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University Students' Perceptions of Web-based vs. Paper-based Homework in a General Physics Course

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The main aim of this study was to determine students' perceptions toward web-based versus paper-based homework and identify any differences based on homework performance score and grade point average. A 21-item perception of online vs. paper-based homework survey was administered to 103 students (54 were male and 49 were female) in general physics-1 classes. Results of the study indicated that there was not a statistically significant difference in physics grade point average scores; however, there was a statistically significant difference in homework performance (average) scores based on assigned homework groups. Overall, students' perception of web-based homework testing was positive. Finally, some tentative recommendations are posed.

Keywords: Web-Based Homework, Paper-Based Homework, Physics Course, Student' Perception

INTRODUCTION

Homework is an important component of introductory physics instruction at the university level. An effective method of student assessment is necessary in physics as well as all areas and levels of education. In the traditional formal classroom, assessment has been conducted with paper and pencil using questioning techniques such as multiple choice, constructed response, fill-in-the blank, and essay items. This type of testing has been used to assess the skills and knowledge of students since the early 1930s (Hatfield & Gorman, 2000). Advancements in technology have led to new methods of student assessment. With the evolution of web-based technologies and the broad availability of computers, student assessment can now include computer-based forms.

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Bonham et al. (2003) indicated their study that nineteen of the 25 journals or conference papers in physics described a system and/or included student responses on surveys. Two papers compared students in a typical classroom to ones using programmed learning CAI to supplement or replace the standard course (Marr, 1999; Weiss, 1971), and one evaluated tutorials using two-way coaching between students and computers (Reif & Scott, 1999). All three reported improved student performance for those using computers, but they also involved differences in pedagogy, significant effort in development of the computer-based materials. One of the remaining three papers found that student performance improved in a course after Web-based homework was introduced (Woolf et al., 2000). Bonham et al. (2003) compared student performance over several years in large introductory physics courses, including both calculus-based and algebra-based courses, and four different instructors who had taught courses with both paper-based and Web-based homework system. Comparison of their performances on regular exams, conceptual exams, quizzes, laboratory, and homework showed no significant differences between groups.

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Alexander, Bartlett, Truell, and Ouwenga (2001) has examined the impact of computer-based forms of testing outcomes, and their research findings provided support that the two forms were equivalent. The current literature does not really answer questions being raised about computerized homework, web-based or otherwise. However, web-based homework system has some benefits. These benefits include obtaining students' results faster, having the ability to place grades into electronic format, measuring learning accurately, focusing on a student-centered environment, and costing less compared to paper-based exams (Bartlett, Reynolds, & Alexander, 2000; Dash, 2000; Oregon to Administer, 2001).

Purpose

The purpose of the study was to determine university students' perceptions toward web-based versus paper-based homework testing. To address this purpose, answers to the following research questions were sought:

1. What are students' perceptions on each of the 21 items composing the students' perceptions of web-based and paper-based homework testing survey instruments?
2. Are there statistically significant differences in students' homework performance scores and physics grade point average scores?

METHODOLOGY

Participants

The participants for this study consisted of all computer education department' students (of the 103; 54 were male, and 49 were female) enrolled in general physics-1 course offered at Balıkesir University, Necatibey Faculty of Education during the fall semester of 2005.

Instrumentation

The researcher has developed the students' perceptions of web-based and paper-based homework preference survey. 56 students [26 were female (46.4%), and 30 were male (53.6%)] had completed web-based homework preference survey questionnaire and 47 students [23 were female (48.9%), and 24 were male (51.1%)] had completed paper based homework preference survey questionnaire via online. The 21 items were arranged to form a Likert-type scale with a five-point spread. Participant scoring options were (1) strongly agree, (2) agree, (3) no opinion, (4) disagree, and (5) strongly disagree. To estimate instrument internal consistency, Cronbach's alpha was calculated and determined to be .87 for web-based survey, and .85 for paper-based survey.

Data Collection

During the last second week of the fall semester of 2005 for each section, participants were asked to complete the students' perceptions of web-based and paper-based homework preference instrument. Both groups, during the fall semester of 2005 students had taken eight homework tests. Students were registered for the two different sections through standard course registration system and were unaware of the homework method until it was announced the first week of physics-1 class. The physics-1 course has two main exams, one of which is mid-term and the other is final exam. The homework performance scores in both groups were added to include the 20 % of the final grade of the course. One is received their homework via online quiz system where it was graded by computer. The other wrote out solutions to homework exercises on paper with working as four or five groups of students. These exercises were turned in and graded by the instructor. Through the semester after each unit of physics-1 course is completed; students were administered homework questions according to their assigned groups. Most of the homework exercises on which the two groups worked was the same or similar problems from the physics textbook (Turkish translation of Principals of Physics by Bueche and Jerde, sixth edition, 1995) with addition of some conceptual questions by the instructor. There were total eight-homework exercises and they all in both groups graded in percent scores and calculated average scores to be their homework performance scores. All homework test scores and student's final grade points at the end of the semester were recorded to compare the results.

