

10-12-2011

Using Low-Stakes Quizzing for Student Self-Evaluation of Readiness for Exams

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Abstract - Introductory level courses in many Science, Technology, Engineering, and Math (STEM) disciplines require students to acquire an enormous new discipline-specific vocabulary in preparation for future courses. Students are often not prepared for the amount of self-directed studying they must do to be successful in these types of courses, particularly in their first year of college. To assist students in more accurately gauging their readiness for an exam, online low-stakes quizzes were implemented in a freshman level course, giving students an opportunity to practice their new language with minimal grade-related consequences. This quizzing strategy provides students an opportunity to self-assess their current level of knowledge. The quizzes also provide feedback, helping students determine how to adjust their behavior to ensure that acquisition of the missing knowledge is successful. This paper presents preliminary results of the research effort and illustrates the effects of this low-stakes quizzing. Specifically, this paper evaluates (1) whether the quizzing helps students to better prepare for medium and high stakes exams; (2) whether the quizzing increases the mean exam scores compared to previous semesters with no quizzing; and (3) whether the quizzing must be required (low-stakes) to be effective, or whether it can be optional (no-stakes) and still benefit students.

Index Terms – Exam preparation, First year students, Low-stakes quizzing, Self-knowledge, Self-regulation.

INTRODUCTION

Introductory courses within an academic field of study often require a student to acquire a new discipline-specific vocabulary in preparation for subsequent courses, as well as for their future career. This is particularly true in many Science, Technology, Engineering, and Math (STEM) disciplines.

Students are often not prepared for the amount of self-directed studying they must do to be successful in these introductory types of courses, particularly in their first year of college. Their first year is often a year of many new and different experiences. Students must make both academic and social adjustments. While the social adjustments are not trivial and should not be ignored (see [1], for example), this paper focuses on the academic aspects. “The first college year is critical not only for how much students learn

but also for laying the foundation on which their subsequent academic success and persistence rest” [2].

Students regularly overestimate their knowledge and abilities [3]. As an anecdotal example, take two students who each received a D or F on an exam. One claims to have studied for hours, although we don’t know what they were studying or how, while the other didn’t study at all because he thought he already knew the information well enough. Besides this sort of overestimation, students also unreasonably expect that their assignment and test grades should reflect not just their achievements, but also the amount of time and effort they expend [4]. We regularly have students in our classrooms, particularly in first-year courses, who fit these or similar patterns.

Accurate self-knowledge, the ability to accurately judge one’s level of knowledge, is necessary at the college level. Accurate self-knowledge means that a student must be able to realize what they already know. More importantly, they must also realize what they do not know so they can take steps to ensure that their end knowledge meets instructor and course expectations [5]. While some students arrive at college with this ability, others do not and need help acquiring this skill.

Related to accurate self-knowledge is self-regulation. This concept moves beyond the ability to recognize what one does or does not know, to the ability to adjust one’s behavior to ensure that acquisition of the missing knowledge is successful [5]. An internal feedback loop is an essential part of self-regulation [6]. Students with better self-regulation tend to have higher academic achievements [5, 6]. Like self-knowledge, self-regulation is a skill that some students need help acquiring.

This paper discusses a strategy using online self-assessments with feedback to help students acquire skills in self-knowledge and self-regulation. Formative assessments have been shown to lead to significant learning gains in numerous studies [7]. More recently, online self-assessment exercises have been shown to help students improve their self-knowledge [5] and effective external feedback can help students improve their self-regulation skills [6, 8, 9].

Online self-assessments with feedback, also known as online formative assessments, are a relatively new phenomenon, enabled primarily by online course management systems (for example, Blackboard). Students can now take short quizzes outside of class and have them scored automatically and immediately, as well as retake them to improve their scores. While instructors could have

provided students with this type of quizzing option in the past, it was impractical without computerized grading [10]. This form of quizzing is essentially allowing the students to practice taking the quiz until they are ready to officially count their score. Simply providing students with their score could loosely be considered a formative assessment, as the students would have minimal feedback regarding their performance (the score), though research is mixed regarding the effectiveness of this practice [11, 12]. However, to truly improve and support student learning, incorporating specific feedback with information that lets them know why their answer is correct or incorrect is an essential part of formative pedagogy [6, 9, 11].

