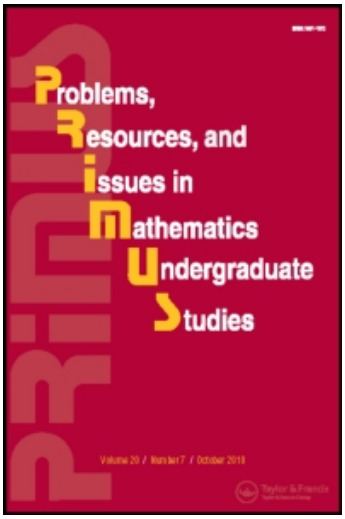

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An Entirely-Online Developmental Mathematics Course: Creation and Outcomes

Katarzyna Potocka

Abstract: In this article the author describes her experiences in an effective, and cost-efficient way of teaching developmental mathematics online in a course that runs on its own once it is set up. The online course described here was created and implemented at Ramapo College. The course is an innovative method of teaching developmental mathematics in which no instructor needs to be hired and students are taught the material entirely by the computer while learning at their own pace. The article consists of three main parts, which describe the procedure used to set up the online course, show how students are being taught the material by the computer, and compare student performance in the online section to student performance in the traditional in-class sections of the course.

Keywords: Online course, developmental mathematics, MyMathLab.

1. INTRODUCTION

This article describes my experiences pioneering a new, effective, and cost-efficient way of teaching developmental mathematics online in a course that runs itself once it is set up. There are colleges across the nation that use various software, including the software described in this article, in order to enhance their regular in-class courses with online problems that are graded by computer. There are also colleges that hire instructors to offer online courses. Examples of such case studies can be found in [2] or [3]. However, the online course described in this article requires no hiring of an instructor and students are taught the material entirely by the computer while learning it at their own pace. The article consists of three main parts: description of

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course setup, description of how students are taught, and a comparison between the online and traditional in-class sections of the course.

The history of computer-based instruction (which dates almost back to the first computers) and a review of its recent development can be found in [1] and [3], respectively. According to [5], online education has become a popular topic in academic communities and corporate America; more and more efforts, studies and technology are being dedicated to making online courses not only reputable, but, for some, a preferred method of teaching.

The idea for our online course was initiated by a departmental colleague of mine, Dr. Giovanni Viglino. Subsequently, the course details and the course itself were created and implemented to an online setting by another departmental colleague, Dr. Pangyen Weng, and myself. In this article, I will be referring to the latter two of us as ''we'' or ''the course administrators.''

2. PART I. THE COURSE SETUP

2.1. The Course

The mathematical content of the online course is Introductory Algebra, which is offered at Ramapo College as MATH 022: Transitional Mathematics. MATH 022 is a 4-credit course that does not count toward graduation, but the grade counts toward a student's GPA. Passing MATH 022 is one way for students to place into most of Ramapo's general education mathematics courses (other ways of placement include a sufficient score on the mathematics portion of the SAT, or a sufficient score on an ACCUPLACER test administered by the college). Completion of a general education mathematics course is in turn a graduation requirement for all majors.

MATH 022, due to its non-credit, review-like, and prerequisite-like nature, constitutes an appropriate background for a rule-driven and procedure-based online setup described in this article, in which deep conceptual understanding and deep problem solving may be compromised. The setup can be easily applied to other, preferably developmental, mathematics courses. We do not recommend it for mathematics courses at the general education level or above.

In Fall 2006 the first online section of MATH 022 was offered along with three in-class sections of the course. In Spring 2007 one online section and two in-class sections were offered. The underlying textbook, the set of homework problems (chosen from the text), and the final exam questions were common to both online and in-class sections. The two online sections of the course were also called the pilot sections of PCMP (Preparation for College Mathematics Program). This article is based on my experiences gained from those two semesters.

In order to take the online course, a student needed to purchase MyMathLab access kit available from Prentice Hall or from the campus

bookstore. The kit enabled the student to log in to CourseCompass.com, a portal website for the MyMathLab software. As the online course administrators, we set up our course on CourseCompass.com by building exams, homework sets, and choosing a variety of settings. CourseCompass.com was the place on the web where students did their coursework: they learned the material, as well as completed their homework, quizzes, and exams.

