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ABSTRACT

This study evaluated the instructional benefits and barriers related to the use of online formative and summative assessment tools. Data were collected from samples of undergraduate students in different semesters to allow for differential use of summative assessment (paper versus online delivery). Formative assessment was manipulated by providing online practice quizzes that students could freely access to prepare for the course examinations. For the computer-based summative assessment sample, the quiz access was restricted to only the final two course exams. The impact of computer-based summative and formative assessments on test anxiety, perceptions of tests as threatening events, study skills, and exam performance was investigated. It was anticipated that those students who used the formative assessment quizzes frequently would have significantly higher scores than those who used the quizzes infrequently. These variations in performance could be attributed to group differences in willingness to use study materials and tools; therefore, control of the availability of quizzes was maintained in part of the study to allow for a baseline test, to ensure that differences observed in performance across groups of students using the quizzes could be more confidently attributed to formative assessment use. The online summative tool was anticipated to have no strong impact on the level of anxiety, emotionality, or perceived level of threat posed by the tests. The expectation was that students would hold similar ratings of these affective constructs, regardless of test format. Data support providing online formative and summative assessments in undergraduate courses. Although the data do not allow for declaration that the formative assessment tools decrease cognitive test anxiety, there are relevant gains in course examination performance based on use of the quizzes, particularly for the group of students taking summative assessment tests online. Furthermore, the data demonstrated that there were no disadvantages to using online summative assessment regarding anxiety, emotionality, or study behaviors, and there was actually an advantage in the domain of perceived threat imposed by the impending test. (Contains 23 references.) (AEF)

The Effects of Internet-Based Formative and Summative Assessment on Test Anxiety, Perceptions of Threat, and Achievement

Paper presented at the Annual Meeting of the
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The use of the internet to provide access to course materials has become a relatively standard practice for undergraduate instruction. Lately, the course materials such as syllabi, notes, announcements and email communication has been augmented by the ability to provide assessment tools related to course objectives. This study investigates the impact of providing internet-based formative and summative assessment experiences on students' attitudes about tests, the learning environment, and overall achievement.

The use of formative assessment tools is generally driven by an attempt to either provide the instructor with an accurate estimation of student ability at a particular point in the course, or to provide the students with an assessment task similar in nature to the summative test. This allows the student to identify strengths and weaknesses and to better prepare for the "real" exam. The benefit of formative testing is generally that the students can take a quiz or test in a less stressful situation, as performance does not influence course grades. In this way, it is likely that the level of test anxiety during formative assessment activities is lower than in summative assessments, due to the reduced level of perceived threat or self-awareness regarding evaluative pressure (Kurosawa & Harackiewicz, 1995; Schwarzer & Jerusalem, 1992). Also, because there is generally less emotionality induced in formative testing, the student is more likely to benefit from the self-regulatory processes of reflection following this evaluative performance, which ideally induces growth and promotes future performances (Schutz & Davis, 2000).

One primary factor influencing the efficacy of formative assessment is the manner by which feedback is delivered. The method of feedback used in formative assessment has a clear influence on eventual performance, as well as level of induced anxiety (Clark, Fox, & Schneider, 1998; Wine, Plake, Eastman, Boettcher, & Lukin, 1986; Wine, Plake, Pozehl, Barnes, & Lukin, 1989). Ideally, feedback for formative assessment should follow the strategy of immediate post-performance reporting, providing the full feedback directly after the entire quiz or test has been completed (King & Behnke, 1999). This provides timely feedback and takes advantage of a primary benefit of computer-aided assessment (Jongekrijg & Russell, 1999), while avoiding the problem of inducing anxiety or distraction that is more prevalent in immediate feedback models that provide data after each item. Although there is great enthusiasm among educators regarding the potential for online delivery of formative assessments (Buchanan, 1998), there is little evidence regarding the impact of web-based user-driven formative assessment tools.

