An Exploration Assessing WebAssign Using Student and Instructor Feedback

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This paper was completed and submitted in partial fulfillment of the Master Teacher Program, a 2-year faculty professional development program conducted by the Center for Teaching Excellence, United States Military Academy, West Point, NY, 2009
The United States Military Academy (USMA) has reformed its mathematics curriculum to focus on student problem solving through the application of mathematics to open-ended problems. The success of our curriculum reform is frequently challenged by our students’ inability to demonstrate proficiency in the mathematical skills considered fundamental to further learning in mathematics. Without an understanding of the basics, students are handicapped in their ability to problem solve. Specifically, many of our students are challenged by their limited exposure to or their inadequate retention of skills in algebra, geometry and pre-calculus. Over the past two years, we implemented strategies to address these weaknesses and have assessed student progress in these skills. This paper will examine, from both the student and instructor perspectives, whether or not WebAssign is an effective tool for augmenting classroom activities intended to contribute to students’ learning or re-learning the fundamentals.

WebAssign has been used by universities and colleges across the country since its creation in 1997. More recently, at the United States Military Academy, it has been used in the Physics and Mathematics curricula to enhance student learning. WebAssign is an “online homework, quizzes, and testing management system.” The web-based system allows instructors to establish assessments which students can access from any internet ready computer. Once online, students have the ability to open assignments and submit their responses, receiving immediate feedback in most instances. Furthermore, the system automatically reflects student scores in instructor grade books, and allows teachers to ascertain both how a student performed and how a student responded.

Over the past year, WebAssign became an essential element of the USMA Math Department’s resources for entering students. Annually, members of the freshman class must demonstrate their proficiency in certain basic skills. These tasks are assessed via an exam. The test, known as the “Fundamental Concepts Exam,” covers topics in algebra, geometry and trigonometry and serves as a tool to assist our department in validating the fundamental skill set of each student before they move forward in the USMA curriculum which includes two semesters of calculus as well as Chemistry, Physics and various Engineering courses. WebAssign has become a key component to student FCE preparation. Specifically, it evolved into a principal medium through which students reviewed or learned the mathematical nuts and bolts necessary to succeed in our program.

For WebAssign to be considered an effective tool, we felt it needed to contribute significantly to student learning and understanding. In order to evaluate its usefulness, we posed several questions: Did the use of WebAssign allow students to take more responsibility for their learning? Did the use of WebAssign allow students to make accurate self assessments of their strengths and weaknesses? Did the use of WebAssign have a significant effect on student FCE grades? Does the program improve student confidence in mathematics? The response mechanisms for the qualitative questions were surveys. The first, located in Appendix A, was designed for 1007 students of the class of 2011 and was both issued and submitted via Blackboard. The second, whose intended recipients were instructors who had taught both with and without WebAssign, can be viewed at Appendix B. Our quantitative analysis considered and compared data collected for Fall 2006 and Fall 2007 Fundamental Concepts Exams (FCEs) as well as data...
collected via our student survey. We begin our analysis by considering each of the aforementioned questions.

Did the use of WebAssign allow students to make accurate self assessments of their strengths and weaknesses?

A key factor used to determine whether or not WebAssign served as an effective tool to supplement learning for our students was their ability to gain improved awareness of their abilities and shortfalls. It is often the case that students are unable to make these determinations without the assistance of one-on-one instruction. Although such instruction is consistently effective, it requires coordination of schedules and is often very time consuming as a result of the student’s inability to focus the discussion on true areas of confusion or weakness. Through the use of WebAssign, students are able to take advantage of problem sets that are organized by concept area, are representative of fundamental concepts exams, or are designed to assist students in identifying the types of problems with which they struggle most. The goal of this design was that the ability to access, solve, and receive performance feedback on multiple problem sets would assist students in diagnosing their competence in each subject area. Student feedback regarding the usefulness of WebAssign to accomplish this goal provides strong evidence that the program served this purpose. In fact, 77.5% of students reported, using the Likert scale, that the program benefitted them by increasing their awareness of their respective strengths and weaknesses within the bounds of the fundamental concepts. Instructors agreed; notably, 100% of surveyed instructors felt that WebAssign did, in fact, increase student ability to identify both their capabilities and their deficiencies. The overwhelming response of instructors and students that WebAssign was indeed able to help students pinpoint their fundamental acumen illustrates WebAssign’s interactive design effectively served to improve student self-awareness. Furthermore, its accessibility made the program convenient for students and ensured that student-teacher interaction was more productive.

