramming” before tests and an increased feeling of helplessness. Finally, some students with high-test anxiety attempt to avoid exam stress entirely by “playing sick” (Rost & Schermer, 1989).

While the above studies present contradictory information, it is possible that differences in preparation relate to locus of control. Students with an internal locus control are likely to feel responsible for their own success or failure, and therefore put more effort into preparation and studying. In contrast, students with an extrinsic locus of control do not associate individual effort with performance, instead feeling that outcome is due to uncontrollable factors. These students would then be more likely to avoid preparation and testing situations as much as possible. However, as the above studies did not include locus of control, this is an area needing further direct investigation.

The difficulties in preparing for an examination may be more serious for females than males. For example, Stober (2004) found that worry relates to task-orientation, preparation, and low avoidance coping in female students, but not in males. As worry is the component of test anxiety associated with lower academic performance, this highlights the greater risk of decreased academic performance for females.
Although differences between test-anxious and non-test-anxious students occur during both the test anticipation and preparation phases, most research on test anxiety has focused on the test-taking phase of the learning cycle. Here we see the direct detrimental effects of test anxiety on student performance.

Test-taking

The test-taking phase includes the actual thoughts and experiences of students during an evaluative performance (Covington, 1985). Individuals who are susceptible to internal distractions (such as distracting or irrelevant thoughts, focusing on increased heart rate) are more likely to be test anxious (Avero & Calvo, 2000; Keogh & French, 2002). Although test anxiety includes both worry and emotionality, worry is more often associated with performance deficits (Morris, Franklin, & Ponath, 1983).

It has been widely reported that high test-anxious students experience more distracting or irrelevant thoughts during the test-taking phase (Salame, 1984; Sarason & Sarason, 1987). Students experiencing test anxiety during an examination are presumably trying to focus on the exam content, but the intrusion of distracting thoughts divides their attention during examinations. Students have to try to work through the distracting thoughts, and re-direct focus to the evaluation at hand. One study specifically investigating this interaction found that increased cognitive-appraisal processes (judgments about test importance) lead to increased task-focusing processes (self-direction towards the examination), which in turn lead to a decrease in emotion-focusing processes (disengagement due to distracting thoughts and feelings) (Schutz, Distefano, Benson, & Davis, 2004). These results indicate the struggle that students with test anxiety experience during the testing process. An individual who is susceptible to external distractions (such as movement in the classroom) is also more likely to be test anxious (Avero & Calvo, 2000, Keogh & French, 2002). For high-test anxious individuals, even distractions that are non-threatening and irrelevant to the actual examination can lower academic performance.
In addition, students with high anxiety perform much worse on exams when hard questions appear earlier on an exam. This earlier difficulty may lead to disruptive cognitions, further decreasing performance (Covington & Omelich, 1987). Besides the order, question format can also make a difference for a student experiencing test anxiety. Miesner and Maki (2007) found that anxiety was a more negative factor on essay tests than on multiple choice tests. Choi (1998) had also found essays tests to evoke more test anxiety than multiple choice tests. Research on testing has also indicated that students taking more tests on smaller units of course material experience less test anxiety than students with fewer exams covering more material (Fulkerson & Martin, 1981). These studies indicate that the format of the test itself, along with an individual’s psychology, can trigger a greater test-anxious response.

Poor test-taking skills may also contribute to the lower performance of test-anxious students. Onweugbuzie and Daley (1996) distinguished between the contributions of exam-taking coping strategies and study coping strategies to test anxiety. Results showed that an individual may be taking adequate steps to prepare for an exam (as indicated by Kondo, 1997), but experience test anxiety due to poor exam-coping strategies. Bruch (1981) investigated the association between test taking methods, test anxiety, and academic performance. He found that high-anxious students reported significantly fewer effective test-taking strategies. For example, students would randomly guess on a multiple choice question instead of narrowing the choice to two possible answers, then comparing carefully. Not surprisingly, students with poor test-taking skills also had significantly lower grade point averages. The association between test-taking skill and test anxiety is important. Students with lower test-taking ability are likely to view test-taking as more difficult and threatening experience, leading to increased test anxiety.

Zimbardo, Butler, and Wolfe (2003) performed a study of the effects of student cooperation on anxiety and motivation during examinations. In an introductory psychology course, students worked in pairs or teams to complete required examinations. By working together, students reported decreased test anxiety, higher confidence, and increased
enjoyment in the course and subject matter, leading to an increase in motivation for learning the subject. Results were consistent in situations where groups were chosen by students or assigned by the instructor, indicating the effectiveness of any supportive group interactions in completing examinations.

Interactions with instructors during test taking can also influence anxiety. In an interesting study, Sarason (1973) found that the experimenter’s level of test anxiety influenced the participant’s performance solving anagrams. Experimenters with lower levels of test anxiety were better able to communicate with participants and created a more comfortable atmosphere. The author suggested that these effects may occur because an experimenter is being “evaluated” by the subject during the experiment. Experimenters with low-test anxiety scores were more relaxed, and better able to communicate with the subjects in this setting. If instructors impact student understanding, this may add another level of difficulty for test-anxious students.

Most research on test anxiety focuses on the test-taking phase. This is where the most common manifestations of test anxiety, such as distraction by internal and external factors, occur. In turn, these experiences lead to decreased performance by test-anxious individuals. However, research suggests that the experience of test anxiety continues after the evaluative event is completed.

*Test Reaction*

During the test reaction phase, students receive feedback on the evaluation (Covington, 1985). This feedback can be positive or negative, but test anxious students may interpret feedback maladaptively. In this phase, the possibility of interactions between test anxiety and locus of control again arises. Some studies have found that during the test reaction phase, students with high test-anxiety were more likely to attribute test failure to general aspects of life (everyone does poorly sometimes), but attribute test success to task-specific factors, such as task difficulty or luck (Arkin, Detchon, & Maruyama, 1981; Hedl, 1987). Students with test anxiety, therefore, seem to view their performances as being related
to external factors, instead of internal effort. The results of these studies indicate an external locus of control in students with test anxiety.

In contrast, other studies have indicated that high test-anxiety individuals maintained a negative self-concept, even when faced with positive feedback or success (Leppin, Schwarzer, Belz, Jerusalem, & Quast, 1987). This seems to indicate an internal locus of control, where self-image is based on individual beliefs about performance instead of actual performance feedback. When faced with poor performance, Spielberger et al. (1976) found test anxious students are more likely to attribute the blame for a poor performance to themselves than to any other source, and to have a generally more pessimistic outlook towards academic events. In order to understand the reaction of students with high or low levels of test anxiety to feedback, locus of control seems to be an important factor to consider.

The type of feedback provided can also influence test anxiety. In a study by Dykeman (1994), graduate students completed questionnaires to assess motivational orientation, self-efficacy, and test anxiety. Students were divided into groups that received either criterion-based or norm-referenced feedback of papers written for the course. Criterion-based feedback related to course objectives, while norm-referenced feedback compared student performance to overall class performance. Results showed that students with high self-efficacy who received criterion-referenced feedback experienced the least test anxiety, and students with high self-efficacy experienced higher levels of test anxiety in the norm-referenced setting. This study illustrates the impact of feedback on test anxiety.

Difference in feedback received would also relate to test format. There is more flexibility in the feedback provision for an essay test compared to a multiple choice test. One study found that multiple choice tests increased final test performance more than short answer tests, regardless of final exam format (Kang, McDermott, & Rodeiger, 2007). In addition, intervening short answer tests lead to better performance only if the final exam was a short answer format. The authors suggest that differences may be due to processing.
Students with a multiple choice test may have an easier time focusing and recalling exact cues from the material. However, this study did not consider the issue of test anxiety. Results may be more complicated if the additional difficulties associated with test anxiety were included.

For a successful and rewarding academic experience, students must be able to adequately focus on and absorb the information being presented. This should start on the first day of class, and should continue through subsequent evaluations. However, a student with test anxiety experiences distractions and disruptions during test anticipation, before an examination is scheduled. The difficulties increase during test preparation, as the test looms nearer. Distractions during the test taking phase directly interfere with exam performance. Finally, misinterpretation of feedback can prevent a test-anxious student from gaining a better understanding of the material, or discourage preparation for future evaluations. The impact of test anxiety across all phases of the learning cycle is clear. However, individual characteristics and contextual factors associated with test anxiety must also be considered. The subsequent section will focus on characteristics of students with test anxiety, and additional contextual factors.

**Individual Characteristics**

Many individual factors that impact test anxiety have been identified in previous studies. These factors can be divided into three primary relevant areas. These are trait anxiety, demographic characteristics and academic performance, and psychological variables. These three areas will be explored in the following sections.

*Trait Anxiety*

Interactions between test anxiety and other forms of anxiety complicate research. In particular, individuals with trait anxiety are more likely to identify any stimuli as threatening (Pury & Mineka, 2001). These individuals are much more sensitive to any environmental cues that may indicate potential physical or psychological harm. Thus, students with higher levels of trait anxiety also experience higher levels of test anxiety (Hong & Karstensson,
2002). This is not surprising, as individuals with higher trait anxiety levels would perceive an examination as threatening.

Trait anxiety and rigidity, or lack of flexibility, have been found to increase with age (Jerusalem, Liepmann, & Herrman, 1985). This presents an additional difficulty for older students. If rigidity increases with age, non-traditional students may be less willing to seek help or alternative study methods. They may also be more sensitive to feedback after an evaluation. If anxiety also increases, the non-traditional student may also be more at risk of experiencing increases in test anxiety, creating a cycle of decreased academic performance.

Demographic Variables

Sogunro (1998) specifically considered the impact of test anxiety on adult students, who are more likely to be faced with demands of jobs and family in addition to schoolwork, and may feel awkward returning to the classroom. This may increase the level of distraction due to intrusion of irrelevant thoughts, increasing the level of test anxiety. Results show that the effects of test anxiety on adult learning included avoidance of courses, subjects, or careers, distress and humiliation, resentment towards the instructor, and continued lowered performance. Females tend to be more test-anxious than males (Hong & Karstensson, 2002; Sharma & Rao, 1983). Students with greater levels of support from family or friends outside an academic situation may experience lower levels of test anxiety due to external encouragement (Orpen, 1996). Taken together, these studies indicate the importance of external support for students, particularly for females, adults, and/or others who experience test anxiety.

Psychological Correlates

Test anxiety is also associated with several psychological correlates that do not directly relate to classroom performance. Three specific areas that will be discussed are pessimism, efficacy, and locus of control. High test-anxious students were more often identified as pessimists (Carver & Scheier, 1989; Topman et al, 1992). Students identified as pessimists showed higher levels of goal disengagement, or the tendency to remove
themselves psychologically from a desired outcome when faced with examination stress than did “optimists” (Carver & Scheier, 1989). These students also reported higher levels of focus on the stress associated with failure. Although this study was not directly linked to levels of test anxiety or distraction, it does parallel the distracting thoughts commonly associated with test anxiety.

Students with higher levels of text anxiety also tend to describe themselves in more negative terms than their counterparts with low levels of test anxiety (Sarason & Ganzer, 1962). In addition, the same study found that high-test anxious students in a threatening condition (participants were told that analysis of an interview was investigating conscious and unconscious personality maladjustments and neurotic tendencies) used more negative self-references (e.g., “I am cowardly”) than high-test anxious subjects in a non-threatening condition (participants were told that analysis of an interview was investigating how students think and feel about themselves). Low-test anxious subjects in the same study showed no significant difference in number of negative self-references in either condition. As in the above studies, individuals with higher levels of test anxiety express more self-criticism, especially when faced with a hostile environment.