As mentioned, a key advantage to the student when completing formative assessment tasks is the ability to relieve evaluative stress or test anxiety. The popular classification of test anxiety has traditionally proposed the presence of two interrelated factors commonly referred to as worry and emotionality (Hembree, 1988). This classification prompted two decades of research that confirmed the presence of the two factors, but also repeatedly demonstrated that worry had the clearest influence on achievement or test performance. However, the term "worry" has been criticized as being an incomplete label for the complex array of cognitive events that are typically included in this factor (Cassady & Johnson, 2001). Thus, we have used the term "cognitive test anxiety" to be more descriptive of the wide variety of cognitive behaviors that can impair performance through manifestation either during a learner's attempts to prepare for or take an examination. These behaviors include (a) comparing self-performance to peers, (b) considering the consequences of failure, (c) low levels of confidence in performance, (d) excessive worry over evaluation, and (e) feeling unprepared for tests (Deffenbacher, 1980; Hembree, 1988; Morris et al., 1981).

The common conceptualization of a student with test anxiety is one who experiences high levels of physiological arousal and distracting thoughts during the evaluation episode, with a related decline in performance (Hembree, 1988). Two factors that have an impact on the final realization of the impact of test anxiety on performance are study habits and skills, as well as perceptions of the level of threat imposed by the evaluative task. Research on the relationship between test anxiety and study skills has shown that students with test anxiety generally spend

more time studying for exams (Culler & Holohan, 1980; McKeachie, 1984). However, the pattern of study habits and behaviors reveals students with high levels of test anxiety have inefficient study strategies, commonly resorting to repetitive tasks in preparation for tests (Wittmaier, 1972) and demonstrating poor time management skills (Kleijn, van der Ploeg, & Topman, 1994; Milgram, Dangour, & Raviv, 1992). Performance decrements for test anxious learners who also have poor study skills are likely due to the combined effects of inadequate processing strategies to encode and store effective cognitive representations of content knowledge and heightened anxiety brought upon by metacognitive awareness of a lack of preparation or ability (McKeachie, 1984; Naveh-Benjamin, 1991; Naveh-Benjamin, McKeachie, & Lin, 1987).

The impact of perceiving tests as threatening episodes is conceptually related to test anxiety, as the belief that a test is threatening is likely to trigger feelings of anxiety. Students with high levels of test anxiety have reported feeling that upcoming examinations are threatening to their academic status, grades, or self-images (Lay et al., 1989). The students with low levels of test anxiety tended to report that these same tasks were challenging. The interaction of test anxiety and perceived threat is explained clearly through a cognitive appraisal model, which suggests that the students have a pattern of repeated failure in evaluative settings that subsequently leads to feelings of self-doubt or worry during test preparation and test taking periods (Schwarzer & Jerusalem, 1992). These feelings of inadequacy are more likely to drive students to identify evaluative tasks as threatening, either to self-worth or academic standing. The impetus for understanding students' perceptions of threat grows out of the interest in maintaining a learning and assessment environment in which the students feel comfortable and motivated, rather than fearful and driven primarily by extrinsic goals.

Present Investigation

The purpose of this study was to evaluate the instructional benefits and barriers related to the use of online formative and summative assessment tools. To accomplish this task, data were collected from samples of students in different semesters to allow for differential use of summative assessment (paper versus online delivery). Furthermore, formative assessment was manipulated by providing online practice quizzes that students could freely access to prepare for the course examinations. For the computer-based summative assessment sample, the quiz access was restricted to only the final two course exams. With these grouping strategies in place, the impact of computer-based summative and formative assessments on test anxiety, perceptions of tests as threatening events, study skills, and exam performance was investigated.

It was anticipated that the formative assessment quizzes would be widely used, as they were reported to be similar in nature and content to the actual tests. Furthermore, it was anticipated that those students who used the formative assessment quizzes frequently would have significantly higher scores than those who used the quizzes infrequently. These variations in performance could be simply attributed to group differences in willingness to use study materials and tools; therefore, control over the availability of quizzes was maintained in part of the study to allow for a baseline test to ensure that differences observed in performance across groups of students using the quizzes could be more confidently attributed to formative assessment use.

The online summative assessment tool was anticipated to have no strong impact on the level of anxiety, emotionality, or perceived level of threat posed by the tests. The expectation was that students would hold similar ratings of these affective constructs, regardless of test format.

