THE EFFECT OF WEB-BASED HOMEWORK ON UNIVERSITY STUDENTS' PHYSICS ACHIEVEMENTS

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ABSTRACT
In this study, the effect of web-based homework on university students' physics achievement was compared. One of the two identical sections of introductory physics course students received pen-and-paper homework done in groups while the other received web-based online homework performed individually. And then both groups' homework performance and achievements were compared by homework assignments and standardized test scores (like Force Concept Inventory and Conceptual Survey of Electricity and Magnetism). Although there was not any significant difference in standardized test score results, in the first (fall) semester, pen-and-paper homework group performed better than the web-based group; yet, the web-based homework group did better in the second (spring) semester.
Keywords: Web-based homework, pen-and-paper homework, physics achievement, first year university students.

INTRODUCTION

The rise of the Internet in the last decade has led to become an important means for disseminating various educational materials to students. As part of this trend, a number of software packages have been developed, which allow students to complete homework assignments online. Student's assessment is one of the most important elements in an education system. The purpose of assessment is to provide a measure of student performance and a context for improving a course or an academic program. The two assessment (self and peer/groups) methods are becoming more pervasive and dominant (Paris & Paris, 2001; Shepard, 2000).

The importance of homework and the relationship between homework and academic performance has already been recognized by many individual and meta-analytic studies (Cooper, 1989; Cooper, Lindsay, Nye, & Greathouse, 1998; Keith & Cool, 1992; Warton, 2001). Homework is an activity related to motivation, mastery of material, and to achievement (Keith & Benson, 1992; Keith, 1982; Paschal, Weinstein, & Walberg, 1984). It is also obvious from some studies that homework may be necessary but not satisfactory for achievement on exams (Peters, Kethley & Bullington, 2002; Porter & Riley, 1996).

Some researchers stated that electronic homework as a course element has more positive effects than written homework (Dufresne, Mestre, Hart, & Rath 2002; Ogilve, 2000; Thoennessen and Harrison, 1996). For example, Dufresne et al. (2002) compared the effect of electronic homework and written homework on student achievement found that electronic homework led to higher overall exam performance. However, the study conducted by Bonham et al. (2001, 2003) showed that no significant differences in student performance that could be attributed to the homework method used.

Web-based homework has some benefits. These benefits include obtaining students' results faster, having the ability to place grades into an electronic format, measuring learning accurately, focusing on a student-centered environment, and costing less in comparison to pen-and-paper homework (Bartlett, Reynolds, & Alexander, 2000; Dash, 2000; Oregon to Administer, 2001). On the other hand, using a pen-and-paper homework has some limitations (for example: recording, scoring, getting immediate feedback, etc.). The possible constraints may be compensated by technology. Several studies (for example: Bonham, Beichner, & Deardorff, 2003; Dufresne, Mestre, Hart, & Rath, 2002; Toback, Mershin, & Novikova, 2005) have reported mixed findings on student homework performance, but little on student homework preferences. Therefore, the present study attempts to determine the effect of web-based homework on university students' physics achievements and to give new insight into the physics educator to use homework in their lectures.

Testing and Online Homework

Testing in general is used for providing feedback and evaluation. Feedback refers to the response regarding a critical analysis of students' work. Evaluation refers to the grading and recording of students' work for assessing their understanding of the material. A testing instrument, whether it is a homework assignment, quiz, exam, or practice test, can satisfy both purposes to a varying degree. Evaluation and feedback have different goals and thus have different implementation requirements. Evaluation is primarily used to record student responses and assign grades, security concerns such as verifying a student's identity, protecting answer keys, limiting access according to a specific time or location, and preventing unauthorized sharing of information need to be

considered. Feedback is to be able to respond to students' input by providing "correct/incorrect" answers, hints, and solutions or by engaging the student in additional learning activities much like present study.

The online homework method has some advantages for the instructor as well (Johnston, 2002). The primary benefit is savings in the effort spent running the coordination of the pen-and-paper homework process. Copying, distributing, collecting, sorting, and filing homework documents are freed by the instructor. Educators should consider and evaluate the effectiveness of this technology for increasing student learning. Homework assignments must exist in education because it might increase students' interest in school and/or course topics and improve their academic development (Altun, 2008). The online method also eliminates the need to score homework and record the scores in a grade book. The problems of missed, lost, and submitted-late assignments are largely eliminated. The online approach automates the tasks. Moving these tedious tasks outside of the class time period enables an instructor to cover more things in classrooms.

Purpose

The main aim of this study was to compare the effect of web-based homework and pen-and-paper homework on university students' physics achievement as measured by exam and homework performance.

METHODOLOGY

Participants

The participants of this study were chosen from a sample of convenience of Computer Education Department. They have many experiences online and computer-based assessment methods. In order to eliminate novelty effect, any kind of activities in the study has to be not new to students. In an introductory physics course, all students were taught partially "peer instruction" method (adopted from Mazur, 1997; Fagen, Crouch, & Mazur, 2002). In the study, there were two identical classes (according to their pretest scores). One class used online homework system and the other class used pen-and-paper homework. Specifically, 41 students in the fall semester of 2005, and 48 students in the spring semester of 2006 used the Web-based homework system; 37 students in the fall semester of 2005, and 42 students in the spring semester of 2006 used the pen-and-paper based homework.

