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Best Practice in Teaching General Physics Courses

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***Abstract*— General Physics I & II are a requirement for both Science and Engineering students, and approximately 1000 students are taking this course every year at United Arab Emirates University (UAEU). In the Department of Physics at UAEU we have introduced the course by using a course-management software "the Blackboard (BB)". Besides putting the regular lecture power point slides and continuous communication with students through BB, we have established a very elaborate database of assignments for students to take at the end of each chapter. Using the embedded technology in BB, students are allowed to take the test more than once with varying questions so that the students learn in each trial of the test. In this paper, we present an accumulated data showing the effect of this method on the students' learning, students'-instructor interaction, and we propose an optimum way of students' assessment for courses of this size and type.**

***Keywords*— Online tests, e-Learning, Blackboard manager, Web based courses, G. Physics**

I. Introduction

Advances in computer technology are transforming the methods of instruction to a web-based one. Their effectiveness for the learners provides a n ew paradigm of research. Mastering physics is an emerging such medium which has been proven to facilitate problem-solving transfer through tutorial problems [1]. Tutorial problems contain help in the form of requestable hints, descriptive text, and feedback. Twice as many students were able to complete problems correctly in real-time compared to those problems that did not provide any help [2]. In United Arab Emirates University (UAEU), the new technologies such as Laptop Projects, Blackboard Academic Suite, e-learning and many others involving various hardware and software products are in use [3, 4]. It has been proven that combining lecturing with other teaching methods and technology helps students retain their interest and attention, allows for more student participation, and emphasizes different learning styles [5,6].

In this paper, we report on the web-based introductory physics course at UAEU we designed by using Blackboard manager. Part of the course is the online assessment which is proven to reliably reflect students' level and improves physics learning.

II. The Study

The data in this study involves 144 students taking the first introductory physics course (Newtonian's mechanics) at the UAEU in fall 2009. The students were asked to complete an online multiple-choice based test at the end of each chapter which enables students to practice solving problems. The test includes questions that measure students' understanding of basics concepts. Once the student login to the self test site, he/she will find several questions that were automatically selected from a prepared pool of questions on blackboard academic web-site. Because of time limitation it is difficult to provide students with all ideas correlated to material covered in the class. Therefore, the questions were prepared to tackle specific ideas and concepts help students to improve their understanding and their math skills. Each student sees about ten questions randomly selected from the questions pool, at least in part, different from those given for other students. Online tests are designed to be considered as assessments for learning. After students submit their answers and see the score, the computer provides them with a feedback on the submitted answers. The feedback on each wrong answer may include some hints to lead students to the correct answer. To encourage students to learn from their mistakes, they are given the opportunity to sit for a second trial and improve their performance and score. Prior to that, they have to discuss their mistakes with other colleagues or even with the instructor whenever they need more help to understand a specific concept. Students were aware they may not see the same questions in the second trial, and only the scores of the last trials were counted towards their grades. The general trend of students' performance in the second trial is usually better than the first. It is worth noting that the online tests were first used in general physics courses as a tool of assessment in fall 2008, and this study was implemented after optimizing the model of teaching and assessment. Before that traditional assessment methods were used in tests and quizzes.

The most popular style of questions used for online tests are the multiple choice questions, and there is a debate on the effectiveness of this type of questions among physics educators locally as well as globally [7]. Therefore, to measure the effect of online tests on students learning and assessment, other traditional tests were scheduled to assess students' performance. During the semester, three written tests were scheduled; each covers the material of three chapters from the course material. The tests were graded uniformly by teaching assistants in the department and recorded it on

Blackboard. On the other hand online tests were automatically graded and recorded by blackboard manager.

The online tests were designed to be completed outside the class and students took it without instructor invigilation. To minimize student's plagiarism (student-student interference) in the trials of the online tests, several restrictions were implemented. Test options feature in blackboard allows the following:

- Limit the effective time of the trial of the test to 30 minutes.
- Fixe the due date for submitting their trials, about a week for each online test.
- Questions appear one at a time.
- Questions are chosen randomly from the pool to minimize duplication of questions.
- Prohibit back tracking of submitted questions.