OBJECTIVES

The larger research project investigates implementing formative no-stakes (optional) quizzing and low-stakes (required) quizzing within Blackboard in a freshman level Construction Management course and evaluates: (1) whether the quizzing helps students to better prepare for medium- and high-stakes exams; (2) whether the quizzing increases the mean exam scores compared to previous semesters with no quizzing; and (3) whether the quizzing can be optional (no-stakes) and still be effective, or whether it must be required (low-stakes). This paper only presents preliminary results from the low-stakes quizzing implementation.

METHOD

This portion of the project (low-stakes quizzing) was carried out with a group of 30 undergraduate students in a 100-level construction management course entitled “Construction Materials and Methods” at Boise State University in the spring semester of 2011. This course is required for construction management (CM) majors and minors and is a three credit course with 45 hours of classroom instruction. The course introduces students to construction methods and materials used on building projects, with three main objectives:

- Demonstrate knowledge of the methods and equipment commonly used to construct buildings including the foundation and framing systems.
- Identify and discuss the technical aspects of basic building materials such as steel, concrete, masonry, and wood.
- Utilize correct terminology and nomenclature associated with the materials, methods, equipment and building components found on building construction projects.

These objectives are divided into five topical areas for testing purposes: (1) foundations and construction related math, (2) steel, (3) wood and light gauge steel framing, (4) concrete, and (5) masonry.

Of the 30 students enrolled in the course in spring 2011, 17 had formally declared CM as their major, 1 had declared

a CM minor, and 12 were non-majors/minors. Attendance at lectures was mandatory and an 89% attendance rate was achieved.

This group of students is being compared with five previous semesters of students in the course (n=32, 28, 58, 42, and 38 respectively for a total of N=198). The characteristics of the students (age, gender, background, major, etc) in previous semesters are similar to the studied population.

Prior to the changes described here, the assessments comprised five paper-based exams with multiple-choice, true/false, matching, and short answer type questions (16% each, with lowest score dropped, for a total of 64% of course grade), participation and attendance at lectures (6% of course grade), and a comprehensive paper-based final exam with multiple-choice, true/false, and matching type questions (30% of course grade). Comprehensive study guides were made available one week prior to each exam. Feedback was only available through marks made on the exams.

This project was developed as a result of the instructor’s desire to help students who were struggling in the course, but were genuinely attempting to do well. Based on statements from several students, they were studying and making efforts, but were not passing the exams. This project was created to help students better assess their readiness to take an upcoming exam and consequently improve their self-knowledge and self-regulation. It was intended that exam scores, particularly for these struggling students, would increase.

In the fall of 2010, the course was modified to include no-stakes (optional) online formative assessments (see [13] for further information on this implementation). All other aspects of the course remained the same as the previous five semesters. In the spring semester of 2011, the online formative assessments were no longer optional and instead became low-stakes quizzes. In this low-stakes implementation, the quizzes were required for students, but the only requirement was completion of each quiz one time. Completion of the quizzes (not scores) counted approximately 1% towards the course grade (for all quizzes combined). The choice to only grade based on completion was made to ensure that students would not be discouraged from retaking the quiz after scoring well. This comes with a trade-off – that some students may simply logon and submit the quiz without any effort. However, it appeared that nearly all students took the quiz seriously and did not follow this unproductive path.

The quizzes consist primarily of multiple-choice and true/false questions, along with a few matching questions. Each quiz was made available on the course website (within the Blackboard course management system) one week prior to an upcoming exam, along with the exam study guide. The quizzes consisted of 20 questions randomly chosen from a pool of 20-38 topically relevant questions. Students were allowed to take the quizzes as many times as they

wished. Upon completion of the quiz, students were given their score, the quiz questions were repeated with the answers they chose, and each answer was marked correct or incorrect. They were also presented with feedback for each question. Feedback for incorrect answers consisted of hints regarding why the answer was incorrect and prompted students to think about a particular aspect more deeply. The feedback also recommended resources to read that discussed the pertinent information, including specific page numbers in the text or other readings. The correct answer was not given, nor should it be when students can retake a quiz [14]. Feedback for correct answers consisted of congratulations and reference information, including page numbers in the text, if they were interested in learning more about that topic.

The medium- and high-stakes exams the students were preparing for consisted of multiple-choice, true/false, matching, and short answer type questions. There were between 40 and 48 questions with a mean of 43.4 questions for the five medium-stakes exams and 150 questions on the high-stakes final exam. The terms medium-stakes and high-stakes are subjective, but in this project are defined based on their weight towards the course grade, 16% and 30% respectively.