Blankenstein, Flett, Boase, and Toner (1991) asked students to complete a difficult analogies test, and then to list thoughts and feelings they recalled experiencing during the test. Students also completed measures of test anxiety and the level of distracting thoughts experienced during normal examinations. Overall, test anxious students in this study made more unfavorable statements about themselves. As expected, students with higher levels of test anxiety also experienced more cognitive interference. However, test anxiety was not associated with deficits in task performance. Similar results were found by Deffenbacher (1978), showing that high anxiety students felt more negatively about their abilities than other students. As above, this indicates test-anxious students have a more negative opinion of themselves. The separation of negative opinions from actual academic performance indicates the persistence of test anxiety, despite evidence based on actual experience.
In a study of high school students, participants were asked their opinions on how someone with test anxiety would think and feel, how the student would behave before, during, or after testing, and how behavior and thoughts of a student with test anxiety would differ from a student who does not suffer from test anxiety (Friedman & Bendas-Jacob, 1997). Here, participants expected a threat to perceived self-image or self-efficacy due to expected failure and tests, as well as a threat to social status if failure on a test was made public. Consideration of perceptions of self, as well as concern over reactions from others, adds to the negative experiences of students with test anxiety. Although this study was specific to high school students, it is likely that results would extend to adult students as well.

The possibility of a relationship between test anxiety and locus of control has been discussed above. Feather (1967) found an external locus of control in both male and female students with high levels of test anxiety. Similar results were reported by Shelton and Mallinckrodt (1991). Butterfield (1964) reported that test anxiety increased as locus of control became more external in college students. In addition, as locus of control became more external, students were willing to settle for a lower grade, but the grades earned actually increased. However, the directions for subjects were very strict.

It is important, however, that you work straight through the questionnaire from beginning to end without either skipping ahead or returning to already completed questions. You are to answer each question as you come to it. When you have completed a question, go on to the next one immediately. Do not return to any previously completed questions, and do not skip any questions for any reason whatsoever. (Butterfield, 1964, p. 360)

It is possible that strictly worded directions could heighten anxiety of some students, causing additional worry about correctly completing the questionnaire. If students with an external locus of control were concerned over the strict directions, they may have been more willing to accept a lower score due to their belief that outcome is determined by chance more than by effort.
In a longitudinal study, secondary school students completed questionnaires measuring test anxiety, manifest anxiety, negative attitude to school, social desirability, orientation for problem-solving behavior, self-concept of mathematical competence, and internal vs. external locus of control. Analysis indicated strong relationships among all factors. Most significantly for this study, low self-concept of competence, more external locus of control, and high chance were found to precede test anxiety (Krampen, 1991). Ray and Katahn (1968) also found locus of control to be significantly correlated to both test anxiety and manifest anxiety. In an Indian population, Krishna (1981) found the same relationships, and an additional association to free-floating anxiety. This may be because a perceived lack of control produces anxiety (Mandler & Watson, 1966).

The relationship of science engagement and science achievement to self-concept and locus of control was also investigated in a longitudinal study (Chang, Singh, & Mo, 2007). These authors found that Caucasian students had a significantly higher internal locus of control than Asian, Hispanic, or African American students. In addition, a more internal locus of control was associated with higher science performance scores, based on National Education Longitudinal Study (NELS) data. This study highlights the possibility of more complicated interactions, including cultural factors that surround performance and locus of control, even when test anxiety is not a factor.

The research summarized so far indicates that many factors (including age, gender, pessimism, and locus of control) are associated with test anxiety. While much is known about test anxiety and how it affects students, the context of education has changed for many students. Therefore, the role of anxiety in web-based courses is considered next.

**Web-based Courses**

The availability of different course and exam formats may also affect students’ levels of anxiety. The majority of data cited above were obtained from traditional classrooms or artificial laboratory settings designed to mimic natural examination settings. Research on test and trait anxiety levels in a web-based classroom may differ from traditional classrooms.
Although the offering of web-based courses is increasing, there is currently little known about the experience of test anxiety in these courses. However, many studies have begun to identify characteristics of students who are successful in web-based courses.

Technology

Before considering issues relevant to students in web-based courses, the issue of access to technology must be addressed. Although access to computers is common in colleges, universities, and public libraries, home access to technology might influence whether a student decides to attempt a web-based course. According to data from 2004, Caucasian and Asian-American households were both more likely to have home computer and Internet access than African Americans, and Latino households had the lowest reported home computer and Internet access (U.S. Department of Commerce, 2004). While home computer and Internet use is increasing for all groups, gaps in technology access among ethnic groups continue (Salpeter, 2006). Although this information is not specific to households with college students, these trends do suggest the possibility that African American or Latino students may avoid web-based courses simply because the technology is not convenient.

Students in Web-based Courses

Expectations and attitudes shape the preconceptions a student brings to a course, whether through a traditional or an alternate format. In addition, the study skills a student brings to a course are likely to impact performance, and in turn, attitude towards a certain class. Richardson (2005) completed a study in order to assess how students viewed academic quality of distance education classes in an open enrollment setting, and to determine how students studied in this setting. He found that student satisfaction with their academic experience was determined by the perception of receiving good course materials, clear goals, and definite standards for the course. These higher perceptions of academic quality also correlated with deeper study techniques. These results highlight the importance of instructor
communication and enforcement of high standards in distance learning courses in order to enrich the student experience.

Understanding possible demographic differences between students in web-based or traditional courses is an important first step before additional psychological factors such as test anxiety can be adequately examined. Halsne and Gatta (2002) assessed demographic differences between students in traditional and web-based courses in a community college outside of Chicago. They found the majority of web-based students were Caucasian, had annual income levels over $40,000, had professional status in their job, and already had some college experience. In contrast, students enrolled in traditional courses were more likely to be Hispanic, had an annual income under $12,499, were full-time students, and had little or no other college course experience. The authors also found significantly more females than males enrolled in web-based courses, while traditional classes had an almost even division of female and male students.

One recent study investigated student pre-entry variables relating to course completion (vs. non-completion) in web-based courses (Dupin-Bryant, 2004). The purpose was to identify variables that could predict students at risk for non-completion in order for instructors or administrators to provide necessary support. Overall, cumulative grade point average, year in college or graduate school, number of previously completed on-line courses, training specific to Internet searches, training relating to operating systems and file management, and training in use of Internet applications were the strongest predictors of web-based course completion. Years of computer experience was not a relevant predictor, indicating that specific training is more beneficial than general computer experience. This study indicates that students who have had more specific training with computers tend to perform better in web-based courses. This study did not report on the effects of gender, age, traditional versus non-traditional status, or other demographic variables. Although the effects of gender were not significant, this author also reported a higher proportion of female students in on-line classes.
Several studies have investigated relationships between various psychological characteristics of students and performance in on-line classes. Wang and Newlin (2002) compared students in traditional and web-based psychology classes. Web-based students had a more external locus of control, and scored lower on the final exam and in the course than traditional students. Unfortunately, this parallels the characteristics of test anxious students who attribute successful performance to luck or chance and tend to perform at a lower level. There may be some effect here caused by test-anxious students enrolling in web-based sections to avoid known stressors. This possible link between test-anxiety, locus of control, and enrollment in web-based courses is worth further investigation.

Another comparison of web-based and traditional psychology classes found the web-based students performed slightly better on examinations, but expressed lower overall satisfaction with the course (Maki & Maki, 2003). In another study, students were randomly assigned to web-based or traditional classroom sections of the same course. Students participating in web-based sections performed better on exams, and gave higher evaluation ratings to the professor (Poirier & Feldman, 2004). These conflicting results are interesting, since students in Maki and Maki’s (2003) study chose to take an on-line course, while students in Poirier and Feldman’s (2004) study did not. This does indicate that even students choosing to take an on-line course may not fully understand course procedure or course demands. Students randomly assigned to a web-based course are less likely to have preconceived notions about course expectations, and so may have a very different experience.

One study attempted to determine whether a relationship exists between students’ preferred learning environment (in class or web-based) and their learning style, and to compare student performance between the two groups (Buerck, Malmstrom, & Peppers, 2003). More students with a “converger” learning style (develops informal theories to solve problems) enrolled in the on-line course, while more students with an “assimilator” learning style (reflects on observations and develops informal theories) were more likely to enroll in
the traditional class. Final course grades did not differ between the on-line or classroom sections. While learning style may impact choice of class format, it did not relate to the likelihood of success in the chosen course.

Henly and Reid (2001) found that the higher-achieving students in a web-based class were more likely to use the available resources, and complete voluntary study aids. However, the majority of students reported that web-based materials were useful in learning, tutorials were beneficial, and that the web-based exercises were more interesting than traditional classroom lectures. This has positive implications for high-test anxious students who rely on preparation and early study as a coping strategy. Having more options for study guides or self-quizzes available in an on-line course may allow students to focus on the material being presented as students prepare for tests.

Non-test Anxiety in Web-based Courses

As discussed above, trait anxiety is a relevant factor influencing test anxiety. It is therefore possible that computer anxiety may confound test experiences in web-based classes. A study of computer anxiety in high school students found higher levels of anxiety in younger grades (King, Bond, & Blanford, 2002). This is likely due to a lack of experience with computers. If anxiety does decrease with experience, students taking web-based courses may be more anxious in their early coursework. However, since prior performance influences test anxiety, students with a bad experience in one web-based course may not enroll in another. An earlier study showed higher levels of computer anxiety increased level of statistics test anxiety (Benson & Bandalos, 1989). It is therefore reasonable to expect that computer anxiety, particularly for a web-based, would interact with subject-specific test anxiety, causing lowered performance in some students. When considering test anxiety in web-based courses, it is therefore important to consider possible interactions with anxiety caused by computers or course content.

Another study considers the effects of web-assisted learning on anxiety of college students (Macaulay, 2003). This study showed that anxiety increased as students retrieved a
larger amount of information from the Internet. As numerous studies have linked anxiety to
decreased motivation or course performance (e.g., Hancock, 2001; Huwe et al., 1998; Musch
and Broder, 1999), this is an important consideration for instructors encouraging general use
of the Internet in any course, and especially for web-based courses where the teacher may not
know what or how a student is searching in an effort to understand course content. If students
are left without structure or guidelines about specific course content, they may become more
overwhelmed by general Internet resources.

Test Anxiety in Web-based Courses

Moving out of a traditional classroom and utilizing the more flexible scheduling
allowed by web-based classes may give anxious students a feeling of control over their
academic success (e.g., Carter, 2002). This sense of control changes the dynamics a student
experiences during the test anticipation and preparation phases. While this does allow more
options for students with extra demands due to work or family, two related studies indicate
that the available options may actually relate to levels of test anxiety experienced by the
student. It was found that test anxiety increased from the morning to the afternoon, and that
the increase was independent of exam anticipation or after-effect from exam reflection
(Smith, 1985). Students also reported higher hopes for success in the morning (Smith, 1987),
but a higher level of perceived effort in the afternoon (Smith, 1985). These studies did not
include the relation of anxiety or effort to performance. However, based on information
reported above, the increase in anxiety later in the day, combined with an increase in
perceived effort, is more likely to lead to self-doubt and blame in the face of poor
performance. Therefore, the perceived benefit of flexible scheduling may be overshadowed
by cyclical increases in anxiety.

