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Full Length Research Paper

Comparison of student performance using web- and paper- based homework in large enrollment introductory physics courses

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The effects of web-based homework and paper-and-pencil homework on student achievement were compared by conducting conceptual tests, exams, and homework assignments. The study was performed on two groups (287 students in total) during three semesters at a public university in the middle region of the US. Of the two identical sections of an introductory calculus-based course, students in one section received paper-and-pencil homework, while the students in the other section received web-based homework. When the results obtained from the study were evaluated statistically, it was found that there was not any significant difference in conceptual test and exam scores between the two groups throughout the three semesters. However, the homework performance scores for the web-based homework group were higher than the performance scores of the paper-and-pencil homework group.

Key words: Higher education, paper-and-pencil homework, physics education, web-based homework.

INTRODUCTION

Web-based homework systems are becoming increasingly popular in the teaching of large introductory calculus-based physics courses all over the world. With decreases in both faculty and teaching assistants, many universities, colleges, and high schools have abandoned time-intensive approaches to homework, such as collecting and grading homework and conducting small discussion sections where instructors go over homework problems. Web-based homework systems can provide an affordable alternative to traditional approaches to administering homework (Dufrense et al., 2002). As part of this trend, many software packages have been developed, allowing students to complete homework assignments on-line.

The importance of homework and the relationship between homework and academic performance has already been recognized by several studies (Keith and Cool, 1992; Warton, 2001). The results from these studies suggested that homework may be necessary but not satisfactory for achievement on exams (Karakuyu, 2010; Peters et al., 2002). Few researchers found that web-based homework as a course element is more effective than paper-and-pencil homework (Dufrense et al., 2002; Thoennessen and Harrison, 1996). Dufrense et al. (2002) and Lenz (2010) compared the effect of web-based homework and paper-and-pencil homework on student achievement found that web-based homework led to higher overall exam performance. However, the study conducted by Bonham et al. (2003) showed that no significant differences in student performance that could be attributed to the homework method used.

Gok (2010) reported that the implementation of problem-solving strategy steps to the computer-assisted systems can enhance the performances of web-based exam. Most of the literature on the use of web-based homework in the sciences describes, how courses are structured or how the web-based homework system itself is structured; statements about the cognitive benefits of web-based homework are often anecdotal, given without rigorous supporting evidence (Hitt, 2010; Hodge et al.,

Abbreviations: LON-CAPA, Learning Online Network with a Computer-Assisted Personalized Approach; **CSEM,** conceptual survey of electricity and magnetism.

2009; Kashy et al., 1995; Lee and Heyworth, 1997; Pascarella, 2004; Rodriguez et al., 2011; Toback et al., 2005; Zerr, 2007). Web-based homework has some benefits. These benefits can be summarized as follows (Bonham et al., 2003; Demirci, 2006; Titus et al., 1998):

Pedagogical approaches

By using automated submission and scoring of assignments, instructors can give students more frequent assignments and more questions on each assignment than is possible with traditional methods, thus increasing the time that students spend studying the material, answering questions, and solving problems. The computer can determine the precise nature of assignment based upon student performance.

Decreased administrative effort

Automated grading makes possible continual administration of homework, thus increasing the amount of time students spend on academic assignments. Automated scoring also allows the instructor to easily perform item analysis to determine which questions are the best predictors of student performance. Instructors can then tailor their assignments (homework, quizzes, or exams) to include questions that probe student understanding.

Multimedia-enhanced questions

The web's capabilities allow questions that include video, animation, simulation, or audio.

Immediate feedback

Surveys given to students indicate that immediate feedback is one of the most appreciated aspects of web-based assessment. This encourages students to consider why they missed certain questions, and the latter ensures that students fully consider their answers before submitting them. Web-based assessment can be used effectively to provide unbiased evaluation and frequent feedback that are immediate, platform independent, multimedia-enhanced, and automated. However, new technology brings new concerns. Some drawbacks of these systems can be summarized as follows (Bonham et al., 2003; Demirci, 2006; Titus et al., 1998).

Inability to see students work

When grading, it is useful for physics instructors to view students' work, check their diagrams, and follow their reasoning. Unfortunately, this is not currently possible on the web.

As grading becomes automated, instructors may lose some insight into the problem-solving processes employed by students.

Less variety of questions and grading methods

Automating the grading process eliminates certain types of questioning and grading. However, there are new types of questions that can be delivered on-line that cannot be delivered on a piece of paper.