Method

Participants

Undergraduate students in an introductory educational psychology course were the participants in all phases of this investigation. The study took place during the Fall 1999 and Fall 2000 semesters, with all students in the courses invited to participate. Eighty-four undergraduate

students participated in the Fall 1999 group. The participants were predominantly White ($n = 81$), with the remaining sample reporting race as Black ($n = 1$) or biracial ($n = 1$), and one student refrained from reporting on racial status. In this sample there were 74 females and 10 males, which was representative of the population in the academic program. Ninety-two participants were involved in the Fall 2000 group, with 3 Black, 2 Hispanic, and 87 White students. There were 24 males and 68 females in the Fall 2000 sample.

Materials

The materials for this study included measures designed to provide data regarding cognitive test anxiety, study habits, undergraduate course examination performance, and usage levels of online formative assessment quizzes. In addition, two computer-based assessment tools were employed in this investigation to allow for the differing needs of the online formative and summative assessment activities.

To measure cognitive test anxiety, the Cognitive Test Anxiety scale was completed by all students between the second and third course examinations (no more than 2 days prior to the taking of the third examination). The Cognitive Test Anxiety scale (Cassady & Johnson, 2001) is a 27-item measure focused on only the cognitive domain of test anxiety, formerly referred to as worry. The cognitive domain includes the tendency to engage in task-irrelevant thinking during test taking and preparation periods, the tendency to draw comparisons to others during test taking and preparation periods, and the likelihood to have either intruding thoughts during exams and study sessions, or have relevant cues escape the learner's attention during testing.

Study habits were assessed through a set of self-report items regarding the habits and skills students exhibit in their preparation for exams or in gathering course-related information throughout the semester. For instance, the participants reported on their ability to acquire information during course lectures, to comprehend text materials assigned for course readings, as well as duration and type of study techniques employed in general.

Performance on course examinations was included in the investigation by gathering participants' T-scores for all tests taken during the semester. The tests included three multiple-choice exams ranging in length from 30 to 36 items. For the Fall 1999 group, all tests were administered in the course classroom in group format. The Fall 2000 group took all tests in the University Computer-Based Testing laboratory using INQSIT testing software, with the addition of a comprehensive final examination. All tests in the Computer-Based Testing laboratory are password protected and monitored by test proctors to ensure confidence in the security of test administration.

Reports of online quiz utilization were also available from both the Fall 1999 and Fall 2000 groups. For the Fall 1999 group, students were asked to simply indicate whether they made use of the quizzes or not. For the Fall 2000 group, the course website tracked student use of all course materials and documented the number of times each student accessed the online quizzes.

The formative assessment tool used in this study was QuizEditor JS.² QuizEditor began as a concept for helping elementary school children self-evaluate their readiness for mastery tests, as a result of conversations with several teachers who indicated the students were poor judges of their level of preparedness for the exams. Therefore, QuizEditor was designed to provide a pressure-free evaluative situation in which students could take practice tests and receive immediate feedback. The expectation was that this program would help advance the performance level of these students through their heightened preparation for summative tests. The unique features of QuizEditor JS are the immediate feedback function, the privacy of feedback (only the

² QuizEditor JS was designed, coded, and debugged at Ball State University by Wayne K. Mock, Multimedia Development Coordinator in the Center for Teaching Technology and Jon L. Weiss, Lead Micro Analyst/CWIS Coordinator in University Computing Services.

student taking the quiz sees the performance report in a separate pop-up window), the simplicity of the question-generation interface, and the cross-platform design.

The online summative assessment measures were all delivered with INQSIT, an assessment tool developed at Ball State University that provides a web-based interface that helps the user deliver text-based assessment tools, with the capability to use all relevant question formats. Although it is possible to use INQSIT to deliver formative assessment quizzes or tests, INQSIT was not used for the formative assessment portion of this study due to the relative difficulty in accessing INQSIT materials as compared to QuizEditor JS. All INQSIT tests must be accessed through the INQSIT Ball State Server, which requires password verification. QuizEditor JS quizzes can be posted to any web address, and are significantly less labor intensive for developing.