Examination format may be important during the test taking and test reaction phases.
Clark, Fox, and Schneider (1998) found that anxiety levels did not differ drastically when
students had a choice of computerized test format. However, differences may be found if
students have the option between similar (or identical) paper-based or computerized tests. A
test-anxious student who is more susceptible to distraction may perform better on a computerized exam due to the different, and usually quieter, surroundings. In addition, having the choice between different exam formats may again increase the feeling of control by the student, in turn potentially reducing the anxiety level.

Summary

Research on test anxiety has been conducted for over 60 years (Brown, 1938), and the effects of anxiety on performance have been researched for over 40 years (e.g., Mandler & Sarason, 1952a, b). Issues surrounding the student experience in web-based courses are increasing. Despite adding factors such as computer anxiety to the classroom and testing format, web-based courses may alleviate pressures due to time constraints or rigid formats. Information processing in this new format is also likely to be very different than in traditional classrooms, so the experience of preparing for these classes is likely to impact student performance.

As of now, studies directly relating to test anxiety in web-based courses are lacking. The current research will compare test anxiety along with relevant demographic and personal factors to gain valuable insights into the student experience. This study will begin to fill the void that currently exists between the fields of test anxiety and research on web-based courses.
CHAPTER III

METHODOLOGY

The purpose of this research study is to investigate possible differences between students’ levels of test anxiety in web-based and traditional science classes, determine what personal or academic factors may impact and predict student test anxiety in traditional and web-based science classes, and to identify student attitudes towards web-based courses, science courses, and science instructors.

Design

Students’ experiences with test anxiety in web-based and traditional classes were investigated using an explanatory mixed-method design. Participants were surveyed during the second half of the spring 2007 semester in order to understand the factors relating to test anxiety in traditional and web-based courses. Students in traditional courses were provided with paper questionnaires; students in web-based courses accessed the web-based version of the questionnaire, created using software from createsurvey.com. Follow-up interviews to further clarify the student experience with web-based courses, science courses, and testing were conducted in person, approximately four to six weeks after completion of the initial questionnaire.
Procedure and Participants

Two institutions in northeast Ohio were originally targeted for data collection. One was a large, open enrollment, urban, four-year university, offering a variety of science courses in traditional and web-based formats. At this institution, the researcher met with the chairperson of the chemistry department, where several web-based and traditional courses were offered. The chairperson then distributed questionnaires or web questionnaire information to her faculty. Only one class completed and returned questionnaires for analysis, and no web-based questionnaires were completed. Due to the limited and unbalanced data collected, the four-year university was excluded from the current analysis.

The second site targeted for data collection was a two-year community college with an extensive University Partnership program, allowing students to pursue a Bachelor’s degree while attending courses offered at the local community college. During the semester data was collected, the student body of 10,135 students was approximately 35 percent male, 65 percent female. Approximately 23 percent of students were age 24 or younger (including high school students enrolled in various programs). Approximately 62 percent of students were enrolled on a part-time basis (eleven hours or fewer). Thirty-four percent of students were enrolled in some form of distance learning, including web-based, cable, or other off-site course delivery methods. This institution has used ANGEL (Angel Learning, 2007) as its course delivery system since approximately 2003. Approximately 81 percent of students enrolled were Caucasian, 8 percent African American, 6 percent Hispanic, 1 percent Native American, 1 percent Asian, and approximately 3 percent were recorded as “unknown” (response left blank or not fitting into another category). The racial/ethnic distribution of the student body is representative of the surrounding community.

At the community college, 15 instructors teaching web-based science courses and 25 instructors teaching traditional science courses were provided with a letter introducing the researcher and the project, and a copy of the questionnaire (see Appendices A-E). Seven web-based instructors distributed questionnaire information to a total of 12 classes. One
instructor offered extra credit for participation. These students were directed to a separate
web page after completion of the questionnaire to record their name for this instructor.
Names were not linked to the questionnaires. After providing the list of names to the
instructor, the file was destroyed by the researcher.

One-hundred and fifteen web-based students accessed and submitted the web-based
questionnaire. One participant was removed from data collection because all questions were
blank. Another was excluded because the participant was not enrolled in a science class, but
had been provided the link by a friend. Six students were excluded from analysis because
they reported being enrolled in traditional classes that had not been provided with the
questionnaire link. This left 107 questionnaires for analysis.

Of the twenty-five traditional classroom instructors asked to provide questionnaires to
their students, seven participated. Questionnaires were handed out to a total of ten classes.
Four instructors provided students with class time to complete the questionnaire. Three other
instructors distributed the questionnaire to a total of six classes, and directed the students to
return questionnaires to the division office for return to the primary researcher. Two of these
instructors offered extra credit for return of the questionnaires. These students recorded the
name of their instructor on the consent form. The researcher compiled lists of these names as
the consent form was being separated from the questionnaire. Lists were provided to the
instructors.

One hundred and eleven students submitted paper questionnaires. One was excluded
from analysis because every other page of the questionnaire was left blank. The remaining
110 questionnaires were included in the final analysis.

Both formats required completion of the informed consent form (see Appendix B),
and included the option for a student to supply contact information (via phone or e-mail) if he
or she was willing to participate in a follow-up interview. Data for students volunteering to
participate in the interview was kept confidential; data for all other respondents was
anonymous.
After initial data analysis, students who volunteered to participate in a follow-up interview were contacted. Twenty-six web-based students who had volunteered to participate were invited to participate in the follow-up interview via phone or e-mail. Two were available for the interview process. Forty-two students from traditional science courses who had volunteered to participate in the follow-up interview were contacted via phone or e-mail. Eight participated in the interview. Of the ten interviews of students in both class formats, one interview took place at the student’s place of employment during a break, one took place at a nearby university where the student was attending summer classes, and the remaining eight interviews took place at the college library.

Measures

*Demographic and personal factors.* Students were asked to provide information regarding age, race, gender, school attended, current number of credit hours being taken, hours worked outside the home weekly, college major, year in school, name of the science course currently enrolled in (or course where they were recruited for the current study), expected grade for the course, overall grades, number of previous courses taken using web-based technology, number of science courses previously taken at the college level, degree program, and test-taking format in the current course (open or closed book) Students were also asked if they had a choice in course format (web-based or traditional) (see Appendix C).

*Test anxiety* was measured using the *reduced Reaction to Tests* (reduced RTT) developed by Benson and Bandalos (1992). The reduced RTT is a 20-item measure, evaluating four dimensions of test anxiety: tension, worry, bodily symptoms, and test-irrelevant thinking (see Appendix D). Tension includes anxious or tense feelings experienced during an examination. An example of an item measuring this factor is “While taking a test, I feel tense.” Worry includes distracting thoughts relating directly to test performance. One item measuring this factor is “During a difficult test, I worry whether I will pass it.” Test-irrelevant thinking includes distraction from thoughts completely irrelevant to the testing situation. An example of an item measuring this factor is “During tests, I find I am distracted
by thoughts of upcoming events.” The bodily symptoms factor includes consciousness of physical symptoms that occur due to increased anxiety during the examination. An example in this category is “I get a headache before a test.”

The RTT was reduced through factor analysis from Sarason’s (1984) original 40-item RTT and confirmed using two random samples (Benson & Bandalos, 1992). To assess levels of test anxiety, the RTT uses a four-point Likert-format (1 = not at all typical of me, 2 = only somewhat typical of me, 3 = quite typical of me, and 4 = very typical of me). Five items measure tension ($\alpha = .92$), six measure worry ($\alpha = .87$), five measure test-irrelevant thinking ($\alpha = .88$), and four measure bodily symptoms ($\alpha = .64$). Overall reliability of the RTT is high ($r = .91$) and comparable to the original RTT ($r = .95$). To score each category, item values are averaged. To obtain an overall score, subscales are added. Higher scores indicate a higher level of test anxiety.

*Locus of control* was assessed using the Locus of Control of Behavior scale, developed by Craig, Franklin, and Andrews (1984) in order to measure subjects’ perceived responsibility for their own behaviors (see Appendix E). A more internal locus of control of behavior means the individual attributes outcomes to chance or luck rather than to individual effort. Someone with a more internal locus of control of behavior would agree strongly with items such as “I can anticipate difficulties and take action to avoid them.” Someone with a more external locus of control of behavior means the individual attributes outcomes to individual effort, and would agree strongly with items such as “A great deal of what happens to me is probably just a matter of chance.”

The Locus of Control of Behavior is a 17-item measure scored on a six point Likert-type scale (ranging from 1 = strongly disagree to 6 = strongly agree). To score results, scores for five items (1, 5, 7, 8, 13, and 16) are reversed. The test is scored by summing all items. Higher scores indicate a more internal locus of control. Craig et al. (1984) report good test-retest reliabilities in a sample of 25 adult subjects at one week ($r = .90$) and at six months ($r = .73$). The authors report substantial correlations to Rotter’s I-E scale of behavior ($r = .67$ for
males, $r = .66$ for females), and successful discrimination between Rotter personal and political control items ($r = .70$ for males, $r = .67$ for females for personal items, $r = .31$ for males and $r = .37$ for males for political items).

**Follow-up interview.** Students participating in the interview completed a second informed consent form (see Appendix F). The interview was semi-structured, with questions regarding current experience with science courses and technology, feelings about studying and test-taking, as well as questions regarding communication with instructors (see Appendix G).

**Data Analysis**

All quantitative data analysis was performed using SPSS version 10. To examine whether differences in demographic or personal factors exist between students enrolled in web-based and traditional classes, a series of one-way ANOVAs or independent samples $t$-tests were used. Differences in degree program and locus of control were analyzed using ANOVA. Differences in race/ethnicity, age, gender, student status (full-time vs. part-time), and work status (full-time vs. part-time), between the two formats were analyzed using independent $t$-tests.

To determine whether student level of test anxiety differs between traditional and web-based course formats, the reduced RTT subscale scores were used. Differences in each factor of test anxiety between the two formats were analyzed using a MANOVA with each of the four subscales as the dependent variables. To determine whether overall level of test anxiety is impacted by personal characteristics, the total RTT score was used as the dependent variable in an ANOVA, with the factors of course format, age, gender, and locus of control as independent variables.

To examine whether student characteristics predict an overall level of test anxiety at the end of the semester, multiple regression analysis was used. Separate analysis was performed for traditional and web-based students in order to provide a more accurate model.
The independent variables included locus of control, previous course experience (enrollment in previous science or web-based courses), and expected course grade.

The student experience in science and/or web based courses was evaluated qualitatively, using a constructivist approach. The goal of this part of the research was to build an understanding of the student experience, including web-based technology use, in science or other courses. To this end, the semi-structured interview was designed to investigate three primary areas. These included student attitudes or ideas towards web-based courses, experiences with testing, and interactions with instructors. All interviews were transcribed, and then summarized by the researcher. As a triangulation step, participants were then presented with the summary, and asked if they wanted to make any corrections to the summary provided. All participants were satisfied with the summary information.

Transcripts were then color-coded for analysis. Although the original design had included three primary areas of information (web-based courses, testing, and interaction with the instructor), review of transcripts identified a total of five emerging themes: experiences or opinions of web-based courses, methods used for study and test preparation, thoughts and experiences with testing, communication with instructors, and communication about testing. These themes were identified from multiple interview participants, and were therefore considered relevant for further analysis. Information relevant to each theme was then merged to create new files specific to each major theme. Color-coding was then used again as specific sub-themes were identified, again finding ideas common to multiple interview participants.
CHAPTER IV
RESULTS AND FINDINGS

This chapter presents the research questions posed in Chapter 1, followed by the appropriate data analyses.