Security issues

If the web is used for evaluation, security issues inevitably arise. How can the instructor be assured that a student is doing his or her own work? For homework, the grade is not heavily weighted, students are usually expected to work together, and password verification may be enough to deter less-motivated cheaters. As a result, security concerns are not so great and there can be benefits to encouraging students to collaborate.

Technical difficulties

When using the web for assessment, instructors must realize that technical problems will occur. For instance, the server may be down or the server software may need to be updated. Instructors must plan to handle these difficulties, and it must be clear to students what they should do in the inevitable event of a technical problem.

Presentation difficulties

Although the web is improving in its graphic design capabilities, it is not easy to represent mathematical equations and symbols within text; therefore, they are usually presented as images where each one is created individually and saved in an image format. This not only involves a time-consuming development process, but, since each image is downloaded separately, it also results in additional strain on the server.

Students' perceptions

Although assessment on the web offers new opportunities to engage students in learning experiences, students may perceive it as minimizing human interaction and ultimately replacing the instructor.

DESCRIPTION OF WEB-BASED HOMEWORK SYSTEM USED

The web-based homework system employed in this study had two main modules. The first module was for students, and the second was for instructors.

The student' module

Students had to register into a password protected web-based homework system at the beginning of the course. Until the end of the semester, they only needed their ID number and password to log onto the system. Once they entered the system, when homework was activated by the instructor after each unit, they were able to complete the unit test. Students could work through the exercises while seated at the computer or they could obtain a printed copy of the exercises to work on elsewhere. After determining the answers, students would then submit their solution, which was most commonly a numerical result or one option from a multiple choice list, but could also consist of selecting multiple options in a list, entering a symbolic (algebraic) answer, typing in a word or a short essay, or uploading a file. In most cases, the computer immediately evaluated the answers, gave the student some level of feedback, and sometimes allowed reworking and resubmission of the assignment depending on how the instructor had set the options. Students were able to ask any question related to testing or other problems simply by clicking the provided link to communicate with the instructor by e-mail. Some systems had additional features such as chat rooms, instructor notes, calendars, and calendars.

The instructor' module

The instructor module provided instructors with a convenient user interface that allowed them to perform various setup and management functions on-line, such as setting up accounts, setting up test parameters, submitting queries about students', scoring process and observing various assessment results at any time. The web-based homework system offered parameters to configure the options of various types of activities. By using the instructor module, the instructor might complete the following main tasks: a) create or delete homework assignments and, quizzes as well as define the number of questions to be asked for each assignment; b) to track students' homework results and progress, and view their detailed assignment results, such as starting and finishing times; c) answer their e-mail messages to communicate with students to solve any problems they might have encountered during the learning process; and d) activate or deactivate any particular assignment (Demirci, 2007; Titus et al., 1998).

LON-CAPA (The Learning Online Network with a Computer-Assisted Personalized Approach) software for web-based homework was used in this study. LON-CAPA is a tutorial and assessment program created at Michigan State University (MSU). LON-CAPA was first used in physics classes at MSU in 1992 (Kashy, 1993; Kashy et al., 1995). LON-CAPA, while similar to many other online learning systems in most aspects, differs in three important ways (Kortemeyer et al., 2005, 2008). The first difference is its capacity to randomize problems, both algorithmic numerical exercises as well as problems that are qualitative and conceptual, so that numbers, options, images, graphs, formulas, and labels, differ from student to student. The students thus can (and are encouraged to) discuss the assignments, but they cannot simply exchange answers. The second difference is found in system's provision of tools that allow instructors to collaborate in the creation and sharing of content in a fast and efficient manner, both within and across institutions, thus performing the first goals of the web. Most course management systems are built around the course as the main entity, and learning content is uploaded to the course website. At the end of the semester, most systems allow export of their content to an instructor's personal computer, but then require that the content be uploaded again in ensuring semesters. Within LON-CAPA, the content is stored independently of a specific course in a shared cross-institutional content pool. The third difference is its one-source multiple target capacities, that is, its ability to automatically transform one educational resource, for example, a numerical or conceptual homework question, into a format suitable for multiple uses: the same source code, used to present problems for on-line homework, can also generate questions for an on-line examination or for a printed version suitable for a proctored bubble sheet examination that is later machine scored.