Procedures

During the Fall 1999 semester, students were provided with online formative assessment quizzes that were generated with QuizEditor JS. The quizzes were connected to the course website, and all students were encouraged to use the quizzes in their preparation for the three course examinations. All course examinations in that semester were delivered as in-class closed book exams. Two days before the third examination, all participants completed the Cognitive Test Anxiety scale, a demographic variables sheet, and the study habits survey. After they received their scores, the participants also completed a post-test survey that provided information regarding their perception of the utility of their study habits, and their attributions for test performance level. Students received course credit for their participation.

The following academic year, the same procedures were established for providing online quizzes and tests to students with minor modifications. One difference was the ability to reliably track individual user access to the materials. The students in the Fall 2000 sample also took all tests in a secured computer-based testing laboratory at their convenience. Finally, to establish a baseline measure of performance, the students were not able to access practice quizzes until the third exam. All other procedures were identical to the Fall 1999 sample.

Results

Data analyses focused on examining the impact of computer-based formative and summative assessment tools on students' test anxiety, performance, perceptions of tests as threatening, and study behaviors. To address the differential impact of summative assessment format (paper vs. online), the performance levels and self-reported levels of anxiety and study habits were compared across the two semesters making use of differential delivery methods. To assess the impact of the computerized formative assessment materials, groups were established based on usage levels. Initially, the group formation was established based on a dichotomous distinction between those who did and did not make use of the materials. For the Fall 2000 sample, additional analyses were possible due to the greater specificity in actual number of times using the quizzes.

Comparisons between the two summative assessment format groups (online and paper) demonstrated no significant differences in level of cognitive test anxiety, $F(1, 176) = 1.19$ or level of emotionality, $F(1, 176) = .07$. Thus, it is reasonable to conclude that delivering the tests online in a computer lab did not induce additional unwarranted test anxious thoughts in the students. In both populations, the test anxiety measure was delivered two days prior to the time they took the test, therefore the contextual factors surrounding the testing event were reasonably equivalent and time sensitive, which promotes the validity of the reported level of test anxiety (Zohar, 1998). Although the levels of test anxiety did not vary from one summative testing format to the other, the level of perceived threat regarding the upcoming test did result in group differences, $F(1, 176) = 74.65$, $MSE = 37.32$, $p < .001$. The group taking the test at a preassigned time in a group setting had significantly higher ratings of perceived threat ($M = 53.78$, $SD = 6.70$, $n = 83$) than

the students taking the test in an online environment over the course of a week ($M = 45.85$, $SD = 5.53$, $n = 95$).

Due to the use of T-scores, comparison of test score trends based solely on the semester-dependent variable of summative assessment format is not a viable approach. The T-score values were formed based on relative performance for the specific semesters, therefore the variability in test scores between the Fall 1999 and Fall 2000 samples were not measurable based on that factor alone. Thus, comparisons between the two formats for summative assessment will be nested with other variables in all analyses.

The impact on achievement related to using online formative quizzes prior to taking course examinations was evaluated through several processes. First, a 2 X 2 multivariate analysis of variance examined group differences on test T-scores based on summative assessment format, use of the online quizzes (with no differentiation for number of uses), and the interaction of those two grouping variables. The MANOVA revealed no course exam performance differences for any of the three course examinations based on format of summative assessment, $F(1, 153) < 1.98$ or use of quizzes, $F(1, 153) < .61$. However, when examining the between subjects effects for the interaction of summative assessment format and use of quizzes, a relevant pattern was revealed. There was no significant interaction for the first course examination, $F(1, 153) = 3.43$ or the second exam, $F(1, 153) = 3.61$. However, for the third course examination, which was the only test for which the Fall 2000 sample had access to the online formative assessment quizzes, a significant interaction was demonstrated, $F(1, 153) = 4.08$, $MSE = 113.74$, $p < .05$. Figure 1 illustrates that there were significant differences for the Fall 2000 sample (online testing) between those students who did and did not use the formative assessment quizzes for only the third examination, and there were no significant differences based on quiz use for any of the tests for the Fall 1999 semester.