The textbook for the course needed to be compatible with MyMathLab, which restricted us to Prentice Hall products. We chose *Introductory Algebra* by Elayn Martin-Gay, 3E. The reader is warned that only a limited selection (50% or less) of homework problems were available online (in MyMathLab) from this text as well as from most other texts for Introductory Algebra. However, according to literature, limitations are to be expected in online courses. For instance, technology and pedagogy are always intertwined in any online course: the fine details of the pedagogy are shaped by the decisions made about the technology, and vice-versa [4].

The textbook was available to students online in PDF format, and its costs were included in the price of the student access kit ($40 per person). Students also had an option of purchasing a hard copy of the text separately, for an additional cost.

Topics covered in MATH 022 include operations on real numbers, solving linear equations and inequalities in one variable, exponents and scientific notation, operations on polynomials, solving quadratic equations by factoring, proportions with problem solving, graphing linear equations, solving systems of two linear equations with two unknowns, and radicals. A copy of the syllabus for the online course can be found at: http://phobos.ramapo.edu/%7Ekpotocka/KPWebpage/Teaching/CoursesTaught/OnlineSectionSyllabusS07.doc.

Students were not required to come to campus for the online course except for the orientation meeting the first day of classes, eight module exams, and one final exam. The eight exams and the final exam were available online on a walk-in basis at a proctored computer lab for 1.5 hours, twice a week. Students were able to do all other coursework (learning the course material, submitting quizzes and homework) from their home computers or from any computers on or off campus, after being directed by MyMathLab in a user-friendly manner to install certain software. The only other technical restrictions from MyMathLab were to use Internet Explorer as the web browser and to use PC machines for best compatibility.

Students in the online course were offered three kinds of support at no additional cost to them: (1) mathematical and technical support provided by a Ramapo College adjunct instructor, available for 3 office hours a week, (2) live mathematical tutors available 40 hours a week and technical support staff available 24 hours a day, 7 days a week, both reachable through a 1–800 number listed on CourseCompass.com, and (3) mathematics tutors at a tutoring center on campus.

2.2. Expenses

As the online course administrators, P. Weng and I each received a compensation equivalent to two Ramapo College credits in Spring 2006 and a $2000 stipend from the Office of the Provost in Fall 2006 for the setup and installation of PCMP.

In addition to hiring a mathematical and technical support person for Fall 2006, we hired an exam proctor. There were two reasons for this: (1) the students were required to take the eight module exams plus the final exam and (2) the software and computers used did not provide a way to verify student identities during testing. The simplest solution, therefore, was to have students come in person for the exams. We purposely chose a person not related to mathematics to be the proctor and it proved to be successful. Students were allowed to do online homework problems ahead of time, from which they had a chance to learn not only course content, but also syntax for entering answers to various problem types. We also let students retake exams an unlimited number of times, so if a student had a mathematics question during an exam (which rarely happened), he or she could always leave and retake the exam later.

In Spring 2007 the college hired one mathematics adjunct faculty to perform the combined duties of proctor and mathematical and technical support for a compensation equivalent to 3 credit hours. His duties consisted of completion of training received from the course administrators; supervision of the online testing for 1.5 hours twice a week at a computer lab during all 15 weeks of the semester, including verification of the student identities and entering test passwords; helping the course administrators with administrative duties, such as presenting an orientation lecture the first day of classes; assistance to students regarding hands-on usage of the course software, mathematical questions, and the flow of the program, all provided during 3 office hours per week and via email; submission of student course grades to the registrar's office, and reporting to the department of mathematics about student progress of the course.

In the future, instead of three in-class sections and one online section of MATH 022, there is a plan to offer only one in-class section and three online sections. This will bring major savings to the college since three online sections can be handled by *one proctor as opposed to three instructors*. Moreover, our choice of hiring our mathematics and technical support person in the past was entirely optional since such support is also available from CourseCompass.com and since in Fall 2006 there were only seven instances of students contacting our on-campus support person for help (all of them were related to logging in, and none of them related to tutoring). Choosing not to hire such a person would provide additional savings. Thus, the future PCMP can be handled by a testing coordinator (who does not need to know any of the course material nor the technicalities of CourseCompass.com) and a course administrator (a mathematics faculty) to oversee the process.

2.3. The Work of the Course Administrators

To place the course online, we began by obtaining a CourseCompass.com instructor login name and password from a Prentice Hall sales representative. We then created a course folder on CourseCompass.com by downloading one of the electronically available textbooks to it.