Since all students registered to the introductory physics course in the university have to sit for a final examination, which can be considered a suitable gage for students learning following our style of assessment (multi-trial online tests). The final exam consists of forty multiple choice problems. Multiple-choice questions are most widely used for measuring knowledge, comprehension, and application of learning outcomes [8]. This makes the final examination covers most of the physics concepts in the material. Moreover, the final examination is designed such that questions are distributed over different levels of difficulties, so that to reflect clearly the level of students.

III. Results and Discussion

The tests were completed by 144 students distributed over eight sections. Each student submitted 10 online tests, and sat for 3 written tests. Students' scores in the online tests and the traditional tests were averaged and plotted in Fig. 1.

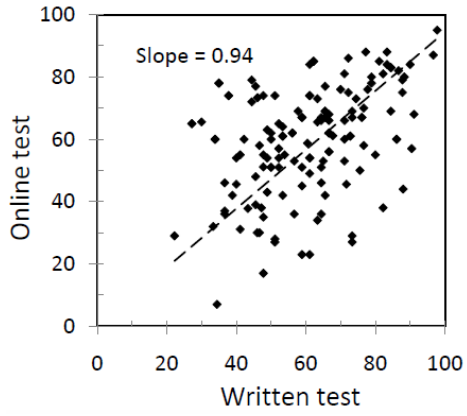

Fig. 1 Average score for students in online tests versus written tests.

Each point in the figure represents the average score of one student. The score is calculated out of one hundred. The dashed line in the figure is the best straight line fit for the data with a slope equal to 0.94. This indicates that the performance of students in online tests in Fig. 1 is very close to that of the written tests. The data is more concentrated around the line and few are scattered away from it on both sides towards high performance either in written or online tests. Students with low performance in online tests are also the students who did not do well in written tests. They are considered to be inactive during the semester, because they showed less interest and missed the opportunity to improve their skills through the online tests and other activities. On the other hand, the high performance in online tests is achieved by high level students or those who asked for help from others to solve the assigned problems. Generally, a good student achieves a high score in both online and written tests.

To categorize the scores of the students we followed the grading scheme presented in Table I. The number of students in each category is counted, and divided by the total number of students in the sample, 144, to calculate the percentage of students in that category. Fig. 2 shows the percentages of students in each category of online test plotted against the corresponding values of written tests.

TABLE I
Grading Scheme and the Percentage of Students in each Category in Online and Written Tests.

Grade	Category	Percentage of students	
		Online test	Written test
90 - 100	A	0.01	0.03
85 - 89	B+	0.05	0.08
80 - 84	B	0.08	0.04
75 - 79	C+	0.08	0.09
70 - 74	C	0.06	0.08
65 - 69	D+	0.16	0.13
60 - 64	D	0.13	0.08
Less than 60	F	0.43	0.47

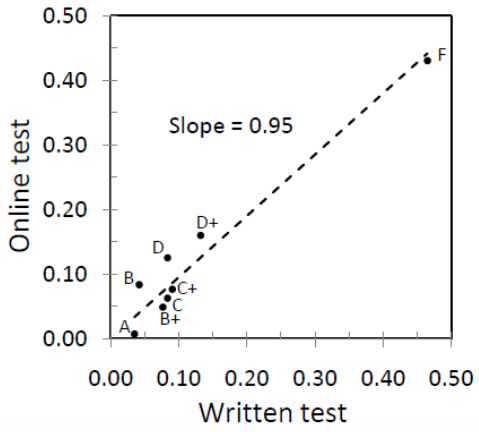

Fig. 2 Percentage of students in each Category in Online versus Written Tests.

Each point in the figure represents a category. The dashed line is the best straight line fit for the data with a slope equal to 0.95. It shows that the online tests results are very close to those of the written ones. Generally, the data demonstrates

that the number of students got score above D is higher in written tests, because they did not lose grades on calculations, and they got partial credits on their answers. Hence those students academic level is around or above average, they were capable to learn from their mistakes in the online-test trials and avoid committing the same mistakes in the written tests. Students below average, D and D+, who might not have done their online assignments by themselves, and consequently their performance in the written tests is lower.