The purpose of the study

The main aim of this study was to compare the effects of web-based homework and paper-and-pencil homework on university students' physics achievement as measured by conceptual test, homework performance, and exams. In this study the author investigates the following questions: Is there any difference between the conceptual understanding achieved by the group using web-based homework and the group using paper-and-pencil homework? Is there any difference between the performance scores of the group using web-based homework and the group using paper-and-pencil homework? Is there any difference between the exam scores of the group using web-based homework and the group using paper-and-pencil homework?

Table 1. The distribution of the students according to groups and semesters.

Semesters	Web-based homework	Paper-and-pencil homework
Spring 2009	48	47
Fall 2009	49	48
Spring 2010	47	48

MATERIALS AND METHODS

Participants

The subjects in this study consisted of 287 students, followed for three semesters, attending a public university in the middle region of the United States. The participants of this study were chosen from a sample of convenience from the Physics Department. The peer instruction approach (Fagen et al., 2002; Mazur, 1997) was used in introductory calculus-based physics courses. The study examined two identical classes. One class used a web-based homework system, and the other class used paper-and-pencil homework. This study was applied to different students over the course of three semesters. The distributions of the students according to groups and semesters are given in Table 1.

Design and procedures

The research method was a quasi-experimental design in which an instructor who was assigned to teach two lecture sections of the same course. Students were registered for the two different sections through a standard course registration system and were unaware of the homework method until it was announced to them.
The treatment group received their homework by LON-CAPA, and it was automatically graded by the software. In the web-based homework group, each student first registered in the system and then did his or her homework on-line individually. Students in the control group wrote out solutions to homework exercises on paper, also working individually. These exercises were turned in and graded by the instructor. The paper section submitted paper homework once a week, usually at the end of class on Friday. These students were asked to write solutions that included (a) identification of the information given in the problem, (b) a drawing, (c) a layout of the solution (the formulas), (d) the solution complete with units and significant figures, and (e) a check for reasonableness (Bonham et al., 2003). The types of problems used in the paper-and-pencil homework assignments were identical to those used in the web-based homework assignments; in fact, most of the problems in the web-based homework library came from the end-of-the chapter problems of the standard first year university introductory calculus-based physics textbooks, with the addition of some conceptual questions.

The data collection tolls

Three sources of data for each group were analyzed: a) exam scores, b) homework scores, and c) conceptual test (Conceptual Survey of Electricity and Magnetism “CSEM”) scores.

Exam scores

This study was performed on the Introductory Calculus-Based Physics II course. This course covers the topics of Electrostatic, Circuits, Magnetics, and Optics. The basic goal of this course are as follows: to enable student to understand the fundamental laws of electromagnetism as summarized in the Maxwell equations and related concepts and principles, to be able to apply these laws with the fundamental laws of motion using calculus, to construct a suitable understanding of the electromagnetic properties of physical systems in an applied context, and to begin to develop critical problem-solving strategies. The classes met Monday, Wednesday, and Friday, with the paper-based section occurring immediately after the web-based section. This course had four main exams, three of which were midterms and the other was the final exam for the semester.

All of the exams asked students to solve 20 multiple-choice questions. The majority of the questions were one-step or two-step physics calculation problems, with some conceptual problems mixed in. Each exam was graded on a scale of 100 points. Each student was given a cumulative exam score equal to the average of his or her four class exams. The students’ average exam scores were used to compute a class average and standard deviation. To ensure the consistency of the study’s results, the exam questions were not changed during the three semesters.

Homework scores

The instructor assigned both groups of students’ weekly problem sets of about 10 problems each (for 14 weeks). For both groups, the problems were obtained from the end of chapter problems in the textbook (Tipler and Masco, 2008). Most of the problems assigned were quantitative. The paper-and-pencil homework and web-based homework groups received the same weekly assignments which were due once a week at nearly the same time.
For the paper-and-pencil homework group, students were required to turn in handwritten solutions individually. The instructor mostly graded the students’ work for completion, with some credit given for correctness of solutions. Also, a complete key was scanned and posted on-line for student viewing after the graded homework was returned. Weekly, homework assignments were graded on a scale of 100 points.

For the web-based homework group, the problems from the paper-and-pencil homework group were adapted to an HTML format and placed on the web using LON-CAPA software. Because most of the problems were quantitative, students were required to type in their final (numerical) answer. As is typical with web-based homework, after submission the homework was automatically graded by computer and available for student viewing within seconds. For each problem, general feedback was supplied. This feedback ranged in detail from describing typical mistakes that students make to giving detailed hints on how one could solve the problem. Each quantitative problem used random number generators for the quantities given in the problem. Thus, each time a homework set was accessed, the correct answers would change. This feature was especially useful in that students could not cheat by copying each other’s final answers or by copying answer

Table 2. The results of CSEM for groups.