Did the use of WebAssign allow students to take more responsibility for their learning?

As it is often difficult for students to ascertain what “taking responsibility for their own learning” is, we felt we could best assess this question by asking students the question in another way. At USMA, we offer something called “additional instruction” or “AI” which is one-on-one interface between the teacher and student during non-class hours. Because students are better able to explain how well prepared they feel for AI, our survey of students alternatively queried, “The use of Web Assign allowed me to come to additional instruction better prepared with specific questions,” and again permitted students to respond using the Likert scale. Although some students admitted to never using the program, the vast majority, 60.83% stated they agreed that the program helped them to more effectively prepare for additional individual instruction. Furthermore, only 6.67% stated that they disagreed or felt that WebAssign did not assist them in their
preparation. From these statements, we can conclude with a fair degree of certainty that WebAssign did motivate students to work problems on their own prior to seeking additional instruction, rather than coming without specific areas of concern. Motivating students to work problems in the absence of an instructor is a constant challenge in entry-level collegiate mathematics; the feedback provided by our students, however, indicates that WebAssign had a significant impact on their willingness to try problems on their independently.

From an instructor’s point of view, a key goal in providing WebAssign to the students as a study aid was the hope that they would take advantage of the program in an instructor’s absence, thereby allowing students to either answer their own questions or to come better prepared to additional instruction. Additional instruction is meant to answer specific questions that a student has, and is not, as some students believe, a venue for re-teaching an entire lesson. As discussed, giving students homework assignments in WebAssign that deal with concepts that will appear on the FCE (homework problems for FCE type questions do not appear anywhere else in the textbook), allows students to identify specific areas of concern. Essentially, when they arrive at additional instruction they have worked through the problems, received feedback from WebAssign, and are able to bring any concept that they are still struggling to understand to the instructor’s attention. After having given such problems an honest effort, hopefully students will ask well thought-out, specific, and intelligent questions. We attempted to measure this goal by assessing two questions in our survey. The two statements requiring instructor feedback were: “The use of WebAssign encourages students to take more responsibility for their own learning,” and “Students using WebAssign come better prepared for additional instruction.” Again using the Likert scale to evaluate the statements, instructors generally agreed that WebAssign did encourage students to work problems on their own and assisted them in better preparing for AI. Furthermore, instructors felt, given the additional resource, many students were able to discern for themselves not only what to study but how, which resulted in fewer requests from students for additional instruction.

**Did the use of WebAssign have a significant effect on student FCE grades?**

Over the past twenty years, Calculus Reform has caused a transition in secondary mathematics education from the rigor of traditional mathematics to a more problem solving based curricula. This transformation has caused many of the basic skills deemed necessary to learning in higher education to atrophy. Consequently, we have developed the FCE to assess student proficiency in these skills. WebAssign serves as a primary medium through which we distribute study materials for the exam. To answer the question of whether or not WebAssign had a significant impact on cadet’s scores on the FCE, we considered comparing the mean FCE scores from the previous two semesters (fall 2005 and fall 2004) where WebAssign was not available, to the mean FCE score from the fall of 2006, the first semester in which WebAssign was available to the cadets. However, the FCE in 2006 covered a broader range of topics with no more than two questions covering the same topic, while the old FCE’s from 2005 and 2004 tested fewer topics, multiple times. In light of this and some other differences, we were not able to
analyze these data sets in order to make any meaningful comparisons. Therefore, we will limit our data analysis to comparing the fall 2006 test with the fall 2007 exam, which were identical in nature. Although 2006 was the first year in which WebAssign was used, lack of experience with the program and difficulties accessing the website itself either precluded or deterred most instructors and many students from making use of the program. In 2007, however, after a year of WebAssign experience, all of the major issues with the program and its operation were resolved, resulting in widespread use. The fall of 2007 mean FCE score was more than four percentage points higher than that of fall 2006, an 85.65% compared to an 81.43%. Assuming that both sets of data, the 2006 and 2007 scores, come from populations that are normally distributed, we can use a two-sample T-test in order to determine if the mean FCE scores from the two years are identical, versus the alternative hypothesis that they differ significantly. Testing at a level of $\alpha = 0.05$, we get a $p$-value < 0.001. Therefore, we resoundingly reject the null hypothesis of equal means in favor of the alternative, providing significant evidence suggesting the mean FCE scores between 2006 and 2007 are different.