The next step was to select a set of homework problems for our syllabus. It was a tedious process due to the following factors: we needed to make sure that the textbook problems we chose were also available online; we were selecting homework for a course with no instructor, so any arising conceptual and vocabulary gaps in homework ''Lifelines'' needed to be closed by carefully adding more homework exercises (we actually closed all gaps in the first two ''Lifelines,'' which contained the least number of gaps to begin with), and it all needed to be done without compromising course content and problems quality. Homework ''Lifelines'' are described in PART II of the article. They are meant to show a student how to do homework problems, from which students were expected to learn the material in the online course.

We then created files in which homework problems were stored for students. We decided to create quiz and exam files using a subset of those homework problems. The resulting quiz and exam problems were similar in structure to the ones in the homework, but all three had different numerical values at each student attempt.

We also needed to reserve a computer lab for testing for the whole semester. We hired and trained a proctor and support person, and delivered an orientation session for students the first day of classes. Prentice Hall offered to have a sales representative at the orientation meeting to help with presenting the log-in procedure to students. After the first day of classes, our course administrator duty was to oversee that the online course was running and attend to questions that the proctor and support person had.

2.4. The Course Rules

Figure 1 (initiated by G. Viglino) shows the online course flow chart. The main idea behind this flow chart is that if a student passes the ''Free Shot'' Exam in a given module, then he or she can move onto the next module. If a student fails, then he or she has to complete a sequence of homework assignments in that module, followed by a quiz, and a ''Re-take'' Exam. The homework requirement was intended to prevent a student's failing the same exam multiple times without any learning in between.

Practice Exam. For each module we made a practice exam with an answer key available to students as a printable file. Practice exams were optional, but recommended to give students an idea of the format of the ''Free Shot'' exams.

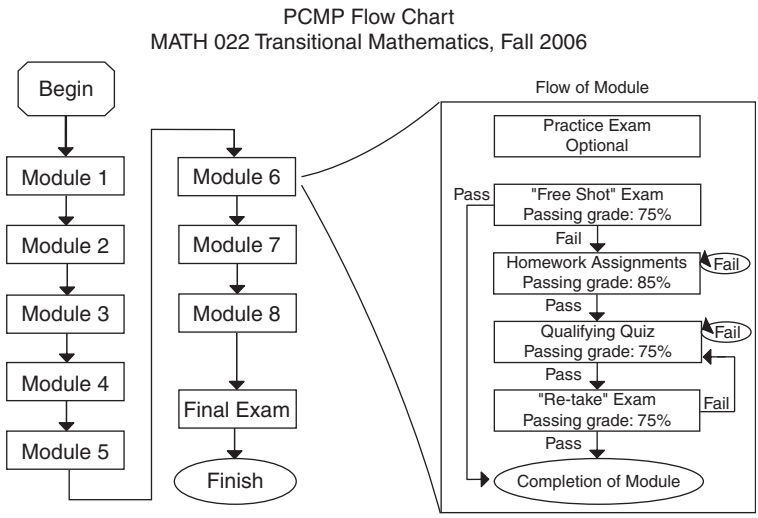

Figure 1. Online section flow chart.

''Free Shot'' and ''Re-take'' Exams. These timed module exams (1 hour, with approximately 20 questions) were administered in a proctored computer lab with a student ID check. At each module a student was entitled to one ''Free Shot'' Exam. If a student scored less than 75% on it, then he or she would need to pass a sequence of homework assignments on that module, followed by a qualifying quiz and a ''Re-take'' Exam. Relevant homework or quiz assignments for a given module could be started or completed before each ''Free Shot'' Exam, as long as the prerequisite for each was satisfied. ''Re-take'' Exams could also be taken by those who passed an exam in a given module but wanted to improve their score.

We chose a setting in which a student could repeat the whole exam as many times as he or she wished. Our decision was driven by one of the benefits this setting offered: we were able to prevent a student from moving onto the next module unless he or she mastered the material and passed the exam in a given module. One of the main drawbacks of this setting is that some students might not be motivated to study efficiently knowing that an exam can be retaken. The software gradebook system displayed records from all attempts, but counted only the highest grade. However, each time a student wished to attempt a ''Re-take,'' he or she had to pass a new corresponding qualifying quiz with the score of at least 75% as a prerequisite. A score of at least 75% on a ''Re-take'' Exam was required in order to move on to the next module. More than one exam could be taken in one day: a module exam could be attempted multiple times and multiple modules could be completed (see Figure 1 for restrictions).