Semesters	Web-based homework			Paper-and-pencil homework		
	Pretest	Posttest	Gain	Pretest	Posttest	Gain
Spring 2009	40.93	59.06	0.30±0.03	41.25	58.12	0.29±0.02
Fall 2009	32.18	52.50	0.30±0.04	33.18	53.12	0.30±0.05
Spring 2010	37.18	61.56	0.38±0.04	34.06	58.06	0.36±0.03

Table 3. The results of homework performance and exam scores.

Semesters	Web-based homework (WBH)				Paper-and-pencil homework (PPH)			
	Exams for WBH	SD	Homework performance	SD	Exams for PPH	SD	Homework performance	SD
Spring 2009	73.02	13.4	87.91	21.7	71.23	12.1	72.16	22.8
Fall 2009	69.05	12.6	88.76	20.5	69.11	13.2	70.29	21.4
Spring 2010	66.90	12.9	90.37	22.1	67.07	12.5	71.44	21.9

SD, Standard deviation.

keys supplied by the program after homework submission. Therefore, and consistent with the common usage practices for web-based homework, the students were allowed to revise and resubmit their homework. Points were given only for correct answers: no points were given for simply completing an assignment. In the end, the grade recorded was only the highest score attained out of all attempts for each problem set. In keeping with typical practice, unlimited attempts were allowed (a choice of the instructor, which can be altered in most web-based homework systems). Finally, the instructor calculated the average homework assignment' scores of web students out of 100 points.

Conceptual test

The Conceptual Survey of Electricity and Magnetism (CSEM) consists of thirty-two questions. This multiple-choice conceptual test is designed to assess student's knowledge of topics in electricity and magnetism (Maloney et al., 2001). Generally, student's scores on CSEM are analyzed by calculating the normalized gain (Hake, 1998). Hake (1998) defines three ranges of g: low (0-0.3), medium (0.3-0.7), and high (0.7-1.0). The Hake gain is a normalized gain defined as

$$g = \frac{\text{Actualgain}}{\text{Max.possiblegain}} = \frac{\text{Posttest} - \text{Pretest}}{\text{Max.score} - \text{Pretest}}$$

Where, g measures the percentage of improvement in the posttest score relative to the pre-test score, as compared with the maximum amount of improvement that could have been achieved. This, improvement, in turn, is assumed to occur because of the learning that occurred between the pre- and post- tests. This conceptual test was given to the students groups on the first day of class as a pre-test and on the final day of class as a post-test during the three semesters. SPSS16.0 was used to conduct statistical processing on the data collected.

RESULTS AND DISCUSSION

To determine the if learning outcomes are as good for web-based homework as for paper-and-pencil-based homework, the author examined the homework scores, pre-test scores, post-test scores, and exam scores. The author collected data on pre/post conceptual test scores, homework performance scores, and exam scores.

The CSEM was administered to all students in the course at the beginning and end of the semester. The CSEM pre-test provides a measure of previous physics understanding from formal or informal learning. Improvement between the pre-test and the post-test provides a measure of conceptual learning gained during the course of the semester. The results of the CSEM pre-and-post-test scores, and normalized gain scores, also known as the Hake factor for the students groups during the three semesters are given in Table 2.`It can be concluded from Table 2 that the learning outcomes for the web-based homework groups and the paper-and-pencil homework groups were statistically equivalent. It was found that all of the gain factors calculated for the groups were medium. According to Hake's gain factors, neither web-based homework nor paper-and-pencil homework was observed to have a positive effect on students' conceptual learning. The results of homework performance scores and exam scores are given in Table 3.The averages reported here for exam and homework performance are the averages of the three mid-terms exams and the final exam and of all of the homework performances, respectively. It can be concluded from Table 3 that the exam scores of the web-based homework groups

Table 4. t-test summary results of the data.