Sample

A total of 217 participants completed the initial questionnaire including information on age, ethnicity, gender, number of credit hours currently enrolled, number of hours worked per week, and program being pursued. Summary information for the relevant background factors can be found in Table 1. Gender and program data were used as reported. Recategorization of age, ethnicity, number of credit hours currently enrolled, and number of hours worked per week are discussed below.

The age of participants in the traditional science courses ranged from 18 years to 51 years. The age of participants in the web-based courses ranged from 18 years to 59 years. For the total sample, 50.5 percent of participants were 24 or younger. This was used as the cut-off to divide participants into two groups; those ages 18-24 were considered “traditional” students while those 25 and older were considered “non-traditional” students.
Table 1.
Summary of Demographic Characteristics by Course Format (N = 217)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Category</th>
<th>Traditional</th>
<th>Web-based</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Age</td>
<td>18-24 (traditional)</td>
<td>61</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>25 and older (non-traditional)</td>
<td>47</td>
<td>59</td>
</tr>
<tr>
<td>Racial Background</td>
<td>Caucasian</td>
<td>88</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>African American</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Hispanic</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Asian</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Middle Eastern</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Native American</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Mixed descent/other</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Gender</td>
<td>Female</td>
<td>67</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>42</td>
<td>21</td>
</tr>
<tr>
<td>Student enrollment Status</td>
<td>Part-time (11 or fewer hours)</td>
<td>44</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Full time (12 or more hours)</td>
<td>64</td>
<td>62</td>
</tr>
<tr>
<td>Employment Status</td>
<td>Part-time (39 or fewer hours)</td>
<td>80</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Full-time (40 or more hours)</td>
<td>28</td>
<td>45</td>
</tr>
<tr>
<td>Degree/program Pursued</td>
<td>Certificate</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Associate’s Degree</td>
<td>69</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>Bachelor’s Degree</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>8</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: Totals for each factor may not equal 217 due to missing responses.

Ethnicity was reported by 206 of the 217 questionnaire respondents. Eighty-two percent of the sample were White/Caucasian, 5.8 percent were Black/African American, 5.8 percent were Hispanic, 3.4 percent were of mixed racial descent, 1.9 percent were Asian, 0.5 percent were Middle Eastern, and 0.5 percent were Native American. Due to the overwhelming number of non-minority participants, ethnicity was narrowed down to two groups: “White/Caucasian” and “Other.”

The number of credit hours taken was used to determine whether students were enrolled on a part-time (eleven or fewer credit hours) or full-time (12 or more credit hours) basis. Of the 108 traditional students who responded to this question, 44 were enrolled on a part-time basis, while 44 of the 106 web-based students were enrolled on a full-time basis.

Number of hours worked was used to determine whether students were working on a part time (39 or fewer hours per week) or full time (40 or more hours per week) basis. Eighty of the 110 traditional classroom participants worked part-time, while 58 of 103 web-based participants worked part time.
Research Question 1

Are there differences in demographics or personal factors between students enrolled in traditional or web-based science courses? Demographics include age, race/ethnicity, and gender. Personal factors include number of credit hours being taken, and number of hours worked per week, degree program currently being pursued, and locus of control.

Independent-samples $t$-tests were used to compare the number of traditional and non-traditional students, racial composition, gender, student status, and employment status between traditional classes and web-based classes. Difference in age was not significant between course formats ($t = -1.78, p = .076$). There was not a significant difference in racial background between the two formats ($t = -.67, p = .502$). There was a significant difference found in gender between traditional and web-based science courses ($t = -3.07, p < .005$). This indicates greater enrollment of female students in web-based science courses than in traditional science courses. The difference between part-time or full-time student status was not significant ($t = .11, p = .91$). The number of students working full-time is significantly higher in web-based courses ($t = -2.75, p < .01$).

One-way ANOVAs were used to determine whether there were differences in program pursued or locus of control in traditional and web-based courses. Results showed the difference in program being pursued across format was not statistically significant ($F (1, 212) = 2.59, p = .11$). The difference in locus of control between traditional and web-based students was statistically significant ($F (1, 215) = 4.93, p < .05, \eta^2 = 0.02$). Participants in traditional science courses had a more internal locus of control ($M = 42.10, SD = 7.77$) than participants in web-based science courses ($M = 39.49, SD = 9.47$). This means students in traditional science courses are more likely to view success as a result of effort, while students in web-based science courses are more likely to view success as a result of random chance or luck. Although the difference is significant, the effect size for this difference is quite small.
Research Question 2

*Are there differences in components of text anxiety (levels of worry, tension, bodily symptoms, or test-irrelevant thinking) between students enrolled in traditional or web-based science courses?*

A MANOVA was used to compare the differences in components of text anxiety between participants in traditional and web-based science courses. Mean score and standard deviation can be found in Table 2. The overall multivariate difference between traditional and web-based courses was significant ($F(4, 194) = 2.87, \lambda = 9.44, p < .05$). Students experience a higher level of test anxiety in the traditional formats ($M = 1.74, SD = .07$) than in the web-based courses ($M = 1.55, SD = 0.66$). Of the four components of test anxiety, univariate analysis indicated only test-irrelevant thinking was higher in traditional formats ($F(1, 197) = 4.22, \eta^2 = .02, p < .05$). Worry, tension, and bodily symptoms did not significantly contribute to a difference in test anxiety between formats. Although test-irrelevant thinking was higher in traditional formats, the effect size for this difference is small.

Table 2.  
*Test Anxiety Sub-scale Scores*  

<table>
<thead>
<tr>
<th>Component</th>
<th>Traditional</th>
<th></th>
<th>Web-based</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Tension</td>
<td>2.39</td>
<td>0.84</td>
<td>2.30</td>
<td>0.82</td>
</tr>
<tr>
<td>Worry</td>
<td>2.08</td>
<td>0.63</td>
<td>2.02</td>
<td>0.68</td>
</tr>
<tr>
<td>Test-irrelevant thinking</td>
<td>1.76</td>
<td>0.69</td>
<td>1.56</td>
<td>0.65</td>
</tr>
<tr>
<td>Bodily symptoms</td>
<td>1.33</td>
<td>0.49</td>
<td>1.45</td>
<td>0.62</td>
</tr>
</tbody>
</table>

Research Question 3

*Is total level of test anxiety impacted by age, gender, course format, or locus of control?*
A 2 (age) X 2 (gender) X 2 (course format) X 2 (locus of control) factor ANOVA was used to determine whether test anxiety is impacted by individual factors or course format. Total test anxiety score was used as the dependent variable. Although there were no significant main effects, the interaction of student age and format was statistically significant ($F(1, 62) = 6.15, p < .05, \eta^2 = 0.90$). Traditional students (ages 18-24) experienced significantly more anxiety in traditional courses ($M = 7.54, SD = .30$) than in web-based courses ($M = 7.30, SD = .34$), while non-traditional students (ages 25 and older) experienced significantly more test anxiety in web-based courses ($M = 7.48, SD = .26$) than in traditional courses ($M = 7.36, SD = .34$) (see Figure 1).

Figure 1. Interaction of student age and course format on total level of test anxiety.
Research Question 4

Do student characteristics of locus of control, expected course grade, or previous course experience (both previous science courses and previous web-based courses) significantly predict level of total test anxiety in traditional or web-based science classes?

Separate multiple regression analyses were used to determine which factors significantly predict test anxiety in traditional or web-based science courses. Out of the 110 participants currently taking a traditional science class, only 55 (50%) reported a previous science course. Of the 107 participants currently enrolled in a web-based science course, only 58 (54%) reported a previous science course. Due to the low values, previous science course experience was excluded from analysis.

For students in traditional classes, only 45 of 110 participants (41%) indicated any use of web-based technology in any previous courses. Previous web-based experience is not expected to be relevant to the level of test anxiety in traditional classes. Therefore, for traditional students, previous experience in web-based courses was not included in analysis. Out of the 107 participants currently enrolled in a web-based course, 94 (88%) had previous experience using any web-based technology in their college courses. For students in web-based courses, previous web experience was included in the regression model.

In traditional science courses, total level of test anxiety can be predicted through a step-wise regression ($\beta = 0.22, p < 0.01$) by expected grade ($\beta = .31$) and Locus of Control of Behavior score ($\beta = .22$) (see Table 3). Test anxiety increases as expected grade decreases and as locus of control becomes more internal. However, this model does not account for a large portion of total test anxiety ($R^2 = .17$), meaning that less than 18 percent of the variance in test anxiety for students in traditional science courses can be explained by expected grade and Locus of Control of Behavior alone. In this model, expected grade contributed 12.4 percent of the explained variance in test anxiety, and Locus of Control of Behavior contributed 4.8 percent of the explained variance.
Table 3.
Regression Analysis Results Predicting Test Anxiety in Traditional Science Courses

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$</th>
<th>SE $B$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected grade</td>
<td>0.77</td>
<td>0.22</td>
<td>0.31</td>
<td>3.51</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Locus of Control of Behavior</td>
<td>0.55</td>
<td>0.22</td>
<td>0.22</td>
<td>2.48</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

Notes: Multiple $R = .415$, $R^2 = .172$, adjusted $R^2 = .156$

In web-based science courses, total level of test anxiety can be predicted through a step-wise regression model ($\beta = 0.25, p < 0.01$) by the factors of expected grade, previous web-based course experience, and Locus of Control of Behavior score (see Table 4). Test anxiety increased as expected grade decreased, if a student had previous web-based course experience, and as locus of control became more internal. However, the contribution of previous web experience to the overall model was not significant. This model also only accounts for a small variation in test anxiety ($R^2 = .17$), meaning that less than 17 percent of the variance in test anxiety for students in web-based science courses can be explained by expected grade ($\beta = .28$), previous web-based course experience, and Locus of Control of Behavior ($\beta = .25$). In this model, expected grade contributed 10.2 percent of the explained variance in test anxiety, previous web-based course experience contributed 0.4 percent of the explained variance, and Locus of Control of Behavior contributed 5.9 percent of the explained variance.

Table 4.
Regression Analysis Results Predicting Test Anxiety in Web-Based Science Courses

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$</th>
<th>SE $B$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected grade</td>
<td>0.80</td>
<td>0.27</td>
<td>0.28</td>
<td>3.01</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>Previous web experience</td>
<td>0.40</td>
<td>0.63</td>
<td>0.06</td>
<td>0.65</td>
<td>0.52</td>
</tr>
<tr>
<td>Locus of Control of Behavior</td>
<td>0.59</td>
<td>0.22</td>
<td>0.25</td>
<td>2.69</td>
<td>&lt; .01</td>
</tr>
</tbody>
</table>

Notes: Multiple $R = .405$, $R^2 = .164$, adjusted $R^2 = .140$
Research Question 5

Are there associations between student experience of test anxiety, experience in science or web-based courses, or their communication with their instructors? Do student perceptions influence their experience of test anxiety?

The original research design had intended for the interview participants to be divided approximately equally between students who had taken traditional and web-based science courses. However, volunteer participation did not align with that plan. Since the proportion of students in traditional sciences was much higher than students in web-based courses, data analyses explored information obtained from the interviews in a more general scope, without trying to compare traditional and web-based science course experience in particular. However, when appropriate, connections were made between the qualitative information obtained and the quantitative research questions presented above.

Ten students participated in interviews regarding their thoughts and/or experiences about web-based courses, their experiences with studying and testing, and their communication with their instructors (see Table 5). Two had completed their science courses on-line, four had previous experience with web-based courses, and five had not taken and do not plan to take any web-based courses. Nine participants were female, one was male.