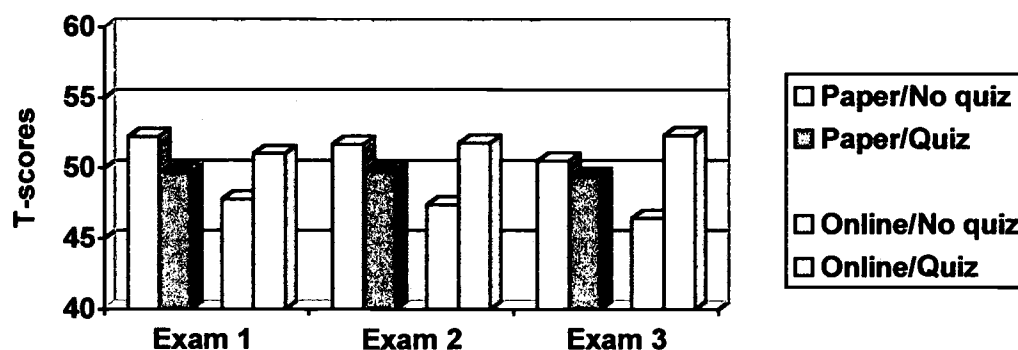


Figure 1. Course examination performance based on type of summative assessment format (Paper or Online) and usage level of formative assessment quizzes. The differences observed in the online assessment group (Fall 2000 sample) reached significance for only the third exam.

For the Fall 2000 sample, further analyses regarding the impact of using online formative assessment measures was possible, differentiating between levels of use. To accomplish the differential levels of use of the formative assessments, the number of times students used quizzes in preparation for the tests was used. For students who did not use the quizzes, or only accessed them one or two times overall, the usage label of "little to no use" has been applied. Students using the quizzes 3-5 times formed the "moderate use" (and are indicative of students who used at least half of the offered short quizzes), while students using the quizzes six or more times were

labeled as "heavy use." A series of one-way analyses of variance were employed to evaluate group differences based on these levels of quiz use. The second examination taken during the Fall 2000 semester served as a baseline comparison, as the online quizzes were not available until the third exam for that sample. Therefore, no differences were expected in exam two performance based on quiz usage, however quiz use was anticipated to be a relevant variable related to performance for exam three and the final. The ANOVA for the second exam confirmed there were no performance differences between the three groups, $F(2, 88) = 2.23, p > .05$. Exam performance did vary as a function of quiz use for the third exam, $F(2, 88) = 3.35, p < .05$ as well as the final exam, $F(2, 88) = 8.03, p < .001$ (see Figure 2). Fisher's LSD post-hoc analyses revealed that the little to no use group performed significantly more poorly on the exam than the moderate and heavy use groups for the third test ($p < .05$ for both contrasts) and the final exam ($p < .001$ for both).

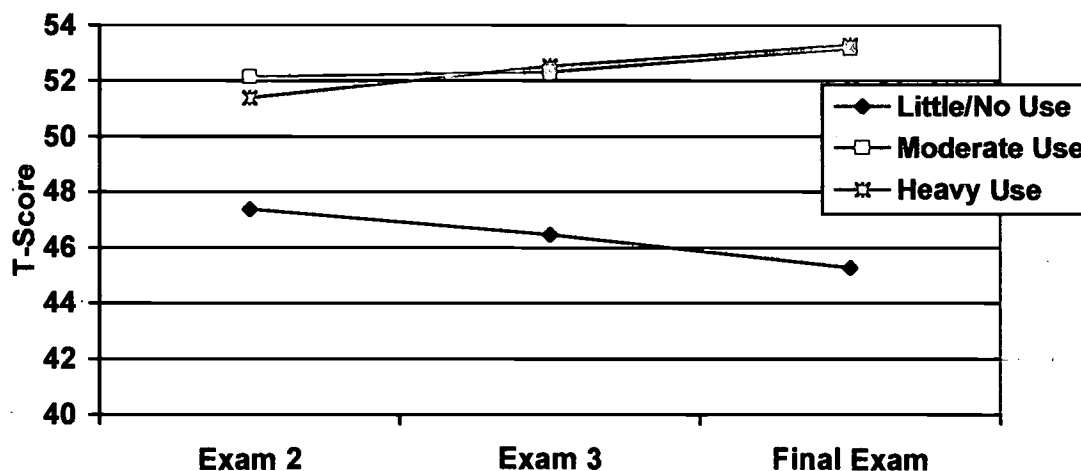


Figure 2. Online summative assessment sample performance levels based on level of quiz usage. No formative assessment quizzes were available for Exam 2 in this sample.