One of the most important outcomes of the application of online testing is to enhance learning. Fig. 3 shows the percentage of students passing, and the grade average of the final examination. It is very clear that the passing percentage and average grades in this study (fa11 2009) and the semesters after spring 2007 are considerably higher than those with using the traditional methods. We can see a trend in the results in previous semesters where the passing percentage and the grade average percentage are relatively low. It is also remarkable that during those years less than 40% of the students passed the exams and the grade average is only slightly higher than the passing percentage. It is also interesting to see that with this approach, the passing percentage becomes higher than the grade average for the first time in fall of 2008. This result is closer to the real situation in a class room, where the distribution of grades among the students is supposed to be a "bell-shaped curve". Hence, it makes no since for the grade average to be high while the passing percentage is low.

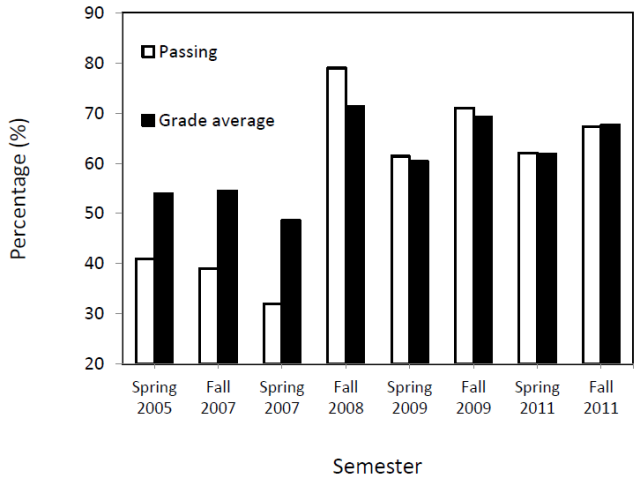

Fig. 3 Comparison between the passing and grade averages of different semesters, fall 2009 is the semester of our study.

It is worth to note the reaction of students during the semester; we noticed that the online tests had a considerable effect on students learning and acheivments. Students felt that they can manage their scores and they were given the opportunity to enhance them by improving their learning between the two online-test's trials. Knowing that they can improve their scores, the students became more responsible and displayed a v ery positive and innocent interaction between the students themselves and with their instructors as well. Using the online tests as assessment for learning is found to be a good practice in undergraduate education, it:

- encourages contact between students and faculty,
- develops reciprocity and cooperation among students,
- encourages active learning,
- gives prompt feedback,
- emphasizes time on task,

IV. Conclusion

We have shown that the online test assessment is a reliable method which is generally reflects the actual student's level, in spite of completing the tests outside the class. The used web based course manager (Blackboard) and the allowed restrictions on the tests minimized plagiarism among students. It is obvious that using online test has led to a noticeable enhancement in students' learning and their score outcomes, as compared with the results from previous semesters. The interaction between students and their instructors has shown remarkable improvement, and consequently better student's attitude toward physics.

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References

[1] David E. Pritchard, World Conference on *Educational Multimedia, Hypermedia & Telecommunications*, 2005, pp. 2976-2983.
[2] Rasil Warnakulasooriya and David E. Pritchard, *Proceedings of the Physics Education Research Conference*, 2004, pp. 205-208.
[3] A Service of the Center for Teaching and Learning Technology, UAEU, 2007.
[4] N. Qamhieh, Saleh T. Mahmoud, A. I. Ayesh, "Web-Based Homework Assignments for Introductory Physics Courses", British Journal of Education, Society & Behavioural Science, 3(2): 132-143, 2013.
[5] Maamar Benkraouda, "Using the peer instruction method in teaching general physics with Blackboard as a tool", Annual Conference for Middle East Teachers of Science, Mathematics and Computing (METSMaC). Abu Dhabi, U.A.E., 2006, 17-19.
[6] MAZUR, E. Science teaching reconsidered – A handbook. Committee on Undergraduate Science Education, National Academy Press: Washington, DC, 1997.
[7] Sevenair, J. P., & Burkett, A. R. (1997). Overview of the multiple-choice format. Retrieved July 21, 2006 from the Xaviar University of Louisiana Web site: http://webusers.xula.edu/jsevenai/objective/overview.html
[8] Instructional Assessment Resources, 2007, University of Texas at Austin.