Common themes emerging from qualitative analysis of transcripts identified experiences or opinions of web-based courses, methods used for study and test preparation, thoughts and experiences with testing. The participants discussed many issues related to communication. Communication was then split into two major themes: communication with instructors, and communication relating to testing in particular. Information relevant to each theme was grouped together, and more specific sub-themes were identified. Sub-themes identified for each are identified in Table 6. Each of these themes and sub-themes will be expanded below.
Table 5.
Interview Participant Information

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Gender</th>
<th>Age</th>
<th>Science course completed</th>
<th>Format</th>
<th>Previous web courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kate</td>
<td>F</td>
<td>20</td>
<td>Aquatic Life</td>
<td>Web</td>
<td>No</td>
</tr>
<tr>
<td>Ann</td>
<td>F</td>
<td>29</td>
<td>Aquatic Life</td>
<td>Web</td>
<td>Yes</td>
</tr>
<tr>
<td>Sue</td>
<td>F</td>
<td>21</td>
<td>General, organic, and Biochemistry I</td>
<td>Traditional</td>
<td>No</td>
</tr>
<tr>
<td>Herschel</td>
<td>M</td>
<td>26</td>
<td>Human Ecology</td>
<td>Traditional</td>
<td>No</td>
</tr>
<tr>
<td>Mary</td>
<td>F</td>
<td>45</td>
<td>Body Structure and Function</td>
<td>Traditional</td>
<td>No</td>
</tr>
<tr>
<td>Beth</td>
<td>F</td>
<td>48</td>
<td>Human Ecology</td>
<td>Traditional</td>
<td>No</td>
</tr>
<tr>
<td>Jane</td>
<td>F</td>
<td>21</td>
<td>Environmental Science</td>
<td>Traditional</td>
<td>Yes</td>
</tr>
<tr>
<td>Alice</td>
<td>F</td>
<td>20</td>
<td>Environmental Science</td>
<td>Traditional</td>
<td>Yes</td>
</tr>
<tr>
<td>Ellen</td>
<td>F</td>
<td>20</td>
<td>Human Ecology</td>
<td>Traditional</td>
<td>Yes</td>
</tr>
<tr>
<td>Lucy</td>
<td>F</td>
<td>19</td>
<td>Human Ecology</td>
<td>Traditional</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 6.
Themes and Sub-themes Identified From Interviews

<table>
<thead>
<tr>
<th>Themes</th>
<th>Sub-Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiences and opinions of web-based courses</td>
<td>Self-discipline</td>
</tr>
<tr>
<td></td>
<td>Flexibility</td>
</tr>
<tr>
<td></td>
<td>Technology use</td>
</tr>
<tr>
<td></td>
<td>Perception of course content</td>
</tr>
<tr>
<td>Study and test preparation methods</td>
<td>Study material and techniques</td>
</tr>
<tr>
<td></td>
<td>Differences in course content</td>
</tr>
<tr>
<td></td>
<td>Differences in course format</td>
</tr>
<tr>
<td>Thoughts and experiences with testing</td>
<td>Role of the instructor</td>
</tr>
<tr>
<td></td>
<td>Preferred test formats</td>
</tr>
<tr>
<td></td>
<td>Flexibility</td>
</tr>
<tr>
<td></td>
<td>Anxiety</td>
</tr>
<tr>
<td>Communication with instructors</td>
<td>Instructor personality</td>
</tr>
<tr>
<td></td>
<td>Course atmosphere</td>
</tr>
<tr>
<td></td>
<td>Perception of response time</td>
</tr>
<tr>
<td></td>
<td>Perception of boundaries</td>
</tr>
<tr>
<td>Communication regarding testing</td>
<td>Personal issues</td>
</tr>
<tr>
<td></td>
<td>Test content</td>
</tr>
</tbody>
</table>

Web-based Thoughts and Experiences

The first major theme identified from review of questionnaires focused on thoughts and experiences about web-based courses. Students with and without web-based course experience expressed concern regarding the self-discipline needed to succeed in an on-line course. Ellen chose to take a traditional science course while taking a different web-based course in the same semester because “…if I had too many Internet classes…I’d just put it all off until the end, and then end up with a mess.” Similar concern regarding scheduling and
appropriate time management were mentioned by others as well. There appears to be a perception of greater accountability when course attendance is required or observed in traditional formats. Interest in the subject matter also influences motivation and self-discipline for on-line course completion, with students indicating that more curiosity or interest in course content is beneficial.

Students who had taken web-based courses mentioned flexibility as one of the main reasons for choosing an on-line format, with time management being a major concern. Being able to take classes around a full-time work schedule, or to avoid coming to campus were mentioned as benefits. Ann, who has taken all of her courses up to this point on-line, stated that “sitting through the lecture…was an absolute waste of time.” Ellen indicated that communication with others influenced her opinion of course format, saying, “…they said it’s better to take it on-line, because it’s not worth coming in every day for that [the lecture].” This flexibility allowed by web-based courses supports the findings of research question one: that significantly more students enrolled in a web-based science course work full time than students in traditional courses.

Surprisingly, technology use was favored by all students participating in the interview, and was not mentioned as a barrier to taking web-based courses. Kate chose to take her science course in a web-based format because she was comfortable with the technology, and felt that the technology could help her feel more comfortable navigating the course content. Herschel and Beth mentioned the convenience of accessing material such as a syllabus or course notes, and Mary stated that taking an exam on-line would not be a problem, as long as course content was delivered in a traditional format. This is interesting, as data for research question three indicated that older students were more likely to experience test anxiety in web-based courses. Herschel, Beth, and Mary are all non-traditional students who have no interest in taking a web-based course. The important distinction here may be between web use and web-based testing. Providing non-traditional
students with web-based course assistance may provide a non-threatening environment helpful in increasing confidence with web-based technology.

Student attitudes towards course content and format also influence some students’ decisions regarding course selection. After taking a Spanish class on-line, Jane felt she would have been better off in a traditional format. Sue and Beth expressed the opinion that since they were not academically strong in the area of science, they were better off in class than working through the material at a slower, personal pace on-line, instead of trying to keep pace with the class in a traditional format. Herschel clearly conveyed this common attitude, saying “…not that I disagree with them offering on-line courses, I just don’t think it’s for me.”

Test Preparation and Study

The second major theme identified focused on study and test preparation methods. All participants were asked what materials and methods they used to study, or to prepare for tests in a course. Alice, Ellen, and Sue found outlines posted on-line by their instructor to be helpful in focusing on material to be studied, using the textbook as an additional resource for vocabulary or main concepts if needed. Jane expanded this idea further, saying she found she was most successful in her class after “going through the slides and highlighting them first and then going back and writing them all out, and then going through them again, probably a couple more times…” Lucy and Mary found their own notes from class to be most beneficial. Lucy would also use the text to review vocabulary, while Mary said she used the text “very rarely.” Ann and Kate both concentrated on the “lecture” material provided for their web-based courses. Only Herschel mentioned reading of the chapter as a useful way to study.

A relationship between course content and studying also emerged. Herschel and Lucy stated that science required studying, while other courses did not. Lucy explained some of the content differences, saying “I really don’t study for other classes. I don’t study for English because there’s not much you can study for, you know, it’s kind of comprehensive. Math,
well, I don’t get it. I don’t know. Science involves things that are more…it’s more stuff that’s not really necessarily common sense, like it’s stuff that you have to learn.”

Differences in course format and studying were also mentioned by students with web-based experience in previous courses. Jane stated that in web-based courses, “you have to read the book yourself actually, and some of them will give you a heads-up of what’s going to be on the test…and then you have to just go back and make sure that you know those out of the book.” This is in contrast to her traditional courses, where she found more success in studying from the notes. Ellen also mentioned a difference, stating that “because like for the lecture classes, I use my notes from the lecture of the day, you know, to look at. But with online classes, you don’t have that. So usually, ‘cause all the ones I’ve taken, the professors give you an outline, like a review thing, so I’d look at that and go from that. Then I’d read over sections again, read over bold words, that sort of thing.” Ellen made similar comments, and felt that web-based instructors were often more clear about their expectations. Kate also cited a preference for studying in web-based courses, saying that “I find it a lot less stressful with web-based in studying, because you have everything right there and you can just go back and you can repeat.”

Test taking

The third major theme to emerge from interviews related to experiences with testing. Here, Mary and Sue spoke of the difference an instructor can make during testing. In describing her biology instructor, Mary said “And he was very nice with the testing and explaining stuff. That right there makes you not real nervous when you have a test.”

Several participants voiced strong preferences about test format. Mary, Ann, Kate, and Herschel prefer multiple-choice questions. As Mary said, “It jogs my memory…and I know why the answers are wrong, so I like that.” Beth describes herself as preferring essay, but comfortable with multiple choice. Beth, Ellen, Lucy, and Sue prefer essay. Lucy stated that “I prefer essay, because then you can--with the multiple choice, you’re either wrong or
you’re right, but with an essay, you can explain why you think the way you do, you can show that you’ve learned the material.”

Participants also cited differences between traditional and web-based courses, but here opinions differed. Jane finds more open-book tests are offered on-line than on campus. Ann, however, commented that her web-based courses are more likely to present only one question at a time, in order to prevent use of the book. Kate prefers the scheduling flexibility in web-based courses, saying that tests are usually offered over a four-day period, leading to a more relaxed experience. However, Ellen holds a different opinion, due to distraction and firm time limits set for web-based tests.

Several participants discussed anxiety related to tests. Alice and Beth both discussed anxiety in terms of worry or nervousness that begins more than a day before the test, and continuing through the day of the test, and possibly after the test, depending on how comfortable they are with their performance. Alice finds her anxiety becomes worse if she is distracted by others in the class, saying that “sometimes when I’m in the classroom, I like to be the first one done, and when I see other people are done before me, I get really nervous that they know what they’re doing and I don’t know what I’m doing.” This is interesting, as data for research question two indicated that students in traditional courses experience significantly higher levels of test anxiety, mainly due to increased test irrelevant thoughts. The comparison to others is not possible in a web-based testing environment, although it is something Alice and others seem to be particularly aware of in a traditional format. For Beth, this stress can lead to a tension headache, and finds her hands shake during a test. This illustrates the importance of recognizing many facets or experiences of test anxiety. Even though results of this study did not indicate a significant difference in bodily symptoms between traditional and web-based courses, students such as Beth must cope with this type of physical disturbance. However, she also said that “…even though I still get nervous for tests, I have improved the more I take tests and get more comfortable in class.” Mary and Herschel also mentioned stress occurring the day of an examination. Kate only finds herself becoming
stressed when she is unsure of what will be covered on the test. Jane and Lucy described themselves as fairly comfortable with testing, and did not express any particular concern.