For both semesters, a subset of the participants provided ratings of the usefulness of the online formative quizzes by responding to the statement, "I found the online quizzes to be helpful in preparation for the exam." Only six of the 64 students who responded to this item during the Fall 1999 and Fall 2000 semesters disagreed with the statement (41 "agree"; 17 "strongly agree"). Chi square analyses revealed no differential rates of endorsing the statement based on method of summative assessment (online and paper tests), $\chi^2(3, N = 64) = 2.64, p > .05$.

To evaluate the relationship between test anxiety and the use of formative quizzes, chi-square analyses were used to identify differential usage rates by test anxiety level. The data were only available from the Fall 2000 sample, as there were not data from the Fall 1999 sample indicating quiz use frequency. The chi-square analyses demonstrated a significant difference in quiz use based on test anxiety level, $\chi^2(4, N = 92) = 9.34, p < .05$ (see Table 1 for group frequencies). The group differences in quiz usage is most marked in the number of high test anxiety students in the little to no use segment. These students either never used any of the online quizzes or logged on to look at quizzes no more than two times (including repetitive access of individual quizzes). The chi-square analysis was confirmed by a one-way analysis of variance examining group differences on total cognitive test anxiety score based on the level of quiz use, $F(2, 89) = 3.11, p < .05$. Fisher's LSD confirmed that the group with little to no use ($M = 72.51, SD = 15.01$) of the online quizzes had significantly higher levels of cognitive test anxiety than the

moderate use group ($M = 63.41$, $SD = 15.51$). The heavy use group ($M = 69.84$, $SD = 13.96$) did not differ significantly from either group.

Table 1
Cognitive Test Anxiety Group Differences in Quiz Use Rates (n = 92)

Cognitive Test Anxiety Level	Quiz Rate Usage		
	Little/No Use (0-2 overall) N	Moderate Use (3-5 overall) N	Heavy Use (more than 6) N
Low	7	12	8
Average	6	7	9
High	24	10	9

Note: Overall use levels determined through self-report and web-based user tracking software.

Finally, the relationship of perceived threat and study skills with using online quizzes was examined. Comparisons between students who did and did not use the online quizzes revealed no significant differences in perceptions of testing events as threatening, $F(1, 155) = .23$. Similarly, no differences in overall level of study skills and habits were observed, $F(1, 155) = .11$.

Discussion

Online Summative Evaluation

No significant differences were observed in self-reported study skills, emotionality, or test anxiety based on the method of delivering the summative assessment measures in this undergraduate course. The similarity in anxiety level is likely due in part to the level of experience these students had with computer use. The frequent requirements to access various course materials online is likely to have promoted high levels of comfort with computers and online information. It is improbable that students in all content areas would have similar comfort, and the level of emotionality and anxiety may be expected to rise in those students who do not have experience with computer-based instructional processes. The comfort levels were induced in this population due to the required access of internet materials on a frequent basis. Thus, systematic integration of technology in the students' courses may have facilitated the adjustment to online testing (Cassady, 2001).

The heightened level of perceived threat reported by students taking tests in the "traditional" group-administered paper format is likely due to the lack of personal control over the testing events. The online testing group had the opportunity to take each test over the course of an entire week, including evenings and weekends. This led to anecdotal reports from the students that they enjoyed being able to take the test on their "light" days. This ability to schedule the tests seemed to allow the students to reduce the level of contextual stress by strategically placing their testing times in convenient time slots. For the students taking the test in class, there was no ability to choose what day would work best with their schedules. These students frequently reported they have several other assignments or tests during the same day or week that the test was offered. The presence of choice in test taking likely influences the level of perceived threat by providing the student with a higher degree of control over the situation.