A brief one page questionnaire was attached to the back of each student's exam. The questionnaire asked about the amount of study time spent for that exam along with the student's methods of study and what grade they expected to receive on the exam. The questionnaire also asked if they had taken the study quiz. If they had, they were asked if they thought it helped them do better on the exam, why or why not, and what might have helped them more. If they had not taken the study quiz, they were asked why they did not, and whether they thought it would have helped if they had taken it.

RESULTS AND DISCUSSION

Over the spring semester 2011, seven quizzes were made available to the students. Five 20-question quizzes were directly related to exams during the semester. The sixth 20-question quiz covered material subsequent to the last regular exam, but prior to the final exam, and the seventh quiz was a 40-question quiz that covered material from the entire semester with the number of questions from each topic in proportion to that of the final exam. No new questions were written for this last quiz – they were taken randomly from the existing pools of questions.

The seven quizzes were used 634 times by 30 different students (all students enrolled in the course). The total amount of time spent by all students was nearly 132 hours. The author was quite surprised at the amount of intrinsic motivation shown by the students, particularly in a first year course, especially since the only requirement was completion of each quiz one time. See Table I for a summary of the quiz usage during the Spring 2011 semester. This data was collected automatically by the Blackboard

course website when students accessed the quizzes. Students must be registered for the course and logged in to access the quizzes; anonymous logins are not allowed.

TABLE I
SUMMARY OF QUIZ USAGE IN SPRING 2011

Quiz #	# of students who took quiz	Total # of times quiz taken	Total # of minutes used	Range of times taken by single student	Range of minutes used by single student
1	28	61	2389	1 - 9	10 - 480
2	30	141	875	1 - 16	4 - 76
3	29	91	1003	1 - 11	5 - 243
4	27	96	510	1 - 13	2 - 79
5	30	92	693	1 - 10	3 - 273
6	24	64	779	1 - 9	3 - 359
7	26	89	1660	1 - 13	7 - 287
Total	30*	634	7909 min = 131.8 hrs		
Mean	29	90.6	1130 min = 18.8 hrs		

* total number of different students who took quiz

Independent sample t-tests were conducted on the medium- and high-stakes tests to determine whether the mean test score from Spring 2011 was higher than the mean test score from the previous five semesters (aggregated). Table II shows that the students in Spring 2011 had a statistically significant higher mean test score than students in past semesters for one of the exams (test 1). In test 2, they performed slightly worse, though it was not a significant difference, and in tests 3, 4, 5, and the final, they performed slightly better, though not significantly. With the removal of a single outlier for all tests (one student, who for all six tests scored more than 3 s.d. away from mean), tests 1, 3, and 5 are found to have a significantly higher mean score in Spring 2011. The t-test data with this outlier removed has also been included in Table II for comparison.

Overall, the low scores improved when compared to previous semesters, with the exception of the single outlier. The overall improvement of the students in Spring 2011 is exemplified by fewer D and F grades given (see Table III). All of the tests were much improved over previous semesters, with the exception of test 2, which had a slightly higher percentage of D and F grades than in any of the comparison semesters (10 out of 30 vs. the next worst semester with 10 out of 32). The author cannot offer any logical reason for the slight increase in D and F grades for this particular test.

Spring 2011 students were asked open-ended questions regarding the usefulness of the self-assessment quizzes in a brief questionnaire attached to the back of each of the tests. The response rate for the questionnaire varied by test but ranged from 76.7% (23 of 30) to 93.1% (27 of 29). Of the students who responded, most who took the quiz at least once believed that it helped them do better on that test (85% to 96.2% felt this way, depending on the test). Some sample comments from the students regarding why they thought the quiz helped are listed below:

“the format of the quiz helped me to know what to expect for the test”
 “it allowed me to pinpoint the things that I needed to spend more time on rather than waste time on material I already knew”
 “helped me review”
 “it helped me to find out what I knew and what I didn’t”
 “the page numbers told me to go where I needed to, where I was weakest”

All of those who responded that they did not take the quiz believed that taking it would have helped them do better on that exam.