Homework. Homework could be attempted online at any time without a time limit, and a given problem could be attempted multiple times to improve one's score. A score of at least 85% was required on each homework assignment in order to move on.

Qualifying Quiz. Qualifying quizzes had a time limit of 1 hour, contained as may questions as a module exam, and had to be completed online, at any location of a student's choice. Qualifying quizzes, being administered in a timed environment, were an excellent way for students to practice for an exam.

Final Exam. The final exam available in electronic format could be taken at any point of the semester during lab testing hours, after successful completion of all eight modules.

Timeline. We wanted to prevent students from starting the coursework late in the semester, but we also tried to preserve the self-paced environment as much as possible. Thus, we announced that if a student does not pass the first three modules by the college's mid-semester deadline for withdrawing from a course with a W (i.e., ''withdrew'') grade, then he or she will be deregistered from the course with a W by the course administrators. Students needed to complete the final exam by the end of the semester.

Calculators. Calculators were only permitted on the Module 4 Exam which contained word problems.

The Grade. In the online section, the final counted for 25% of a student's grade and the remaining 75% was the cumulative weight of the eight module exams. In the in-class sections, the same final exam counted for 25% of a student's grade, but the remaining 75% came from two in-class exams, numerous quizzes, and collected homework (clearly, it is not possible to give eight in-class exams in a traditional class setting).

2.5. MyMathLab Settings

MyMathLab gave us a variety of settings to create assignments in the Homework and the Quiz/Exam modes. We could select problems from the adopted text and from other available texts, and had an option of creating our own problems. We chose the first of these three for simplicity of the setup. Due to the limited number of textbook problems offered online, as well as the elementary level of homework problems in the available books, we are planning to create in the future our own PCMP exercises using MyMathLab, and to separate PCMP from MATH 022.

We also used the options of setting a start and a due date for an assignment, setting an already created assignment as a prerequisite for another, and setting a minimum prerequisite score for assignments. Additionally, on any assignment created in the Homework mode, we allowed students to continue to work to change their scores after the due date, to save exercise values and submitted answers, and to print their homework assignment. Students could attempt any homework problem an unlimited number of times (the only setting available in the Homework mode), just as students in a conventional course can access their homework at any time.

On the other hand, on an ''assignment'' in the Quiz/Exam mode, that is, a quiz or an exam, we allowed an unlimited number of attempts (or could select a desired number of attempts), and required a password that the proctor needed to enter in order for a student to begin an exam. We did not allow students to resume an incomplete exam attempt unless the proctor enabled access to it. We limited the time to complete an ''assignment'' to a chosen number of minutes. Moreover, in the Quiz/Exam mode, we had the options of allowing students to review an ''assignment'' any time after submitting it, only immediately after submitting it, or not allowing review of any kind. We chose the first of these options for quizzes and the last one for exams.

Also, the Quiz/Exam mode gave us an option of allowing students to print the test with the correct answers and their answers while reviewing. We allowed it on quizzes. No special computer experience nor software training were necessary to select the settings described above or to set up the whole course online. The main benefit of these settings was their flexibility: we were able to create a homework environment similar to the in-class one, created a quiz environment that gave students a good opportunity to practice for exams, and built a secure and effective exam environment.

MyMathLab software had one drawback in its settings, which consumed a portion of the proctor's time in every session: the software's inability to set more than one prerequisite for an assignment. The assignments, with their prerequisites, had to follow a linear order. The following paragraphs explain how it affected the proctor's job.

Consider Exam 2. Since there could be only one prerequisite for Exam 2, the ''Free Shot'' Exam 1 and the ''Re-take'' Exam 1 had to be stored as the same file in the system, called Exam 1. Similarly, Exam 2 had to be stored as one file. Exam 1 was set to be the prerequisite for Exam 2.

Once a student passed a given exam, the proctor was permitted by the system to enter the password for the student's next module exam. Suppose a student came to the lab to take Exam 2, for which he or she was eligible at that point (i.e., had a passing grade on Exam 1). The proctor needed to verify manually in the online gradebook whether this attempt on Exam 2 was the student's ''Free Shot'' Exam 2 or a ''Re-take'' Exam 2. If it was the ''Free Shot,'' then the proctor only needed to type in the password for Exam 2. If it was a ''Re-take,'' then, to enter the password, the proctor needed to verify

manually in the online gradebook whether the student had a record of a passing score on Qualifying Quiz on module 2, and whether the date for that quiz was more recent than the student's latest attempt on Exam 2.