	Spring 2009			Fall 2009			Spring 2010		
	df	t	p	df	t	p	df	t	p
CSEM pretest differences	93	1.06	0.291	95	0.44	0.660	93	1.40	0.164
CSEM posttest differences	93	0.32	0.749	95	0.21	0.834	93	1.28	0.203
Exam differences	93	0.67	0.504	95	0.00	1.000	93	0.06	0.952
Homework differences	93	3.41	0.000*	95	4.29	0.000*	93	4.15	0.000*

Df, degree of freedom; p* <0.05.

and the paper-and-pencil homework groups were roughly equivalent during all three semesters. However, the homework performance scores of the web-based homework groups were higher than that of the paper-and-pencil homework groups'. The average exam scores of the web-based homework groups were lower than their average homework performance. When these results were evaluated, it can be concluded that one concern about web-based homework was that it further reduces the incentive for students to write out systematic solutions to communicate clearly and avoid mistakes: working step by step, writing explanations, working algebraically, and keeping track of units. Also, the web-based students were allowed to resubmit problems without a limit until the deadline, and their score represents their final submission. The paper students were able to submit their assignments only once, but their scores included partial credit. Therefore, it is not surprising that, in the Introductory Calculus-Based Physics II course the web students had a higher homework performance scores. When the results of the paper-and-pencil homework groups' scores were examined it could be concluded that because of the extra practice they received in writing complete solutions on homework, they had developed better habits in the mechanics of writing solutions that did not make a significant difference on these scores. Finally, summaries of the two-tailed t-test results related to the CSEM pre-and- post- test scores, homework performance scores, and exams scores according to semesters are represented in Table 4. It can be concluded from Table 4 that the calculated t-values for CSEM pre-test difference, CSEM post-test difference, and the difference in exam performance between web-based homework groups and paper-and-pencil homework groups were each lower than the critical t-values of 1.68 at p=0.05 (95% confidence) level of significance. When these results were evaluated, it could be said that there was no significant difference between the groups' scores. However, the calculated t-values (8.14, 9.58, and 8.80 according to the semesters) for homework performance scores in the groups were each greater than the critical t-values of 1.68 at p=0.05 level of significance. These findings indicate that the homework performance scores of the web-based homework groups were higher than the scores of the paper-and-pencil homework groups. Also, it was determined that there was a significant difference between the groups' scores in this area. All these results supported the findings of the research conducted by Bonham et al. (2001, 2003), Demirci (2010), Dufrense et al. (2002) and Lenz (2010).

The homework is no doubt, very important for it distinguishes the difference between the class work and homework. However, in some cases the students can find the results by trial and error strategy. The web-based homework systems should be modified and the problem solving steps of students should be asked to reveal the real value of this homework method in the exams. This modification will encourage the students to indicate their performances not only in exam but also in homework assignments.

Conclusion

A detailed study comparing the use of paper-and-pencil homework and web-based homework in introductory calculus-based physics courses was conducted. Student' performance on conceptual tests, exams, and homework assignments were analyzed in this study. When the results were evaluated, it was determined that the homework method did not lead to a difference in conceptual learning, as measured by gains on the CSEM. However, there was a significant difference in students' homework performance scores in favor of the web-based homework group.

Research Limitation

It is, perhaps, not surprising that the difference in homework method had such a limited effect on student performance. First, similar or identical end of chapter problems were used, so there was no real difference in pedagogical content. The differences between the two homework methods are the level of completeness required and the feedback provided to students. The paper students were required to work out the entire solution and show their work, whereas the web students needed only to submit the final numerical answer. The paper students received more detailed, but less immediate feedback, whereas the web students received immediate feedback on whether their answers were correct. Furthermore, the study practices of many students may tend to reduce these differences further. Many web students usually printed out assignments, worked them out on paper-sometimes thoroughly-and then returned to the computer to submit them. Therefore, they used the computer as a means to check their answers and receive credit. On the other hand, many of the students in the paper section did not spend much time reviewing the returned homework, viewing it as unimportant or unhelpful, and so did not derive as much benefit as they might have from the written grading. Both of these student habits tended to further reduce the differences between the effects of the two homework methods (Bonham et al., 2001; 2003; Demirci, 2010; Hake, 1998).

Future directions

Some potential drawbacks of using web-based homework include a lack of detailed feedback for the students, the danger of multiple submissions encouraging lazy habits, and further impersonalization of the course by replacing a human grader with a computer (Bonham et al., 2003). Possible remedies to these problems could be loss of points for excess submissions, limiting the number of submissions allowed, or basing the students' scores on an average of all submissions.

REFERENCES

Bonham S, Beichner R, Deardorff D (2001). On-line homework: Does it make a difference. Phys. Teach., 39:293-296.