Data Analysis

Several procedures were used to analyze the data. Specifically, to answer question one and determine the level of students' perceptions on each of the 21 items of the students' perception of online and grouped paper and pencil based homework testing instruments, descriptive statistics were used. Means and percentage were used to determine the level of students' perceptions on each item. The t-test was used to determine where significant differences existed in homework performance scores and final grade point average for both groups.

RESULTS

Research question one sought to determine the level of students' agreement or disagreement on each of the

21 items on the students' perception of online, paper, and pencil-based homework testing instruments.

Level of Students Perceptions on each of the 21-Items for web-based homework testing group

Students' perceptions ranged from a high of 4.61 (indicating agreement) for the item web-based "The online test and its direction were easy to use and read on computer screen and the testing was user friendly" to a low of 2.68 (indicating disagreement) for the item "The way in which evaluation of the online homework scares me." Of the 21 statements, thirteen (61.9 %) had means between 3.31 and 4.61, eight (38.1 %) had means between 2.51 and 3.30. Each item's percentage and mean are presented in Table 1.

Table 1. Students' perceptions of web-based homework

Survey Items	*Strongly Agree*		*Agree*		*No-opinion*		*Disagree*		*Strongly Disagree*		**mean**
	%	N	%	N	%	N	%	N	%	N	
1. I prefer taking physics homework online.	28.6	16	17.9	10	21.4	12	25.0	14	7.1	4	3.36
2. Doing physics homework online is a modern approach than traditional paper and pencil homework.	39.3	22	57.1	32	-	-	-	-	3.6	2	4,29
3. Online homework has to be widespread out to the other courses.	32.1	18	32.1	18	21.4	12	10.7	6	3.6	2	3,79
4. Taking homework online could not be easily controlled*.	17.9	10	28.6	16	25.0	14	21.4	12	7.1	4	2,71
5. Doing homework online has disadvantages for me*.	10.7	6	21.4	12	21.4	12	32.1	18	14.3	8	3,18
6. I spend less time when doing homework online.	10.7	6	17.9	10	28.6	16	28.6	16	14.3	8	2,82
7. I prefer paper-pencil based homework than online homework* .	17.9	10	21.4	12	14.3	8	28.6	16	17.9	10	3,07
8. The technical computer problem reduced my test grade*.	3.6	2	10.7	6	25.0	14	28.6	16	32.1	18	3,75
9. Online homework provides me with more responsibilities in managing my time.	28.6	16	42.9	24	7.1	4	14.3	8	7.1	4	3,71
10. Getting immediate result and feedback from online homework system motivated me.	64.3	36	21.4	12	3.6	2	10.7	6	-	-	4,39
11. Students' progress and results can be easily achieved via online homework system.	46.4	26	28.6	16	-	-	7.1	4	17.9	10	3,79
12. Along with the online homework, the paper-pencil homework should be also given*.	21.4	12	17.9	10	14.3	8	28.6	16	17.9	10	3,04
13. The way in which evaluation of the online homework scares me*.	25.0	14	25.0	14	17.9	10	21.4	12	10.7	6	2,68
14. I want to continue taking homework online for general physics 2 course.	32.1	18	28.6	16	10.7	6	14.3	8	14.3	8	3,50
15. I am more comfortable with taking online homework than paper-pencil based one.	21.4	12	25.0	14	28.6	16	21.4	12	3.6	2	3,39
16. I had some difficulties getting access to computer and/or Internet and taking homework online*.	21.4	12	14.3	8	7.1	4	35.7	20	21.4	12	3,21
17. The online test environment is appropriate for test taking and convenient.	28.6	16	35.7	20	14.3	8	14.3	8	7.1	4	3,64
18. Online homework is a positive experience and I prefer taking some other courses via online.	17.9	10	35.7	20	10.7	6	21.4	12	14.3	8	3,21
19. I do not want to take any homework test via online*.	7.1	4	10.7	6	14.3	8	39.3	22	28.6	16	3,71
20. Preparing physics exams and getting my physics final grade, the online homework tests have helped a lot.	25.0	14	32.1	18	17.9	10	10.7	6	14.3	8	3,43
21. The online test and its direction were easy to use and read on computer screen and the testing was user friendly.	64.3	36	32.1	18	3.6	2	-	-	-	-	4,61

Note:*Negatively worded statements were used in order to avoid response set bias. For analytical purpose, these negatively worded statements were recorded in the positive form. Means and standard deviations are reported as if they were positively worded; participant scoring options were (1) strongly agree, (2) agree, (3) no opinion, (4) disagree, and (5) strongly disagree.