Another compelling statistic, related to student grades, is the comparison of the percent of students who earned a passing score, more than 80%, on their first FCE attempt. In 2006, 65.2% of the students passed on the first try, while nearly 79% of the students in 2007 passed. Augmenting this quantitative analysis is the fact that on the whole, instructors felt strongly that students’ use of WebAssign significantly increased their preparedness for the FCE.

Here, it is necessary to mention that there were two possible contributors to improved student grades in 2007. Not only was WebAssign in full use but we also asked students to complete two homework assignments, 12 questions each, covering fundamental skills. These homework sets were graded by instructors and returned with feedback provided on individual performance. In order to ascertain which element contributed most greatly to the improvement, students were asked to rank order available study tools in terms of their helpfulness in test preparation. These tools included their instructor, another instructor, a tutor, WebAssign, Practice Tests, and graded homework assignments - only two of these resources were new, WebAssign and graded homework assignments. Student feedback indicates that WebAssign, although 3rd in the ranking, rates very similarly to the top two selections, practice tests and primary instructors. Furthermore, a comparison of WebAssign to graded homework yields the discovery that, although ranked in direct succession, students did not evaluate them as equals. Again, assuming these populations are normally distributed, the two-sample T-test results in a $p$-value = 0.022 thereby indicating with 95% confidence that the means are unequal. Based on our comparisons, we contend that the primary reason for the improvement in student test scores on the FCE is WebAssign.

**Does WebAssign improve student mathematical confidence?**

Students often arrive at undergraduate institutions with a high degree of anxiety regarding their mathematics education. Whether this anxiety stems from being ill-prepared for the
rigors of college math as a result of a lack of exposure to mathematics or they have typically struggled with the subject, students often begin their college coursework with low self-confidence. One of our hopes in implementing WebAssign was to reduce student fear and improve student assurance in mathematics regardless of background. Although student confidence is difficult to measure, we feel that given the student and instructor feedback obtained through our survey, we can infer how WebAssign affected student aplomb. The congruence between student and faculty views on student willingness to conduct self-study, students’ ability to define their mathematical strengths and weaknesses, and students’ capacity for coming to AI more effectively prepared, certainly assists us in deducing that WebAssign made a comprehensive contribution to student learning. But this feedback also provides definitive evidence that, through the use of WebAssign, student confidence has improved. Our students’ improved mathematical determination manifests itself in many ways, most obviously in their ability to score higher on the FCE – recall that students scored more than four percentage points higher on 2007 tests than they did on the same tests in 2006. We also have noticed an increased willingness to tackle difficult problems unrelated to the FCE throughout students’ tenure in the introductory mathematics course, a likely result of improved confidence. These observations, improved grades and problem solving acumen, allude to the educational growth and maturity of our students and indicate the beginning of a transformation in student attitudes – from dependent to independent learners.

A program such as WebAssign, as we have shown, can have a tremendously positive impact on student learning; however, there are some expenses associated with its implementation and operation. As is often the case with a technological program, there are various start-up costs associated with it both in terms of time and in terms of money. For ease of use, it is advantageous to identify one or more members of the staff to become the subject matter experts (SMEs) for the program. The learning curve for these individuals is fairly steep. These SMEs will need to spend a significant amount of time gaining proficiency with the user, instructor and to some extent, the programming aspects of the system in order to assist students and teachers with any WebAssign questions or problems they might have. Although it does take some time to gain a working knowledge of the system, the average instructor or student is able to deftly navigate the program after just a few sessions. Finally, there are monetary expenditures associated with the use of WebAssign. There are several ways to finance the purchase including: a site license, individual student purchase or in conjunction with the student text. Although packaging student purchase of WebAssign with a textbook can reduce program overhead, on average, the cost is $14.95/semester.$^2$ Prior to employing a tool like WebAssign, the operating expenses should be researched, identified, and carefully weighed against the program’s potential benefits. In our case, it is clear that the benefit to student learning far outweighs the expense.