Course	14.1%	3.4% - 26.2%	3.3%
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A majority of the comments of dissatisfaction related to the fact that the questions on the quiz were not the same as those on the test. Additionally, there were a few students who took a quiz only once, got a good score and falsely assumed they were prepared, yet had trouble when they took the exam. Had they taken that quiz more than once, they likely would have realized they needed to study more. Unfortunately, this negative experience, combined with the requirement to take the quiz at least once for each test, appears to have led to some resentment in a very small number of students. For example, one student noted that taking the quiz “took some time away from reading handout/book [sic].” In this particular instance, the student spent a total of 8 minutes on the quiz.

This negative attitude did not appear when the quizzes were optional in Fall 2010, even though there was some dissatisfaction by individual students on occasion. The requirement to take the quizzes seems to be the larger cause, implying that optional quizzes for the purpose of self-assessment may be a better choice than requiring them.

While the intended strategy for students using the quizzes was to study, take the quiz, learn about the material they missed, and then retake the quiz, not all students followed this path. Based on quiz usage and comments on the questionnaire, there were several other strategies used as well. Some students used the quiz prior to studying to judge where they were and what they should study (and, likely, how much time they might need to spend). The students using these strategies were definitely getting practice developing their self-knowledge and self-regulation skills.

Other students used the quiz itself as the study tool, retaking it over and over again until they were successful, while apparently ignoring any feedback they received for incorrect answers (data showed multiple attempts with 1 minute or less between attempts). This method implies trial, error, and memorization, which would not be the recommended use of the quizzes. This method was discouraged through the technology by having the questions randomized from a larger pool of questions, as well as having the answers to each question presented in a random order. This group of students was not really improving self-knowledge or self-regulation. They appeared to be more focused on the quiz score, instead of gaining useful knowledge.

Still other students seemed to study first and only take the quiz when they were done studying. It is likely that students using this last strategy are made up of two groups. Some of these students seemed to only use the quiz to get a feel for what grade they might get on the test, and if it met their needs, they were done. They are improving their self-knowledge skills, but are likely ignoring self-regulation. They aren’t willing to adjust their behavior any further to improve their knowledge. They may also have only taken

TABLE II
DESCRIPTIVE STATISTICS AND 1-TAILED INDEPENDENT T-TEST

Test #	Group	n	Mean (SD)	t statistic	1-tailed p
Test 1	5 comparison semesters	198	82.09 (10.15)	-2.12	0.0176*
	Spring 2011	29	86.45 (11.66)		
	Spring 2011 w/o outlier	28	88.07 (7.86)	-2.99	0.0015**
Test 2	5 comparison semesters	193	77.94 (11.18)	0.49	0.6892
	Spring 2011	30	76.83 (12.69)		
	Spring 2011 w/o outlier	29	78.22 (10.32)	-0.13	0.4484
Test 3	5 comparison semesters	189	77.64 (12.56)	-1.30	0.0967
	Spring 2011	28	80.91 (11.15)		
	Spring 2011 w/o outlier	27	82.54 (7.22)	-1.98	0.0246*
Test 4	5 comparison semesters	193	80.56 (12.68)	-0.54	0.2962
	Spring 2011	30	81.88 (11.91)		
	Spring 2011 w/o outlier	29	83.28 (9.31)	-1.11	0.1344
Test 5	5 comparison semesters	192	75.95 (12.54)	-1.33	0.0933
	Spring 2011	30	79.30 (14.84)		
	Spring 2011 w/o outlier	29	81.21 (10.73)	-2.14	0.0167*
Final Exam	5 comparison semesters	190	79.53 (9.04)	-0.04	0.4845
	Spring 2011	30	79.60 (10.18)		
	Spring 2011 w/o outlier	29	80.92 (7.30)	-0.79	0.2154

* p<0.05, ** p<0.01

TABLE III
PERCENT OF D AND F GRADES GIVEN

Test #	Average of 5 Comparison Semesters	Range of 5 Comparison Semesters	Spring 2011
Test 1	13.6%	7.1% - 21.4%	6.9%
Test 2	23.8%	11.1% - 31.3%	33.3%
Test 3	25.4%	14.3% - 29.8%	7.1%
Test 4	18.7%	9.7% - 27.8%	10.0%
Test 5	25.7%	10.7% - 45.0%	23.3%
Final Exam	13.7%	6.5% - 25.0%	13.3%

the quiz because it was required and felt that their score was irrelevant, which would imply that they are ignoring both self-knowledge and self-regulation. Others students used the quiz to improve their confidence and prove to themselves that they were prepared for the upcoming test. These students are likely to be the students who are well-versed in both self-knowledge and self-regulation. They would do well on the exam whether the quizzes were available or not.