If the manual check had not been done, a student eligible to work on Exam 2 who failed a ''Free Shot'' Exam 2 could take a ''Re-take'' Exam 2 without passing the Homework and a Qualifying Quiz in between (violating the flow chart rules in Figure 1), since he or she already satisfied *the only possible prerequisite* for Exam 2 by passing Exam 1. Similarly, without the check, a student who failed a ''Re-take'' Exam 2 could start another such re-take exam without a quiz in between, violating the course rules.

The following is a summary of the resulting proctor's job of getting a student started on an exam: (1) Matching the student's face with the one on their photo ID; (2) matching the student's name found on their photo ID with the corresponding one in the gradebook; (3) matching the log in name printed from the instructor gradebook with the one the student is typing in to the computer; (4) manually verifying in the online gradebook whether the exam the student is about to take is a ''Free Shot'' or a ''Re-take,'' then verifying the Qualifying Quiz grade and date in the case of a ''Re-take,'' and (5) typing in the password for the exam.

3. PART II. HOW STUDENTS LEARN FROM MyMathLab

When a student opens a particular homework problem online, four ''Lifelines'' appear next to the homework question: Help Me Solve This, View an Example, Video, and Textbook Pages. The ''Lifelines'' come with the software and teach the student in four different ways how to solve the problem that he or she is working on. The ''Lifelines'' are the only devices in CourseCompass.com from which the students can learn the material in an instructor-free online course.

The ''Lifelines'' appear only in the Homework mode and not in the Quiz/Exam mode. Each of the ''Lifelines'' can be used an unlimited number of times on a single question. Moreover, in the Homework mode only, once a student types in the answer to a question, the computer provides immediate feedback.

A student does his or her homework on scratch paper and only types in a final numerical answer, with an exception of a limited number of questions, (e.g., graphing), that have a multiple choice format (same in the Quiz/Exam mode). There are buttons similar to the ones in Microsoft Equation editor available for students to type in answers that require a variety of forms, such as improper fractions, mixed numbers, exponents, etc. (same in the Quiz/Exam mode).

The next few paragraphs describe the ''Lifelines'' in detail.

Help Me Solve This. This ''Lifeline'' teaches a student in an interactive step-by-step way how to solve a problem, and uses the numerical values exactly from the student's homework problem. It is interactive in a sense that the student needs to fill in the answer to a question asked at the end of each

intermediate step. Once the answer to the last step of this ''Lifeline'' solution is completed, the software directs the student back to the original homework problem. However, the problem not only still remains unsolved but also has new numerical values. The student can now solve it on their own or can use more help from the ''Lifelines''. The problem solved with the help of the ''Lifeline'' does not count toward the student's homework score.

View an Example. This ''Lifeline'' provides a non-interactive step-by-step solution to the same type of problem the student is working on. The same problem type means that the same question is solved with different numerical values.

Video. This is a recording of a mathematics instructor solving on the board the type of problem the student is working on. There are two main drawbacks to this tutorial method:

1. Currently only 50% of exercises that are available online have a video available.
2. The solution methods presented in some of the videos vary from the ones presented in the text and in other ''Lifelines,'' which mostly occurs in texts that have videos recorded by instructors other than the textbook authors. Such lack of consistency with the textbook creates vocabulary and content gaps, which are especially disadvantageous in an instructor-free course. However, some students may benefit from having alternative solutions.

Textbook Pages. By clicking on this ''Lifeline,'' the student is redirected to a PDF file that consists of the textbook section from which the homework problem was assigned. Additionally, the whole textbook is available to students in an electronic format at another location on CourseCompass.com.

The software contains some less computer-based characteristics of a course that reinforce current education standards and recommendations, such as reading and writing mathematics. For instance, custom problems can be built by an instructor, in which students can be asked to type in some intermediate steps rather than just the final answer. Moreover, building an assignment in a quiz mode with no time limit and no password protection creates a homework set without lifelines, which is a way to compel students to read the online textbook.