*Communication*

Communication with instructors was an issue relevant to most participants. Here, instructor personality and classroom atmosphere were often discussed. Beth, Mary, and Lucy all included preference for direct classroom and instructor interaction as a reason to avoid web-based courses. Beth spoke about the importance of flexibility in the classroom, saying “…the instructor makes a big difference, because if the instructor is open to discussion during the class, and even though you don’t stick entirely to what he or she plans for a particular night, you know, following the schedule, for me that works a lot better…but if they want to go out a little, and let you learn outside of that area, it makes it a better class.” Kate spoke along similar lines, saying that “It helps me when they’re really approachable, meaning they don’t get--meaning they have patience, they don’t get mad easily, like with little things and stuff throughout the class…if I have a question, or if I’m having trouble, no matter what the--how approachable a teacher is, I’ll usually go up and ask then anyway, if it’s something I can’t find on my own. If he’s unapproachable, I usually try and go find it on my own.” Herschel also discussed the importance of having a good relationship with the instructor in comparing the two science courses he had taken. He said that just “liking” the instructor can make a big difference, and that for him, “I’m not using it as a crutch, but I feel like it kind of made a difference in you know, wanting to be there. I cut a lot more of my Human Biology class than I did my--I think I only missed one Ecology class…It [Human Biology] almost felt like a social club, and I really wasn’t there for that. I just wanted to get my science out of the way.

Almost all participants communicate with their instructors outside of class, either by waiting to ask questions immediately after class, or by e-mailing at a later time. E-mail was listed as the primary method for communication with instructors, with Kate describing finding an instructor during office hours only as a “last resort.” She expanded further, saying
“...on campus, teachers or professors are in a hurry to go to their next class or they have appointments somewhere or what not, so when you, they can only give you quick answers, usually, if they’re in a hurry. With Internet courses, usually it’s--they have time to tell you what the answer is and (...) help you out, give you the steps of what you need to do if it’s a question about something that you’re not sure of in class.”

Web-based instructors were perceived as having a faster response time to their students. Alice said that “It would be faster for the web-based class, because the teacher needed to contact students via e-mail pretty much 90 percent of the class, because there was no face to face. The immediacy that I got from the other teacher, like the class-based courses, was pretty effective. It came, like, within the next day.”

The participants are respectful of boundaries between an instructor’s work and private time. This seems to be part of the reason e-mail is preferred as a means of communication. Ellen felt that “For on-line classes, I prefer not to do it in person, because, it’s like it’s an on-line class, you don’t really have to…I think they prefer it, to be contacted on-line seeing as it’s an on-line class.” Herschel explained that several of his instructors had given out their home telephone numbers, but that he had never found a reason to use that contact information.

*Communication About Testing*

Finally, participants discussed their communication specifically relating to testing. The first area here included communication relating to personal issues, such as anxiety. This was an area not commonly discussed with instructors. Alice, Jane, and Mary made statements that their emotions during testing were personal, and not something relevant to their instructors. Even Beth, who experiences headaches due to tension stated that “…I think it’s a personal thing with me, and other than where I’m really really really not understanding the material, I don’t think the instructor can help me with that, so I don’t usually approach them about it.” Herschel was the only participant self-identified as a special needs student with
Attention Deficit Disorder. Even he stated that “…it’s not their problem…I don’t want to rely on it as a crutch.”

Although personal issues relevant to testing were not commonly discussed, the participants were willing to discuss test format with their instructors. Here, it seems that knowing how questions will appear on a test (e.g., multiple choice, essay, fill-in) is important to students. Lucy discussed this directly, saying that “I think all students like to be prepared as to what kind of format is going to be on the test: true or false, multiple choice, essays. And, for the most part, all of my instructors let us know what the format would be, which is helpful.” Ellen discussed the willingness of one instructor in this type of situation. “A bunch of us actually stayed after class to ask her how our grades are, you know, so we knew how good we need to do on the tests, and what way she was going to form the test, like if it was going to be multiple-choice, we just have to work out problems and show our work and stuff like that….so I don’t think she was quite equipped to like answer our questions about it because she hadn’t made the test yet. But that worked out good, because then all of us just talked, we figured out how we wanted the tests, how it would be easier for us and for her.”

Through this qualitative exploration, it seems that there are several common issues for the students interviewed. However, experiences with test anxiety or course format do seem to influence how students perceive and react to some issues. This is an intersection that may influence whether students choose to enroll in a web-based course.

Summary

This study did find differences in test anxiety and attitudes of college science students in traditional and web-based courses. The quantitative research presented showed differences between students in traditional and web-based courses, as well as differences in test anxiety between formats, and factors that predict some aspect of test anxiety. The qualitative research presented identified common themes in the experience of students in traditional and web-based science courses, and highlighted differences between students with and without
previous experience in any web-based courses. The next chapter will summarize the findings presented here, and present conclusions about the current research, along with recommendations for practice by science instructors and for future research.
CHAPTER V
SUMMARY, DISCUSSION, AND RECOMMENDATIONS

The purpose of this study was to investigate differences between students in traditional and web-based science courses, to determine whether differences occur in factors relating to test anxiety in traditional or web-based courses, and to better understand the experience of students in college science courses. The research questions and summary of major findings are re-stated below. This is followed by discussion of these findings, recommendations for practice of college science instructors, and recommendations for future research. Limitations of the current study will also be discussed.

Summary of the Method and Findings

This research was designed with an explanatory mixed-method design, using questionnaires followed by semi-structured interviews in order to understand the experience of test anxiety of students in traditional and web-based science courses. Questionnaire data were collected in the second half of the spring 2007 semester, with interviews in the following summer session. One hundred and ten students completed the questionnaire in traditional science courses, and 117 completed the questionnaire in web-based courses. A total of ten students participated in the follow-up interview, two from web-based science courses, and eight from traditional science courses. A summary of the results is presented below.
Research Question 1

Are there differences in demographics or personal factors between students enrolled in traditional or web-based science courses? Demographics include age, race/ethnicity, and gender. Personal factors include number of credit hours being taken, and number of hours worked per week, degree program currently being pursued, and locus of control.

There were not significant differences in the age, racial/ethnic background, full-time or part-time student status, or degree or program being pursued by students in these courses. However, significantly more females, more students with full-time jobs, and a more external locus of control were enrolled in the web-based science courses.

Research Question 2

Are there differences in components of text anxiety (levels of worry, tension, bodily symptoms, or test-irrelevant thinking) between students enrolled in traditional or web-based science courses?

Test anxiety is higher for students in traditional courses, primarily due to test-irrelevant thoughts. No other differences among the components of test anxiety were found between the two course formats.

Research Question 3

Is total level of test anxiety impacted by age, gender, course format, or locus of control?

Students from 18-24 years of age experience more anxiety in traditional courses, while older students experience more anxiety in web-based courses. Total level of test anxiety was not impacted by any other factor, or any other interaction of factors explored here.
Research Question 4

*Do student characteristics of locus of control, expected course grade, or previous course experience (both previous science courses and previous web-based courses) significantly predict level of total test anxiety in traditional or web-based science classes?*

A small portion of test anxiety can be predicted by expected course grade and locus of control for students in traditional courses, or by previous web experience, expected course grade, and locus of control for students in web-based courses. In the current study, the number of students with previous experience in science courses was not adequate for analysis, and could not be investigated.

Research Question 5

*Are there associations between student experience of test anxiety, experience in science or web-based courses, or their communication with their instructors? Do student perceptions influence their experience of test anxiety?*

Students with experience in both formats spoke about their thoughts and perceptions of web-based courses, studying or test preparation, testing, communication with instructors, and communication relating specifically to testing. Most students mentioned benefits of flexibility in web-based courses, and several mentioned the need for self-discipline in order to successfully function in an on-line course. Opinions about testing were divided, with some students preferring multiple choice, while others preferred essay. Students reported using class or provided notes as a preferred study method. However, opinions of interaction with instructors or others in the class were divided. Those with web-based experience cited rapid feedback, while those preferring the classroom environment cited the benefits of immediate feedback through class discussion. For all students, e-mail was mentioned as the primary method for communication outside of the classroom.
Discussion and Conclusions

Demographic and Personal Factors

Previous research had identified some demographic and personal differences between traditional and web-based students. These include finding more Caucasian students who work full time (Halsne & Gatta, 2002), higher proportions of female students (Halsne & Gatta, 2002; Dupin-Bryant, 2004), and students with a more external locus of control (Wang & Newlin, 2002), in web-based courses than in traditional courses. These earlier findings were not completely supported by the current research.

The present study did not find a difference in the age of students enrolled in traditional or web-based science courses that has been reported in previous research (Halsne & Gatta, 2002; Sullivan, 2001). This finding is interesting when the interview information is considered. Non-traditional interview participants expressed stronger opinions about web-based courses, specifically the avoidance of that course format. Since completion of a science course is a common degree requirement, the subject itself may also account for these findings. Students close to degree completion may seek any science class to fit into their schedules. If that is the case, both traditional and non-traditional students may find web-based courses to be a better scheduling option, regardless of format preference.

Ethnic composition was not significantly different between traditional and web-based science courses. This is an encouraging result, as the ethnic distribution of participants in this study mirrored the distribution of the college, as well as the community. Data indicate that access to home computers and the Internet is increasing for all ethnic groups, despite a consistent gap between Caucasian or Asian households, and African American or Hispanic households (Salpeter, 2006). The consistency with the racial/ethnic composition of the surrounding community in the present research may be due to a decrease in the gap relative to computer access when compared to 2001, when Halsne and Gatta were conducting research.
Significantly more female students were enrolled in web-based science courses. Although the current study investigated employment and full time or part time student status, parenting was not a variable investigated. The higher number of female students in web-based classes may reflect demands of child care, and easier scheduling as a result of the flexibility offered through web-based courses. This was an idea expressed by the research of Sullivan (2001), finding that a high percentage of female students found web-based courses to be beneficial due to demands of parenting. Higher female enrollment in web-based science course may also be influenced by stereotype threat (Greenburg & Mallow, 1982), causing female students to avoid the traditional classroom setting. The perceived anonymity in web-based course is likely to make female students, and especially non-traditional students, more comfortable as they attempt a difficult course.

There was not a significant difference in the number of students in web-based and traditional science courses enrolled on a part-time or full-time basis. These findings are in contrast with earlier research that identified more part-time students enrolled in web-based courses (Halsne & Gatta, 2002). Timing of the two studies may account for the difference in part-time or full-time student status. Web-based offerings have increased dramatically since 2002 (Sloan Consortium, 2006). It is possible that as more web-based courses were offered, more full-time students began to take advantage of that opportunity. The flexibility of web-based instruction means web-based courses fit around hectic work schedules, as well as around more intense academic schedules. By taking a web-based course, full-time students may find scheduling their other courses to be easier.

This research also supports previous studies showing that students in web-based courses are more likely to work full-time (Halsne & Gatta, 2002). It is reasonable that students who work full-time would prefer the flexibility allowed by web-based courses, an idea also supported by interview participants in the current study. Being able to access course material at any time, and achieving academic improvement (e. g., degree completion) was mentioned by participants in an earlier study (Sullivan, 2001). It seems reasonable that
students still view accessibility as a factor promoting academic and professional achievement.

No differences were found in the level of education (degree or certificate) being pursued. This is logical when considering the larger academic context, because at least one science course is required by most liberal arts programs (Associate’s or Bachelor’s degrees). The even distribution between traditional and web-based science courses is likely a reflection of program requirements.

The present study supported earlier research findings that web-based students have a more external locus of control (Wang & Newlin, 2002). Students with a more internal locus of control may prefer traditional courses that offer direct interaction with other students and their instructor, and allow for more immediate feedback during the learning process. Desire for direct interaction with the instructor, as well as others in the class, was cited by interview participants as a benefit of traditional courses. In contrast, students with a more external locus of control may be more attracted to a web-based format. As these students feel performance results are due to chance or luck, they may feel that classroom interactions would not influence their performance, and prefer the more independent environment of web-based courses.