Regardless of the strategy used, any improvement in self-assessment skills (i.e., self-knowledge and self-regulation) in students leads to students being more prepared to be lifelong learners [4], something that all teachers can appreciate.

A limitation of this study is the type of questions asked in the quizzes. It was limited predominantly to multiple-choice and true/false questions because of the desire to have the quizzes automatically graded and scores/feedback available immediately upon completion. The author has experimented with other question types (in other courses), such as fill in the blank questions, but they have been largely unsatisfactory. However, the question types chosen do not limit the depth of knowledge required of students. Multiple-choice questions are not limited to only the lower levels of Bloom's taxonomy, such as recall, comprehension, and application. Well thought out questions and answer choices can also test higher levels, such as analysis and evaluation [10]. This course requires students to learn a great deal of terminology related to their major and the quizzes (and corresponding tests) reflect this with many lower level questions. However, the quizzes and tests in this course also include some questions at higher levels because it is important for students to begin analyzing and evaluating choices between materials and construction methods, as this is something they will be expected to do when they begin their career.

Another limitation of the study relates to the tests being compared. This project compared the Spring 2011 tests with tests from five previous semesters and the tests over the six semesters were not the same. While having different tests is not an ideal situation, it would not have been practical to use the same tests for multiple semesters. Using the same tests over and over would likely have introduced more bias when comparing test scores between semesters (due to students sharing information) than having different tests. To limit the issues introduced by having different tests, they were similar in content and format, and they were all written and graded by the same instructor for all six semesters. The descriptive statistics (high, mean, low, s.d., median) from one semester to the next have been similar (see Table IV for an example). To statistically minimize the differences that do exist between different versions of the tests, the independent t-tests performed compared the aggregate of the previous five semesters with the Spring 2011 semester. Additionally, it is planned that the study will be repeated with additional students in future semesters.

With repetition, the differences between the tests (and the students taking them) begin to disappear.

TABLE IV
DESCRIPTIVE STATISTICS FOR TEST 1

Semester	# taken	High score	Mean score	Low score	s.d.	Median score
1	32	95	78.59	62	8.48	79.5
2	28	96	81.80	68	6.56	82.75
3	58	103	83.93	60	9.38	85
4	42	100	80.81	56	12.51	82.5
5	38	100	83.84	50	11.28	85.5
Spring 2011	29	103	86.45	41	11.66	89

This limitation already begins to diminish when the Fall 2010 (no-stakes) and Spring 2011 (low-stakes) semesters are combined together and contrasted with the five comparison semesters. While not the focus of this paper, the success of the self-assessment quizzes becomes quite obvious when looking at the student improvements shown in Table V. A comparison of D and F grades shows similar improvements in the two semesters with self-assessment quizzes versus the five that did not.

TABLE V
DESCRIPTIVE STATISTICS AND 1-TAILED INDEPENDENT T-TEST

Test #	Group	n	Mean (SD)	t statistic	1-tailed p
Test 1	5 comparison semesters	198	82.09 (10.15)	-2.71	0.0035**
	Fall 2010 & Spring 2011	67	85.91 (9.37)		
Test 2	5 comparison semesters	193	77.94 (11.18)	-1.26	0.1041
	Fall 2010 & Spring 2011	68	79.94 (11.50)		
Test 3	5 comparison semesters	189	77.64 (12.56)	-3.10	0.0011**
	Fall 2010 & Spring 2011	64	82.94 (9.31)		
Test 4	5 comparison semesters	193	80.56 (12.68)	-0.03	0.5118
	Fall 2010 & Spring 2011	68	80.61 (10.65)		
Test 5	5 comparison semesters	192	75.95 (12.54)	-1.98	0.0242*
	Fall 2010 & Spring 2011	67	79.41 (11.51)		
Final Exam	5 comparison semesters	190	79.53 (9.04)	-0.13	0.4469
	Fall 2010 & Spring 2011	68	79.70 (8.08)		

* p<0.05, ** p<0.01

CONCLUSIONS

The study described here was used to supplement an existing course with a number of students who needed help with their self-knowledge and self-regulation skills when studying for medium- and high-stakes exams. It appears to

have been successful in addressing this problem. Specifically, nearly all students perceived that the quizzing helped them better prepare for exams, and the quizzing increased the mean exam scores for three out of six exams, compared to previous semesters with no quizzing.