The initial intent of implementing WebAssign was to positively influence student learning, re-learning, and retention of fundamental math skills. Student performance on the FCE as well as student and instructor perception of WebAssign indicate that our goal was met, and suggests that perhaps we should consider expanding our use of WebAssign
to include other areas of mathematical learning, throughout and beyond the core math program.

Certainly WebAssign should not be the only tool used to prepare for the Fundamental Concepts Exam. One of the major advantages of using WebAssign is that the student gets instant feedback on their performance. That feedback, however, is limited in its scope. WebAssign is only able to indicate if a student got an answer completely correct without mathematical or syntax errors, but is unable to identify minor mistakes. Therefore, a student who genuinely understands a concept but makes a minor error will get the same feedback as one who demonstrates no understanding. As a result, it is necessary to supplement WebAssign with instructor feedback through the use of graded homework and/or in-class board work.

Is WebAssign an effective tool to supplement undergraduate mathematical learning? By soliciting the feedback of instructors and students, we gathered compelling evidence to answer this question in the affirmative. Our analysis considered questions concerning the program’s ability to assist students in identifying their mathematical strengths and weaknesses, its impact on student motivation to claim ownership for their learning, its influence on student FCE grades, and finally, its affect on student confidence levels. It was interesting to note that teacher and student responses to each question precisely mirrored each other, something we didn’t expect. Oftentimes, student and teacher viewpoints are diametrically opposed due to age, perspective, and a myriad of other issues. In the end, we found WebAssign contributed greatly to the success of our students. More important than merely improving the knowledge base of our students and their FCE grades, WebAssign seemed to impart something of greater consequence to our students. Things that instructors find incredibly hard to teach, like increasing a student’s willingness to tackle, deconstruct, and master concepts on their own. This benefit, we believe, is a beginning to developing the habits of mind of our students and suggests that exposure to such an influence may result in a continued desire to explore new topics. Perhaps it is the medium of WebAssign that caused such an unexpected but desired change. As our society places more and more emphasis on technological advance, our student body becomes not only accepting but expecting of technological integration in their educational experience. Certainly, WebAssign captured the attention of our students and ultimately produced impressive results.
Works Cited


Appendix A: Survey for MA103 Students

1. Rank order the following tools in the order in which they were most helpful in preparing you for the Fundamental Concepts Exam, with 1 being the most helpful and 6 being the least.

_____Your Instructor
_____Another Instructor Who Was Not your MA103 Teacher
_____WebAssign
_____Practice Tests
_____Graded Homeworks
_____Cadet Tutor

The following questions are designed to assist the math department in assessing the effectiveness of WebAssign. Please read each of the following questions and respond according to the following scale:

1 – Strongly Disagree
2 – Disagree
3 – Neither Agree / Disagree
4 – Agree
5 – Strongly Agree

2. Access to WebAssign prior to arriving at West Point increased my level of preparedness for the FCE.

3. The use of WebAssign allowed me to come to additional instruction better prepared with specific questions.

4. The use of WebAssign helped me better assess my strengths and weaknesses in fundamental math skills.

5. The thing I liked most about WebAssign was:

6. The thing I liked least about WebAssign was:

7. Additional general comments on the use of WebAssign in MA103 that you would like to make.
Appendix B: Survey for MA103 Instructors Who’ve Taught With & Without WebAssign

Please read each of the following questions that deal with the implementation of WebAssign in MA103 and respond according to the following scale:

1 – Strongly Disagree
2 – Disagree
3 – Neither Agree / Disagree
4 – Agree
5 – Strongly Agree

Note: All questions are contrasted against teaching MA103 without WebAssign.

1. WebAssign provides a better and more efficient means of assessing a student’s / section’s strengths and weaknesses?
   1 2 3 4 5

2. A student’s use of WebAssign prior to arriving at USMA can increase their level of preparedness for the FCE.
   1 2 3 4 5

3. The use of WebAssign encourages students to take more responsibility for their own learning.
   1 2 3 4 5

4. The use of WebAssign increases the ability of a student to self-assess their strengths and weaknesses.
   1 2 3 4 5

5. Students using WebAssign come better prepared to additional instruction.
   1 2 3 4 5

6. The thing I liked most about WebAssign was:

7. The thing I liked least about WebAssign was:

8. Additional general comments on the use of WebAssign in MA103 that you would like to make.