Test Anxiety

Although this study found test anxiety to be higher in traditional courses, only test-irrelevant thinking made a significant contribution to this experience, which may be partially explained because of the actual examination setting. Students in traditional classrooms would be more likely to experience distractions due to other students in the room, while students in web-based courses have more control over their surroundings during an examination. For students who experience test anxiety, this control may provide a substantial benefit during testing (Carter, 2002).

Students who experience test anxiety may be less likely to choose web-based courses. Previous research indicates that students with test anxiety are often aware of their difficulties
in learning and testing (e. g., Covington, 1985; Rost & Schermer, 1989), and that a more comfortable classroom environment may decrease the experience of text anxiety (Hancock, 2001). This interaction may lead a test anxious student to choose a traditional course. The familiar environment of a traditional course is likely to be preferred by student who experiences test anxiety.

Of the potential factors impacting test anxiety, only the interaction of age and course format showed a significant effect. Higher levels of test anxiety were found for younger students in traditional classes, and for older students in web-based courses. Previous research had indicated older students to be less flexible in their learning styles (Jerusalem et al., 1985). Older students may be returning to school with more anxiety than their younger counterparts. In a web-based learning environment, these students may be less willing to ask for help, but feel more comfortable in a traditional classroom where questions can be immediately answered.

Previous research indicated that uncertainty of course expectations to be associated with higher levels of test anxiety (Rost & Schermer, 1989). This may also help explain the interaction noted above. Younger students may be unsure of their role as a student and be intimidated in a classroom setting, making them more vulnerable to test anxiety. In a web-based course environment, the student may feel more comfortable and feel less embarrassed about asking a question when he or she can be more anonymous, either through a discussion board, or e-mail. Friedman and Bendas-Jacob (1997) found a threat to perceived self-image or self-efficacy due to expected failure on tests, as well as threat to social status if failure on a test was made public. Younger students may be more vulnerable to the opinions of others in the traditional classroom setting.

Expectation of lower grades and a more internal locus of control predicted higher levels of test anxiety in traditional and web-based science courses. Several prior studies have indicated that students with test anxiety score lower on exams and in classes (e. g., Sogunro, 1998; Spielberger, 1979; Zeidner & Nevo, 1992), and that students with higher levels of test
anxiety are more likely to predict lower performance than students with low-test anxiety (Miesner & Maki, 2007). This balances the present finding that students expecting a lower course grade also experience higher levels of test anxiety.

The findings of this study suggest that as locus of control becomes more internal, test anxiety increases. This contradicts earlier research showing students with test anxiety had a more external locus of control (e.g., Butterfield, 1964; Shelton & Malickrodt, 1991), and is at odds with other research that found no relationship between test anxiety and locus of control (Choi, 1998). Current results seem to indicate that a student who accepts more responsibility for academic performance is more likely to experience test anxiety. This is consistent with earlier studies that have found test preparation behaviors, such as concentration, preparation, and extensive review for approaching tests, are related to a more internal locus of control (Huwe et al., 1998; Kondo, 1997). Negative self-descriptions made by test anxious students also seem to indicate a more internal locus of control (e.g., Spielberger et al., 1976).

The disparity between the present results and prior research indicate a complex situation surrounding the issues of test anxiety and locus of control. One possible explanation is that locus of control is changing over time, with younger students possessing a more external locus of control than students in previous generations (Twenge, Zhang, & Im, 2004). This effect would help explain the interaction of student age and course format on test anxiety, showing traditional students experience more anxiety in a traditional classroom format, while non-traditional students experience more anxiety in web-based courses. Although there was not a direct effect of locus of control on test anxiety, it may be a mediating factor between age and course format. Another possible explanation is that the relationship found between test anxiety and locus of control indicated by this research may be specific to science anxiety, which has not been examined in prior research. The timing of the current study may also help explain the findings. It is possible that students with a more
external locus of control dropped their science course during the first half of the semester, if lower performance were considered to be a matter of chance or luck.

*Student Experience*

The current qualitative analysis supported previous research indicating students feel web-based courses allow more scheduling flexibility, require more self-discipline in order to perform well (Halsne & Gatta, 2001; Sullivan, 2001), and that students who work full-time perceive a major benefit in being able to pursue continued education through web-based courses (Sullivan, 2001). Students preferring both traditional and web-based courses made comments about the learning environment. Students favoring traditional courses mentioned interactions with instructors or classmates on a direct basis, while students preferring web-based courses mentioned the advantages of interactions through course discussion boards. In all, both formats support a community feeling in the course. Since environment can increase positive opinions about a course and decrease test anxiety (Stefanou & Salisbury-Glennon, 2002), it is interesting to note that some students are able to experience that feeling of community involvement without communicating in person.

Students indicated use of notes and repetition as ways to study, and some noted that studying was unique to their science courses. This may be in part because the students expected science courses to be more difficult, and anticipated needing to do more work as well. Unfortunately, the repetition and other study methods most commonly discussed were indicative of memorization attempts characteristic of students with higher levels of test anxiety (Fransson, 1977; Kondo, 1997). Students who had taken web-based courses also spoke of putting more effort into web-based courses, because they were responsible for working through course material without a lecture. This supports the research of Wang and Newlin (2002), as it seems more students with an external locus of control enroll in web-based courses because they feel that course outcome depends more on chance. However, the students with a more internal locus of control were more likely to be successful, due to the additional effort put into web-based courses.
Student opinion on testing was divided between preferences for multiple choice or short answer formats on tests, and for some students, preference of test format varied depending on the course material. Miesner and Maki (2007) found test anxiety to be a stronger factor on essay than multiple choice tests. In a subject such as science, where students may be entering the course with the opinion that the material is difficult, multiple choice tests may provide the students with more opportunity to recognize the learned material. There may be a greater benefit for students in web-based courses, where feedback for multiple choice questions can be provided as soon as students finish an exam, which may be particularly beneficial to students who experience test anxiety (DiBattista & Gosse, 2006).

Although test anxiety was not mentioned frequently in the interview process, it was an issue for two of the students in particular. These students discussed issues relating specifically to test irrelevant thoughts, either due to activity in the classroom or due to recognition of bodily symptoms triggered by anxiety. Previous research had also found a higher incidence of test anxiety for students distracted during testing situations (Avero & Calvo, 2000; Keogh & French, 2002). Neither participant discussing their experiences of test anxiety had completed a test in a web-based environment. It is possible that away from a normal classroom context, students who regularly experience test irrelevant thoughts--and performance deficits due to those thoughts--may perform at a higher level.

Participants in the current study prefer to use e-mail as the primary method for communicating with the instructor of traditional or web-based courses outside of class. Students here seemed to prefer the quality of feedback received through e-mail, and also considered it an effective method of receiving help while respecting the instructor’s privacy and schedule. Previous research had found similar results, adding that students also prefer the privacy of e-mail, as well as the time to clearly think out and ask questions without fear of embarrassment that may occur within a classroom (Kitsantas & Chow, 2007).

Although many felt their teachers were “nice” or “approachable,” they did not view test anxiety, or their feelings during tests, as subjects to be discussed with their instructors.
Previous research on student interactions found distance learning environments provided less threatening ways for students to seek help through e-mail or discussion boards (Kitsantas & Chow, 2007), and that shy students preferred communicating in web-based courses where they had time to compose their thoughts without seeing a physical reaction from their fellow students (Sullivan, 2001). Technology in general, and web-based courses in particular, may be a way for students to become more comfortable interacting with their peers and instructors, and eventually more able to initiate discussions about difficult topics such as test anxiety.

**Recommendations**

The findings of this study suggest a number of recommendations for college instruction in traditional and web-based courses, and for science courses in either format. Students are often faced with difficult scheduling demands due to other academic requirements, family, or professional demands. The scheduling flexibility offered by web-based courses may seem like an ideal solution for many students. However, in order to have a successful college experience, a student should consider self-evaluation prior to enrollment in web-based courses (e.g. Kerr, Test of Online Learning Success). Use of such assessments may assist individuals in determining whether a web-based course would be an appropriate learning format.

Determining how to evaluate a course is an important consideration for any instructor. Currently, the National Science Teacher’s Association advocates multiple forms of assessment, including items such as portfolios, laboratory practicals, or group projects (NSTA Official Positions). Science faculty of at least one college view portfolios as a comprehensive tool evaluating student progress through an academic program (Roecker, Baltisberger, Saderholm, Smithson, & Blair, 2007). This multifaceted approach could help test anxious students.

While multiple assessment methods do provide a more complete view of student learning, exams are likely to be part of this assessment process. Somewhat surprisingly,
students in this study said they preferred multiple choice tests, particularly in less subjective academic areas such as science. This preference is supported by studies that indicate performance advantages for this format, as well as increases in subject comprehension (Clary, Wandersee, & Elias, 2007; Miesner & Maki, 2007). Multiple choice tests also allow quicker grading and more rapid feedback, particularly in web-based courses. As this may decrease the experience of test anxiety for some students (DiBattista & Gosse, 2006) considering use of multiple choice tests, as one method of evaluation, may provide a benefit to all students.

**Recommendations for Instruction of Traditional Courses**

Although the effect was small, test-irrelevant thinking caused an increase in test anxiety for students in traditional formats. Instructors should be aware of this, and work to discourage distractions in the classroom. Asking students to bring only required materials to their seat, leaving spaces between seats when possible, and minimizing talking and other interruptions during tests to reduce distraction may be beneficial. Placing written reminders throughout the test to keep focus on the task at hand may reduce internal distractions. Although it would not be possible to remove all distractions, these are small changes an instructor can make that may benefit students with test anxiety.

Students, especially test-anxious students, are likely to benefit from a comfortable classroom environment. It seems likely that technology can provide students with a direct, non-threatening avenue for communication with their instructors (Kitsantis & Chow, 2007). For a student with any type of performance anxiety, communicating using technology is likely to be preferred to asking questions in class, or seeking out an instructor during office hours. Encouraging students to use e-mail, discussion boards, or instant messaging to communicate with the entire class, is likely to benefit students in both traditional and web-based classes. Instructors should take advantage of resources provided to their classroom, and make efforts to be aware of the technology they can easily access.

**Recommendations for Web-based Courses**
A continued increase in offerings of web-based courses in a variety of disciplines can be expected to benefit many members of the student population. The population of web-based students seems to be becoming increasingly diverse as access to technology continues to improve (Salpeter, 2006). Students may benefit from the web-based classroom environment where racial/ethnic, age, and even gender cues are often removed from classroom interactions (Kitsantas & Chow, 2007). This allows a greater freedom of expression with a decreased risk of stereotype threat impeding student progress.

Instructors in web-based courses should regularly remind students that their performance is impacted by their participation, because these students are more likely to have an external locus of control. Requiring frequent assignments or discussions may help students with an external locus of control see that their personal activity is impacting their performance. Communication may also increase this feeling. If an instructor provides timely, structured feedback to a student, this is more likely to encourage activity in a web-based course than simply receiving random grades from a faceless instructor.

**Current Limitations and Recommendations for Future Research**

A limitation of the current research is that only one community college served as the sample. Therefore, future research should expand to other institutions. Differences between traditional and web-based students in larger campuses, different parts of the country, or within other academic disciplines will provide additional data and useful comparisons to the current population.

The present study relied on self-report data collected towards the end of the semester. Although the data were anonymous, students may have misrepresented their expected course performance. By the second half of the semester, it is possible that many students had already withdrawn from their courses due to poor performance or for other personal factors. In response to the question “What grade do you expect to earn in your current science course?” one traditional student reported expecting a “D,” while one web-based student reported expecting a “D” and one reported expecting the grade of “F.” When considering the impact
of expected grade on the predicted level of test anxiety, future research allowing access to actual course performance would help strengthen this finding.