4. PART III. THE RESULTS OF THE ONLINE COURSE (AND OF ITS PARALLEL IN-CLASS SECTIONS)

4.1. Final Exam

Figures 2–4 show the results of the Fall 2006 final exam taken by students in the online and three in-class sections. The online section had an option of taking the

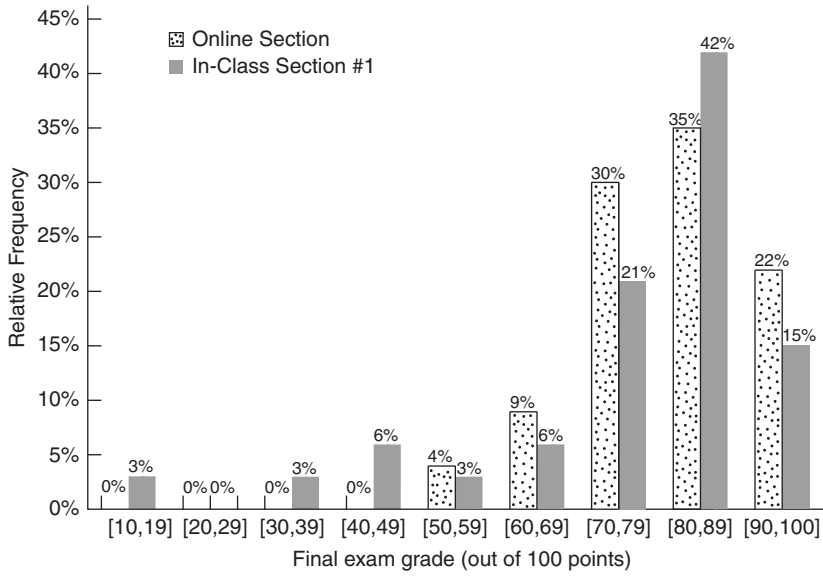

Figure 2. Final exam grades: Online section vs. in-class section #1.

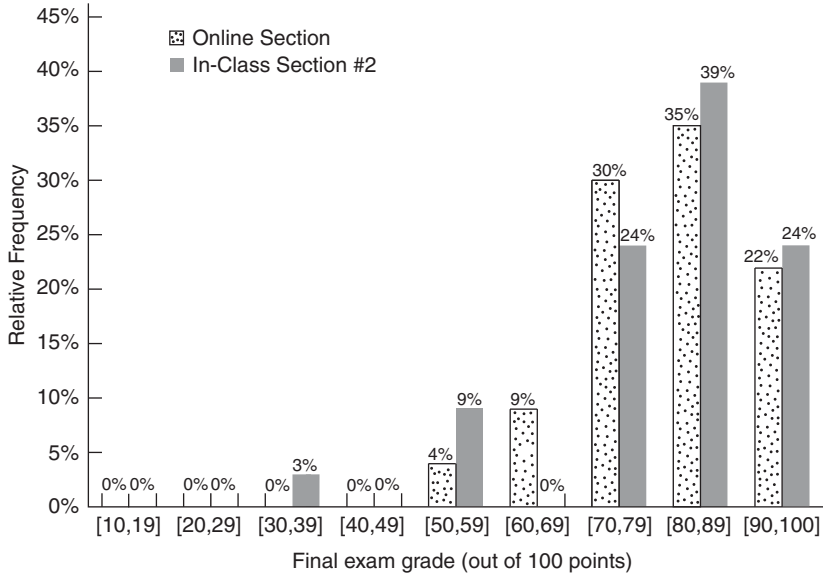

Figure 3. Final exam grades: Online section vs. in-class section #2.