Level of Students Perceptions on each of the 21-Items for paper-pencil -based homework group

Students' perceptions ranged from a high of 4.02 (indicating agreement) for the item of paper and pencil-based homework "The way in which using grouped pencil and paper homework for this course is appropriate" to a low of 2.81 (indicating disagreement) for the item "The way in which evaluation of the paper and pencil homework scares me". Of the 21 statements, fifteen (71.4%) had means between 3.31 and 4.10, six (28.6 %) had means between 2.51 and 3.30. Each item's percentage and mean are presented in Table 2.

Table 2. Students' perceptions paper and pencil-based homework

Survey Items	*Strongly Agree*		*Agree*		*No-opinion*		*Disagree*		*Strongly Disagree*		**Mean**
	%	N	%	N	%	N	%	N	%	N	
1. I prefer taking paper and pencil homework with groups in physics	31.9	15	29.8	14	14.9	7	12.8	6	10.6	5	3,60
2. Doing physics homework online is a modern approach than traditional paper and pencil homework.	25.5	12	38.3	18	19.1	9	10.6	5	6.4	3	3,66
3. Paper and pencil homework with groups has to be widespread out to the other courses.	29.8	14	46.8	22	6.4	3	8.5	4	8.5	4	3,81
4. Taking paper and pencil homework with groups occurs out of controlled.	12.8	6	34.0	16	25.5	12	25.5	12	2.1	1	3,30
5. I spend more time when doing paper pencil homework with groups*.	2.1	1	23.4	11	19.1	9	48.9	23	6.4	3	3,34
6. I prefer paper-pencil based homework with group than online homework	19.1	9	21.3	10	29.8	14	19.1	9	10.6	5	3,19
7. Doing paper and pencil homework with groups has disadvantages for me*.	8.5	4	19.1	9	8.5	4	44.7	21	19.1	9	3,47
8. Gathering with group members to do pencil and paper based homework reduced my grades*.	10.6	5	23.4	11	29.8	14	27.7	13	8.5	4	3,00
9. Pencil and paper homework with groups provides me with more responsibilities.	29.8	14	42.6	20	4.3	2	17.0	8	6.4	3	3,72
10. Getting late result and feedback from paper and pencil homework motivated me negatively.	19.1	9	34.0	16	34.0	16	6.4	3	6.4	3	3,53
11. Students' progress and results cannot be easily achieved via paper and pencil based homework system	21.3	10	31.9	15	19.1	9	25.5	12	2.1	1	3,45
12. Along with the paper-pencil based homework, the online homework should be also given*.	12.8	6	29.8	14	17.0	8	25.5	12	14.9	7	3,00
13. The way in which evaluation of the paper and pencil homework scares me*.	14.9	7	25.5	12	27.7	13	27.7	13	4.3	2	2,81
14. I want to continue taking grouped paper and pencil based homework for general physics 2 course.	42.6	20	23.4	11	12.8	6	2.1	1	19.1	9	3,68
15. I am more comfortable with taking grouped paper-pencil based homework than online.	19.1	9	36.2	17	21.3	10	17.0	8	6.4	3	3,45
16. I had some difficulties gathering and doing pencil and paper homework with groups.	21.3	10	36.2	17	6.4	3	25.5	12	10.6	5	3,32
17. I encounter many problems when doing pencil and paper based homework*.	2.1	1	29.8	14	17.0	8	29.8	14	21.3	10	3,38
18. Grouped pencil and paper based homework is a positive experience and it has to be adopted the other course.	17.0	8	29.8	14	23.4	11	17.0	8	12.8	6	3,21
19. I do not want to take any homework test via online.	14.9	7	27.7	13	8.5	4	23.4	11	25.5	12	2,83
20. Preparing physics exams and getting my physics final grade, the grouped pencil and paper-based homework has helped a lot.	14.9	7	38.3	18	23.4	11	14.9	7	8.5	4	3,36
21. The way in which using grouped pencil and paper homework for this course is appropriate.	46.8	22	29.8	14	8.5	4	8.5	4	6.4	3	4,02

Note:*Negatively worded statements were used in order to avoid response set bias. For analytical purpose, these negatively worded statements were recorded in the positive form. Means and standard deviations are reported as if they were positively worded; participant scoring options were (1) strongly agree, (2) agree, (3) no opinion, (4) disagree, and (5) strongly disagree.