Design and Procedures

A two-group pretest–posttest quasi-experimental design was used in this study. One group is subjected to a treatment, and the other is subjected to a control group (Fraenkel & Wallen, 1996). Students were registered for the two different sections through a standard course registration system and were unaware of the homework method until they were announced that they were assigned the indicated homework group (the first week of physics-1 [in the fall semester) and physics-2 (in the spring) classes, respectively]. The physics-1 and -2 courses have two main exams, one of which is mid-term and the other is the final exam. The homework performance scores in both groups were added to include the 20 % of the final grade of the course for each semester. The treatment group received their homework via an online quiz system where it was automatically graded by the software. Control group wrote out solutions to homework exercises on paper with working as groups consisted of four to five students. These exercises were turned in and graded by the instructor. Through semesters completing the each unit; homework assignment was administrated to students according to their assigned method (pen-and-paper or online) (mainly these assignment questions derived from Turkish translation of Principles of Physics by Bueche and Jerde, sixth edition, 1995). There were eight-homework exercises in the fall semester (for physics-1) and six exercises in the spring semester (for physics-2). All results were graded in percent scores, and then average scores were calculated to be used as the homework performance score. In the fall semester, T*he Force Concept Inventory (FCI)* test *(Hestenes,* Wells, & Swackhamer, 1992) administered before (in the first week of the semester) and after the instruction (the last second week semester). In the spring semester, also *The Concept of Survey on the Electricity and Magnetism* (CSEM) test (Maloney, O'Kuma, Hieggelke, & Heuvelen, 2001) was administered before (in the first week of the semester) and after (the last second week of the semester) the instruction to both groups. FCI and CSEM tests scores (in percent average scores) and homework performance scores were entered into the SPSS package programme for statistical analyses.

Structure of groups

Pen-and- paper homework group consisted of four or five students per group. There were 37 students in the fall semester and 42 students in the spring semester. Heterogeneous groups (according to prior knowledge) were formed to provide students with opportunities to interact with the content through the varying perspectives of their peers. According to Mahendra, Bayles, Tomoeda, and Kim (2005), promoting a collaborative, supportive classroom culture increases the opportunities for learners to be exposed to diverse viewpoints and values.

Students in this group worked with their group members and turned in their homework at the end of each unit by the end of each semester.
The types of problems used in this group homework assignment were identical to those used in web-based homework assignments; in fact, the vast majority of problems in the web based homework library came from the end-of-the chapter problems of the standard first year university algebra-based physics textbooks with the addition to some conceptual questions. After finishing every unit --there were eight units in the fall semester and six units in the spring semester--, students were given one assignment of five to nine problems. Gibson, Tesone, and Blachwell, (2001) suggested that the online testing should be one component of the evaluation of the student; therefore, in both groups, 20 % of the course final grade comes from the average homework score. In the web-based homework group, each student first registered the system and did their homework via online individually. The web-based homework system is called "*online testing*" and detailed description of the program is given below.

The Web-based homework system
The goal of the web-based homework system called "online testing" is to get immediate "correct" or "incorrect" feedback. The "online testing" system did not correct the student's errors or give them hints. The Web-based homework system was developed by Linux based .php extension html environment with using the MySQL database system and has two main modules. The first module is for students, and the second is for teachers.

In students' module, students have to register into a password protected web-based homework system at the beginning of the course. Until the end of the semester, they only need their ID number and password to log into the system. Once they enter the system whenever homework is activated by the instructor after each unit, one would be able to take that test. After finishing that test, students could see their results immediately and get the feedback. Student may ask any question related to testing or any problem encountered any time just clicking the provided link to communicate with the instructor via e-mail.

The teacher module provides teachers with a convenient user interface that allows them to execute various setup and management functions online, such as setting up accounts, setting up test parameters, queries as to students' scoring process and observing various assessment results at any time. Web-based homework system offers parameters to configure the options of various types of activities. By the teacher module, the instructor might do the following main tasks:

- Create or delete homework assignments, quizzes and define the number of questions to be asked for each assignment.
- To see students' homework results and progress, and see their detailed assignment results such as starting and finishing time.
- Answer their e-mail messages to communicate with them to solve their problems they might have encountered during the process.
- Able to activate or deactivate any particular assignment.
- Define the level of difficulties of questions uploaded to a server (specifically based on Bloom's taxonomy, questions in cognitive, knowledge and conceptual level labeled as "easy"; questions in application level labeled as "normal"; questions in complex application and analysis level labeled as "difficult").

RESULTS
This part consists of two sections, descriptive statistics, and inferential statistics.

Descriptive Statistics
Results devoted to FCI and CSEM tests
The results of FCI pre-, posttest scores, normalized-gain scores also known as Hake factor (Hake, 1998), and homework performance scores (in percent) for both groups are given in Table 1.