Additionally, the quizzing appears to have drastically reduced the failure rate on the exams and reduced the failure rate of the course. When both semesters of quizzing (Fall 2010 and Spring 2011) are compared with the five previous semesters with no quizzing, the student improvement becomes marked. It is hoped that these trends will continue in future semesters.

Regarding whether the quizzing must be required (low-stakes) to be effective, or whether it can be optional (no-stakes) and still benefit students, based on student comments regarding the quizzes, the optional quizzing is a better choice for self-assessment purposes. Intrinsic motivation seemed not to be an issue with this group of students based on the fact that they took the quizzes many more times than was required of them. They took the seven quizzes an average of three times per student per quiz, when the requirement was one time per student per quiz. Intrinsic motivation was also not a factor in Fall 2010 when the quizzing was optional, based on the high percentage who took the quizzes (an average of 31.4 students out of 38 took each quiz and all 38 students took at least one of the seven quizzes offered).

Similar quizzes could certainly be used for lower division courses in other disciplines where students have comparable issues adjusting to the requirements of college. Additionally, the concept of online self-assessment quizzes is definitely scalable to larger class sizes which are quite common in many first-year courses.

ACKNOWLEDGMENT

This project was supported by a grant from the Center for Teaching and Learning at Boise State University.

REFERENCES

- [1] Wilcox, P., S. Winn, and M. Fyvie-Gauld. Dec 2005. "It was nothing to do with the university, it was just the people': the role of social support in the first-year experience of higher education." *Studies in Higher Education*. Vol. 30 (6), pp. 707-722.
- [2] Reason, R. D., P. T. Terenzini, and R. J. Domingo. March 2006. "First Things First: Developing Academic Competence in the First Year of College." *Research in Higher Education*. Vol. 47 (2), pp. 149-175.
- [3] Glenberg, A. M., A. C. Wilkinson, and W. Epstein. 1982. "The illusion of knowing: Failure in the self-assessment of comprehension." *Memory & Cognition*. Vol. 10 (6), pp. 597-602.
- [4] Taras, M. October 2003. "To Feedback or Not to Feedback in Student Self-assessment." *Assessment & Evaluation in Higher Education*. Vol. 28 (5), pp. 549-565.
- [5] Ibabe, I. and J. Jauregizar. February 2010. "Online self-assessment with feedback and metacognitive knowledge." *Higher Education*. Vol. 59 (2), pp. 243-258.
- [6] Nicol, D. J. and D. Macfarlane-Dick. April 2006. "Formative assessment and self-regulated learning: a model and seven principles of good feedback practice." *Studies in Higher Education*. Vol. 31 (2), pp. 199-218.
- [7] Black, P. and D. Wiliam. 1998. "Assessment and Classroom Learning." *Assessment in Education: Principles, Policy & Practice*. Vol. 5 (1), pp. 7-74.
- [8] Nicol, D. J. June 2009. "Assessment for learner self-regulation: enhancing achievement in the first year using learning technologies." *Assessment & Evaluation in Higher Education*. Vol. 34 (3), pp. 335-352.
- [9] Miller, T. April 2009. "Formative computer-based assessment in higher education: the effectiveness of feedback in supporting student learning." *Assessment & Evaluation in Higher Education*. Vol. 34 (2), pp. 181-192.
- [10] Thelwall, M. 2000. "Computer-based assessment: a versatile educational tool." *Computers & Education*. Vol. 34 (1), pp. 37-49.
- [11] Gipps, C. V. April 2005. "What is the role for ICT-based assessment in universities?" *Studies in Higher Education*. Vol. 30 (2), pp. 171-180.
- [12] Davis, K. A. "Improving Motivation and Knowledge Retention with Repeatable Low-Stakes Quizzing." 2009. *2009 ASEE Annual Conference & Exposition*. Austin, TX, USA.
- [13] Davis, K. A. "Using No-Stakes Quizzing for Student Self-Evaluation of Readiness for Exams." 2011. *2011 ASEE Annual Conference & Exposition*. Vancouver, BC, Canada.
- [14] Buchanan, T. 2000. "The efficacy of a World-Wide Web mediated formative assessment." *Journal of Computer Assisted Learning*. Vol. 16 (3), pp. 193-200.