Table 3. T-test summary results

Test differences between groups	$\overline{X}_{web}$, and S.D. $_{web}$	$\overline{X}_{paper}$,and S.D $_{paper}$	$\overline{X}_{difference}$	df	t-test	p
Homework performance differences	71.15 and 15.49	80.30 and 7.24	-9.15	101	-3.29	0.02*
Final grade average differences	62.20 and 15.06	65.13 and 13.93	-2.93	101	-0.78	0.43

*p<0.05

Research question two sought to find out if there exist significant differences in students' homework performance scores and physics grade point average.

Summary t-test results of both groups related to homework performance scores and grade point average scores are given in Table 3.

It can be seen in Table 3 that there were not any statistical differences in physics-1 grade point average scores in terms of assigned groups of being web-based or paper-based (t_{101}= -0.78, p>0.05). However, there was a statistically significant difference in average homework performance scores with respect to assigned two groups (t_{101}= -3.29, p<0.05) in favor of paper-based homework group.

CONCLUSIONS

The main aim of this study was to find out students' perceptions toward web-based versus paper-based homework and seek if any differences exist based on homework performance score and grade point average. A 21-item perception of online vs. paper-based homework survey was administered to 103 students (54 were male and 49 were female) in general physics-1 classes at computer education department in Necatibey Faculty of Education, Balıkesir University. There was a not statistically significant difference in the means for web-based individual homework and grouped paper-based homework system with respect to physics-1 grade point average scores. However, there was a statistically significant difference in homework performance score in terms of assigned groups. The current literature does not really answer questions being raised about computerized homework, 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 venue for practicing, many students struggle 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).

While comparison of their performances on regular exams, conceptual exams, quizzes, laboratory, and homework showed no significant differences between groups; other measures were found to be strong predictors of performance(Bonham at al., 2003), however, in this study, there was a statistically significant result between web-based and paper-based homework performance results in favor of paper-based group. Dufresne, Mestre, Hart, and Rath, (2002) compared student performance over several years in large introductory physics courses, including both calculus-based and algebra-based courses, and four different instructors who had taught courses with both paper-based and web-based homework system. Student exam scores generally improved at a significant level after the introduction of web-based homework. Students using web-based homework reported spending significantly more time on assignments than did those using paper homework.

The students participating in the study were enrolled in a required, introductory physics course at computer education department. Since computer use is a major component of their academic studies, students may have higher perceptions toward web-based homework testing than students in non-computer education departments. However, in terms of homework performance score, the paper-based group's homework performance score is found higher than web-based group. Students' perception about web-based and paper-based homework is found to be positive. Students' perceptions ranged from a high of 4.61 (indicating agreement) for the item web-based "The online test and its direction were easy to use and read on computer screen and the testing was user friendly" to a low of 2.68 (indicating disagreement) for the item "The way in which evaluation of the online homework scares me". Of the 21 statements, thirteen (61.9 %) had means between 3.31 and 4.61, eight (38.1 %) had means between 2.51 and 3.30. In addition to this result, also, students' perceptions ranged from a high of 4.02 for the item of paper and pencil-based homework "The way in which using grouped pencil and paper homework for this course is appropriate" to a low of 2.81 (indicating disagreement) for the item "The way in which evaluation of the paper and pencil homework scares me". Of the 21 statements, fifteen (71.4%) had means between 3.31 and 4.10, six (28.6 %) had means between 2.51 and 3.30.

Implications and Discussion

The findings of this study offer physics educators several implications for practice. First, given no practical differences in students' perceptions of web-based testing based on the variables investigated, physics educators who are working with similar groups may find online testing to be a viable alternative to traditional paper and

pencil testing. Several studies have reported no differences in student performance when online and paper and pencil test scores have been compared (e.g., Alexander *et al.,* 2001; Bicanich, Slivinski, Hardwicke, & Kapes, 1997; Bonham at al., 2003). Second, while students' perceptions of web-based testing are generally positive, in some areas physics educators may have to adapt the online testing process to better fit the desires of students.

Recommendations for Further Research

Based on a review of the relevant literature and data analysis, the following recommendations for additional research are offered.

1. Further study of students' perceptions toward web-based testing should be conducted in classes where computer use is not a chief component of their academic profession. A study of this type would provide insight into how students perceive web-based testing in courses where the computer is not used as a primary tool of instruction.

2. A study investigating students' perceptions of web-based testing with other variables should be conducted. For example, comparisons of undergraduate and graduate students, face-to-face and distance education students, and instruction (e.g., traditional, peer-based, etc.) would be beneficial.

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