Table 1 *The results of FCI Tests and Homework Performance Scores in Percentage*

	Web-based homework-group			Pen-and-paper homework group		
	n	Average	S. Deviation	n	Average	S. Deviation
Homework performance	41	71.15	15.428	37	80.30	7.237
FCI pre-test	40	41.05	11.89	33	42.73	9.69
FCI post-test	39	62.87	9.96	36	61.44	9.97
FCI normalized gain		%37.01			%32.66	

It can be seen in Table 1 that average FCI pretest score calculated (in percent) in both groups are about in the forties and posttest score are about in the sixties. However, homework performance (percent) score calculated for web-based group is about 71%, and for pen-and-paper group is about 80 %. While web-based homework group's FCI normalized gain score is about 37 %, the pen-and-paper-based homework group's gain scores are found about 32.6 %. Pen-and paper group got higher scores on homework performance, but lower on the normalized gain score than the web-based homework group in the fall semester.
The results of CSEM pre-, posttest scores, normalized-gain scores, and homework performance scores (in percent) for both groups are given in Table 2.

Table 2 *Results of he CSEM Tests and Homework Performance Scores in Percentage*

	Web-based homework-group			Pen-and-paper homework group		
	N	Average	S. Deviation	N	Average	S. Deviation
Homework performance	48	78.13	8.41	42	71.66	10.60
CSEM pre-test	42	31.40	11.15	31	31.25	9.24
CSEM post-test	42	53.79	17.19	31	53.43	8.12
CSEM normalized gain		%32.63			%31.36	

Inferential Statistics
Summary of the t-test results related to FCI and CSEM pre- and post-test scores and homework performance scores for both groups are given in Table 3.

Table 3 *t-test Summary Results*

Test differences between groups	df	t-test	p
Homework performance differences for physics-1	76	-3.29	0.002
FCI pre-test differences	71	-0.65	0.517
FCI post-test differences	73	0.61	0.539
Homework performance differences for physics-2	88	3.08	0.003
CSEM pre-test differences	71	-0.264	0.793
CSEM post-test differences	71	0.153	0.879

CONCLUSION AND DISCUSSIONS
There was not any statistically significant difference were found in the means of the web-based and grouped pen-and-paper homework with respect to FCI and CSEM pre- and posttest scores. Although there was a significant difference in students' homework performance scores in favor of the pen-and-paper group in the fall semester, this was changed in the spring semester to the web-based group. Bonham, Beichner, and Deardorff (2001, 2003) reported that students who used traditional hand-written homework experienced no significant differences in learning gains comparing to students using the WebAssign system. Dufresne, Mestre, Hart, and Rath, (2002) compared student performance over several years in large introductory physics courses with both pen-and-paper-based and web-based homework system, and they found similar results from the study done by Ployhart et al. (2003) suggesting that automated homework led to higher performance scores.

Studies carried out by the CAPA development team concluded that online homework had a significant, positive effect on student learning (Demirci, 2007; Kashy, Sherrill, Tsai, Weinshank, Englemann, & Morrissey, 1993; Kashy, Morrissey, Tsai, & Wolfe, 1995; Morrisey, Kashy, & Tsai, 1995; Kashy, Thoennessen, Tsai, Davis, & Wolfe, 1998).

Web-based homework is a possible alternative to the traditional pen-and-paper -based approach. It does not bring significantly greater advantage to the students, but neither does it work much worse than standard methods of collecting and grading homework. This supports the opinion that technology itself does not improve or decrease student learning. Automated homework system most likely will help students in courses where homework could not otherwise be assigned.

The current literature does not really answer questions being raised about pen-and-paper-based web-based or otherwise. Homework is important in technical courses such as introductory physics, where problem solving is a major focus, and homework is the main place for practicing. Many student struggles to develop problem-solving skills in physics (Maloney, 1994), although directed instruction and feedback has been shown to be effective (Heller & Reif, 1984; Heller & Hollabaugh, 1992).

A limitation of the study was that online homework was done individually while the pen-paper based homework was done collaboratively with groups of 4/5 students. Individual versus collaborative work itself can be the conditions for other experimental studies. Furthermore, FCI and CSEM test scores thought to be fits and an adequate for measuring students' conceptual understanding and physics achievement. The online course cannot be an example of good pedagogy if technology is used without a student-centered approach to learning (Hiltz, 1990). When online material is submitted, and when it becomes an important student-centered activity and requirement of the class, Bauer and Anderson (2000) recommend three criteria to judge the students' content, expression, and participation. "These can provide a unique perspective from which to view students' formal writings and informal discussions". Besides, "an e-folio can offer students a chance to reflect on their own work and thus become more involved in the assessment process" (Bauer and Anderson, 2000, p.70).

For future study, it would be fruitful to examine such behaviors in relation to other factors associated with learning, such as students' attitudes, possible environmental variables, and different learning strategies and methods. Further work could focus on how online-mediated evaluation affects distance and open learning, how the development of content delivery and assessment tools is directly related to learning styles, how feedback in e-learning environments can be enriched and finally how the evaluation of e-learning methods differs from more traditional ones in great details. Additional contextual factors could reflect on students' some extra-curricular activities. Such inquiries could prove to yield some beneficial results (Kotas & Finck, 2002).

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