Bonham SW, Deardorff DL, Beichner RJ (2003). Comparison of student performance using web and paper-based homework in college-level physics. J. Res. Sci. Teach., 40: 1050–1071.

Demirci N (2006). Developing web-printed homework system to access student's introductory physics course performance and compare to paper based homework. Turk. Online J. Distance Educ., 7: 105-119.

Demirci N (2007). University students' perceptions of web-based vs. paper-based homework in a general physics course. Eurasia J. Math. Sci. Tech. Educ., 3: 29-34.

Demirci N (2010). The effect of web-based homework on university students' physics achievements. Turk Online J. Educ. Tech., 9:156-161.

Dufrense R, Mestre J, Hart MD, Rath KA (2002). The effect of web-based homework on test performance in large enrollment introductory physics courses. J. Comput. Math. Sci. Teach., 21: 229-251.

Fagen AP, Crouch CH, Mazur E (2002). Peer instruction: results from a large classrooms. Phys. Teach., 40: 206-209.

Gok T (2010). A new approach: Computer-assisted problem solving syst. Asia Pacific Forum on Sci. Learn. Teach., 11: 1-22.

Hake RR (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. Am. J. Phys., 66: 64-74.

Hitt EP (2010). Effective use of web-based homework in high school physics (Unpublished Master Dissertation). Louisiana State University.

Hodge A, Richardson JC, York CS (2009). The impact of a web-based homework tool in university Algebra courses on student learning and strategies. MERLOT J. Online Learn. Teach., 5: 618-629.

Karakuyu Y (2010). The effect of concept mapping on attitude and achievement in a physics course. Int. J. Phys. Sci., 5: 724-737.

Kashy E, Sherrill BM, Tsai I, Weinshank D, Englemann M, Morrissey DJ (1993). CAPA–An integrated computer-assisted personalized assignment syst. Am. J. Phys., 61: 1124–1130.

Kashy E, Graff SJ, Pawley H, Stretch WL, Wolfe SL (1995). Conceptual questions in computer-assisted assignments. Am. J. Phys., 63:1000-1005.

Keith TZ, Cool VA (1992). Teaching models of school learning: Effects of quality of instruction, motivation, academic coursework, and homework on academic achievement. School Psychol. Quarterly., 7: 209-226.

Kortemeyer G, Hall M, Parker J, Minaei-Bidgoli B, Albertelli II G, Bauer W, Kashy E (2005). Effective feedback to the instructor from online homework. JALN. 9: 19-28.

Kortemeyer G, Kashy E, Benenson W, Bauer W (2008). Experiences using the open-source learning content management and assessment system LON-CAPA in introductory physics courses. Am. J. Phys., 76: 438-444.

Lee F, Heyworth R (1997). Electronic homework. Paper presented at the annual meeting of the Am. Edu.Research Association, Chicago. (ERIC Document Reproduction Service No. ED405859).

Lenz L (2010). The effect of a web-based homework system on student outcomes in a first-year Mathematics course. J. Comput. Math. Sci. Teach., 29: 233-246.

Maloney D, O'Kuma T, Hieggelke C, Heuvelen AV (2001). Surveying students' conceptual knowledge of electricity and magnetism. Am. J. Phys., 69: 12-19.

Mazur E (1997). Peer Instruction, Prentice Hall Inc., New Jersey.

Pascarella AM (2004). The influence of web-based homework on quantitative problem-solving in university physics classes. Paper presented at the National Association for Research in Science Teaching (NARST), Vancouver, BC, Canada.

Rodriguez GS, Anton AJM (2011). The use of ICT tools in physical sciences education. Int. J. Phys. Sci., 6: 944-947.

Thoennessen M, Harrison M (1996). Computer-assisted assignments in a large physics class. Comput. Educ., 27: 141-147.

Tipler PA, Mosca G (2008). Physics for Scientists and Engineers, 6th edition. W. H. Freeman & Co, New York.

Titus A, Martin L, Beichner R (1998). Web-based testing in physics education: Methods and opportunities. Comput. Phys., 12: 117-123.

Toback D, Mershin A, Novikova I (2005). Integrating web-based teaching tools into large university physics courses. Phys. Teach., 43: 594-597.

Warton PM (2001). The forgotten voices in homework: Views of students. Educ. Psychol., 36: 155-165.

Zerr R (2007). A quantitative and qualitative analysis of the effectiveness of online homework in first semester calculus. J. Comput. Math. Sci. Teach., 26:55-73.