Thus, in comparison it appears that providing tests online in a secured proctored computer laboratory may not simply provide an equivalent means of gathering summative assessment data from students, but may actually prove to be a better method of testing. With this testing format, not only did students report lower levels of perceived threat, but the course also gained instructional time. The gains in instructional time are a by-product of delivering the tests outside of the confines of class meeting rooms and sessions. The use of online testing produced a total of 4.5 additional hours of instructional time in the Fall 2000 course, as compared to the Fall

1999 course. This additional time was gained by replacing the three 75 minute periods formerly reserved for testing (total time = 3.75 hours) as well as an additional 15 minutes per test for passing back the corrected papers and providing the correct answers (conservative estimate; total time = 4.5 hours).

Online Formative Evaluation

The pattern of findings demonstrated a relationship between test anxiety level and quiz usage. Clearly, the students with high levels of test anxiety were less likely to use the online preparation quizzes. The directionality of the relationship between test anxiety and use of quizzes is not clear. According to the cognitive appraisal and information processing theories of test anxiety, the students who did not use the online quizzes could have a heightened feeling of anxiety based on the realization that they did not prepare adequately (Naveh-Benjamin, 1991; Schwarzer & Jerusalem, 1992). However, recent work by Elliot and McGregor (1999) has provided strong evidence for the mediational relationship between cognitive test anxiety (worry) and avoidance achievement motivation variables in predicting performance. This relationship may suggest that the highly test anxious students avoid the formative assessment quizzes, through some strategy to avoid unwanted self-doubt and emotional discomfort prior to testing.

The absence of differences in emotionality, perceived threat, and study skills between students who did and did not use quizzes was surprising. It was anticipated that students would feel more comfortable about the content in the tests after seeing related items in the formative testing materials. Furthermore, those students who used the practice quizzes were expected to have study skills that were overall superior to those who did not use the quizzes.

As for the performance differences observed in course examinations as a function of using online formative assessment quizzes, the data are very promising. The data demonstrated significant performance advantages for those students taking the practice quizzes. The presence of a baseline performance task in the Fall 2000 sample further solidified the positive impact of formative assessment tools on standard undergraduate course exams. It is essential to stress that the benefits enjoyed by using the QuizEditor program were not likely due to the delivery method, especially considering the similarity in performance and comfort level noted for students taking summative assessments online and on paper. However, the unique contributions provided by the QuizEditor JS software rest in the primary benefits afforded through computerized delivery of assessment: greater access, flexibility, and ease of constructing the assessment tools.

Conclusions

The data support providing online formative and summative assessments in undergraduate courses. Although the data do not allow for declaration that the formative assessment tools decrease cognitive test anxiety, there are relevant gains in course examination performance based on use of the quizzes, particularly for the group of students taking summative assessment tests online. Furthermore, the data demonstrated that there were no disadvantages to using online summative assessment regarding anxiety, emotionality, or study behaviors, and there was actually an advantage in the domain of perceived threat imposed by the impending test.

Instructors of undergraduate courses should view the use of online delivery of both formative and summative assessment measures as an opportunity to advance the level of learning for all students, with particular benefits for committed students. All students will benefit from the ability to choose when tests are taken. All students will also benefit from the additional instructional time provided in a standard course (4.5 hours of instruction gained in this sample). The committed students will have yet another valid means of preparing for upcoming exams when provided with a set of quizzes that are related to the summative assessment tool. When the students have the combination of online formative and summative assessment tools at their disposal, they are able to best determine when to take course exams. The ability to take exams at

a time most convenient and strategic for each individual student's schedule, in combination with that student's knowledge of performance level on a set of preparatory quizzes can provide higher rates of confidence, as well as performance on course tests.

Naturally, barriers exist in implementing this type of assessment scheme. A computer-based testing lab is not available on all campuses, which limits the ability to offer tests at a wide variety of times. In the absence of such a secure testing lab, instructors lose the confidence that the testing procedures are secure. Furthermore, the use of online study materials requires some level of computer access by all students. In most higher education settings, there are computer labs that can provide these resources, but the reluctant students may miss key course opportunities. Finally, the students' technology comfort levels need to be considered prior to providing course examinations through web-based methods. High levels of discomfort with the testing procedure will likely translate to heightened levels of cognitive test anxiety, as the student fixates on irrelevant information or worries about the method of testing. Thus, it is imperative to have procedures in place before the first test to allow students to become comfortable with the methods and materials of assessment to gain valid estimations of knowledge or ability.

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