The current research found several differences from earlier studies. In particular, demographic and personal factors indicate that the current population is distinct from groups in previous studies. One possible explanation is that the interaction between an increasing number of web-based courses being offered along with improved technology access has created a substantial shift in the population of web-based students. Longitudinal analysis directly exploring changes in course offerings and course enrollment may help to explain these issues.

Although research presented here provided significant predictions for test anxiety, only a small number of factors were examined. Future research should continue to expand on other factors that predict test anxiety. Because this study did not obtain significant numbers of students with previous science experience, this is one factor in particular that should be investigated further.

The interaction between test anxiety and locus of control is an interesting one, and worth further consideration. Current findings contradicted earlier results showing that students with test anxiety had a more external locus of control (e.g., Butterfield, 1964; Shelton & Mallinckrodt, 1991), or that there is no relationship between test anxiety and locus of control (Choi, 1998). Descriptions of other characteristics, such as accepting blame for poor performance as a personal characteristic (Spielberger et al., 1976), seem to indicate a relationship between test anxiety and an internal locus of control. Studies so far have explored this relationship on a relatively small scale, looking at one or a few classes at a time. Larger scale research, across several disciplines, may provide beneficial information for analysis.
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achievement motivation college students for performance on examinations.
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Appendix A.

Instructor Information Letter

My name is Meghan Andrikanich, and I am a laboratory instructional assistant in biology here at LCCC, and a Ph.D. student in Urban Education at Cleveland State University. My dissertation research is titled “A Comparison of Student Test Anxiety in Traditional and Web-Based Science Courses,” which is the reason for this packet you are receiving.

Please review the enclosed information, and let me know if you would be willing to distribute my survey to students in your course. This research has been approved by Dr. Wells at LCCC, and by the Institutional Review Board for Human Subjects in Research Committee at CSU. I have enclosed the informed consent, as well as the survey measures for your consideration. The informed consent must be collected, but will be stored separately from actual surveys to protect student information.

Please note that I will not disclose raw data to instructors, in order to preserve student confidentiality. However, I would be very happy to provide you with a summary of my analysis and conclusions if you are interested.

If you would be willing to ask your students to participate, please complete the form on the last page and return it to my mailbox in PS 210. I will then provide you with the appropriate number of surveys, or e-mail the web-link students can visit to complete the survey.

Thank you for your time.

Meghan Andrikanich
Appendix B.

Questionnaire Informed Consent

You are being asked to participate in a research project at Cleveland State University that is being conducted by Meghan Andrikanich in order to fulfill a Ph.D. in Urban Education, under the supervision of Dr. Rosemary Sutton. Through this project, we hope to gain a better understanding of characteristics of adult students enrolled in science classes. Any further questions about the research, or information on the outcomes of this research can be obtained by contacting Meghan Andrikanich at (216) 402-7938, or Dr. Sutton at (216) 687-4753.

You must be 18 years or older to complete this survey. Otherwise, please destroy or return this survey.

The survey will take approximately 20 minutes of your time. Results will be maintained in an electronic format only. Information you provide will remain anonymous. No identifying information will be included in the write-up of this research. Your participation in this research is completely voluntary. You may choose not to respond to any question, and if, at any time, you wish to withdraw from the research, you are free to do so. There are no foreseeable risks to you, beyond those of daily living, for participating in this survey.

Please choose an option below the following paragraph: I have read and understand the information that has been provided regarding the procedure, my tasks, and the risks that may be involved in this research project. I understand that my participation is voluntary and that I may withdraw at any time. If I agree to participate, I promise I am at least 18 years of age. I understand that if I have any questions about my rights as a research subject I can contact the CSU Institutional Review Board at (216) 687-3630.

___________________________________________________________________

Signature Date
Appendix C.

Background Information

What is the name of the college/university you are currently attending?
___________________________________________

In what type of program are you currently enrolled?

( ) certificate
( ) Associate’s degree
( ) Bachelor’s degree
( ) post-baccalaureate, other

What is your major?
____________________________

What is your gender?
( ) male
( ) female

How many hours per week do you work?
____________________________

What is your year in school?
( ) freshman
( ) sophomore
( ) junior
( ) senior
( ) graduate student
( ) post-baccalaureate, other

How old are you?
____________________________

How many total credit hours are you registered for this semester?
____________________________

Please describe your racial/ethnic background.
____________________________

What is the name of the science course you are currently enrolled in? Please list only the course that offered you this survey.
____________________________

Did you have a choice between taking this course in a web-based format or in a traditional format?

( ) yes
( ) no
What grade do you expect to earn in this course?

( ) A  
( ) B  
( ) C  
( ) D  
( ) F

Are tests in this course open book or open notes?
( ) yes  
( ) no

Please list any courses you have taken that used any web-based technology. This would include optional use of notes or discussion boards to complement classroom activities.
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

What were your grade(s) in these courses?
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

Please list previous college-level science courses you have completed.
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

What were your grade(s) in these courses?
_____________________________________________________________________

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Appendix D.

The Reduced Reaction to Tests

Please evaluate each of the following statements. Indicate whether the statement is not at all typical of you, only somewhat typical of you, quite typical of you, or very typical of you.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Not at all typical of me</th>
<th>Only somewhat typical of me</th>
<th>Quite typical of me</th>
<th>Very typical of me</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel distressed and uneasy before a test</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>I have fantasies a few times during a test</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>While taking tests, I find myself thinking how much brighter the other people are</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>I feel jittery before tests</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>I think about current events during a test</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Thoughts of doing poorly interfere with my concentration during tests</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>While taking a test, I feel tense</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>During tests I find myself thinking of things unrelated to the material being tested</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>I am anxious about tests</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>I sometimes find myself trembling before or during tests</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>While taking tests, I sometimes think about being somewhere else</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>My mouth feels dry during a test</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>I have an uneasy feeling before an important test</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>The thought, &quot;What happens if I fail this test?&quot; goes through my mind during tests</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>During tests, I find I am distracted by thoughts of upcoming events</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>During a difficult test, I worry whether I will pass it</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>After a test, I say to myself, “It’s over and I did as well as I could.”</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>I feel the need to go to the toilet more often than usual during a test</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>During tests I think of how poorly I am doing</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>I get a headache before a test</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
Appendix E.

The Locus of Control of Behavior

Below are a number of statements about how various topics affect your personal beliefs. There are no right or wrong answers. For every item there are a large number of people who agree and disagree. Please rank each item based on how much you believe the choice to be true.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Generally Agree</th>
<th>Somewhat Agree</th>
<th>Somewhat Disagree</th>
<th>Generally Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

I can anticipate difficulties and take action to avoid them………………………1…..2…..3…..4…..5…..6
A great deal of what happens to me is probably just a matter of chance………. 1…..2…..3…..4…..5…..6

Everyone knows that luck or chance determines one's future. .........................1…2…3…4…5…6
I can control my problem(s) only if I have outside support. .........................1…2…3…4…5…6
When I make plans, I am almost certain that I can make them work………………1…2…3…4…5…6
My problem(s) will dominate me all my life. ………………………………………..1…2…3…4…5…6
My mistakes and problems are my responsibility to deal with. …………………….1…2…3…4…5…6
Becoming a success is a matter of hard work, luck has little or nothing to do with it.
………………………………………………………………………………………………………………………………………………….1…2…3…4…5…6

My life is controlled by outside actions and events. .................................1…2…3…4…5…6
People are victims of circumstance beyond their control. ..........................1…2…3…4…5…6
To continually manage my problems I need professional help. .....................1…2…3…4…5…6
When I am under stress, the tightness in my muscles is due to things outside my control.
………………………………………………………………………………………………………………………………………………….1…2…3…4…5…6

I believe a person can really be the master of his fate. ..............................1…2…3…4…5…6
It is impossible to control my irregular and fast breathing when I am having difficulties.
………………………………………………………………………………………………………………………………………………….1…2…3…4…5…6

I understand why my problem(s) varies so much from one occasion to the next.1…2…3…4…5…6
I am confident of being able to deal successfully with future problems.........1…2…3…4…5…6
In my case maintaining control over my problem(s) is due mostly to luck………1…2…3…4…5…6

Thank you for your time!
Appendix F.

Interview Informed Consent

You are being asked to participate in a research project at Cleveland State University that is being conducted by Meghan Andrikanich in order to fulfill a Ph.D. in Urban Education, under the supervision of Dr. Rosemary Sutton. Through this project, we hope to gain a better understanding of characteristics of adult students enrolled in science classes. Any further questions about the research, or information on the outcomes of this research can be obtained by contacting Meghan Andrikanich at (216) 402-7938, or Dr. Sutton at (216) 687-4753.

The interview will take approximately 45 minutes of your time. Interviews will be audiotaped for use of the researcher only. Results will be maintained in an electronic format only. Information you provide will remain confidential. No identifying information will be included in the write-up of this research. Your participation in this research is completely voluntary. You may choose not to respond to any question, and if, at any time, you wish to withdraw from the research, you are free to do so. There are no foreseeable risks to you, beyond those of daily living, for participating in this survey.

Please choose an option below the following paragraph: I have read and understand the information that has been provided regarding the procedure, my tasks, and the risks that may be involved in this research project. I understand that my participation is voluntary and that I may withdraw at any time. If I agree to participate, I promise I am at least 18 years of age. I understand that if I have any questions about my rights as a research subject I can contact the CSU Institutional Review Board at (216) 687-3630.

______________________________________________
Signature                                      Date
Appendix G.

Student Interview
As you remember, you completed a questionnaire about your science course earlier. The purpose of this interview is to further clarify your experiences in science classes, with testing, and find out about how you communicate with your instructors.

You have taken human ecology in (traditional/web format). Can you tell me more about that course?
Possible probes: Is it a required course or elective?
   Was it offered as a web-based course?
   Has taken any web-based courses? Why/why not?

I see you have/have not taken previous college science courses. Do you plan to take more science courses? Why/why not?

Next I’d like to talk to you more about test-taking.
How do you feel about tests in general?
If the student experiences anxiety: Does this happen in all courses? When are you more likely to experience anxiety?
How do you feel when preparing for tests?
How do you study, or prepare for a test in your science course?
  How is this different from how you study for other tests?
  If the student has taken a web-based course:
     Do you study differently in web-based and traditional courses?
     How is your studying different?
     Do you feel differently about tests or test preparation in web-based courses? Please explain.
Do you feel your test performance usually reflects the amount of effort you put into a class?

(Brief summary of student responses) Is there anything else you would like to add about science courses or testing that we haven’t talked about?

Now I’d like to talk to you about how you communicate with your instructors. Students communicate with their instructors outside of class for many reasons.

In general, how comfortable do you feel communicating with your instructors?

Why/why not?

Do you often communicate with instructors outside of class?

Prompt with: asking for additional help, seeking advice?

How do you usually contact instructors outside of class?

If the student has taken a web-based course, Do you think there are differences in communicating with the instructor of a web-based course instead of a traditional course?

Prompt with: amount of communication? Type of communication? Type of response?

Depending on anxiety discussion above: Have you ever communicated with an instructor regarding your feelings about testing?

If yes, how did your instructor respond?

If no, why?

Prompt with: are you comfortable with tests, are you concerned about the instructor’s response?

Thank you for your time. In the next week, I would like to contact you with a summary of today’s interview to make sure I understand you correctly. What would be the best way to do this?