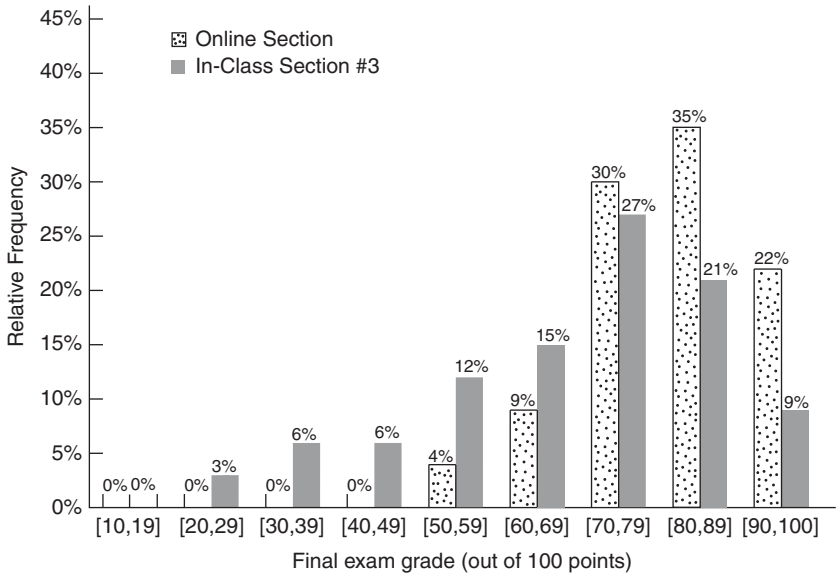

Figure 4. Final exam grades: Online section vs. in-class section #3.

same common final exam on computers in a proctored computer lab or on paper jointly with the in-class sections. All the final exams offered had the same problem types but different numerical values. No students in the online section took advantage of the opportunity of taking the final exam more than once thereby making this comparison valid. Also, for the sake of comparison, Fall 2006 final exam was graded uniformly throughout all four sections, with graders of the paper exam only awarding a point for the correct final answer to a problem, mimicking the way the computer would grade the online exams.

The number of students who took the final exam (from those who either passed or failed the course) was 22 in the online section and 33 in each of the in-class sections, which is relevant for interpreting Figures 2–4. The horizontal axes in these figures represent student scores on the final exam (out of 100 points), where the scores are treated as grouped data combined into intervals of length 10.

The following observations may be deduced from Figures 2–4:

- As many as 12%, 3%, and 15% of students scored lower than 50% on the final exam in the three in-class sections, respectively, while no student in the online section scored below 50%.
- The online course with the proposed flow chart is an excellent screening system that does not let students move on to the final exam unless they meet a desired standard. Once the students qualify to take the final exam, they succeed on it (as it was in Fall 2006 with an exception of only one student)!

Table 1. Fall 2006 Final Exam Score Statistics (in %)

Course section	Mean	Median	Population standard deviation
Online Section	80	80	10
In-Class Section #1	76	83	19
In-Class Section #2	80	88	14
In-Class Section #3	68	70	18

Table 1 shows Fall 2006 final exam score statistics. It indicates that the mean for the final exam grades in the online section (of 80%) was the same or better than the mean grades in the in-class sections (76%, 80%, 68%). The mean was lower than the median in the in-class sections (see the low end values in Figures 2–4) while it was equal to the median in the online section. The distribution of the final exam grades in the online section was least spread out, with the population standard deviation of only 10%, as opposed to the standard deviations in the in-class sections, some of them being nearly twice as big as the online standard deviation. The results shown in Table 1 clearly favor the online section.

4.2. Enrollment

Table 2 shows enrollment facts for all four sections of the course. Only 2 students out of 34 enrolled (6%) failed in the online section (one passed only the first module and did not withdraw, the other failed the final exam and did not retake it), but as many as 12 out of 102 cumulatively enrolled in the in-class sections (12%) failed. Failing the course in any of the sections meant receiving a course average of less than 60% or a final exam grade of less than 55%.

Table 2. Fall 2006 Enrollment Facts

	Online section	In-class section 1	In-class section 2	In-class section 3
Initial Enrollment	34	33	35	34
# of students who withdrew	5	0	2	0
# of incomplete grades	5	0	0	0
# of students failing the course	2	4	1	7
# of students passing the course	22	29	32	27

There were five students in the online course who received incompletes. Those students were not considered as ''failing''. They took between two and six exams that semester (out of the required eight module exams) on which they received an average of 74% to 86%. Their grades are due primarily to weak time management skills. This was expected to occur in a self-paced online course. Anecdotal evidence and studies by individual institutions suggest that course-completion and program retention rates are generally lower in distance education courses than their face-to-face counterparts [2].

However, administering tests after the end of the semester to students who received incomplete grades is effortless in an online course such as ours since although a proctor is needed, the tests are generated and graded by the computer. Moreover, offering the online course during the summer is a benefit, especially to incoming freshmen. It enables them to take this developmental course during the summer prior to their freshman year.

4.3. Attempts Made on Exams

This section discusses the time and number of attempts students took to complete their exams in the Fall 2006 online course. It is a good starting point for the reader wanting a gauge on the number of hours of proctoring required:

- Module exams. There were 291 attempts made on the eight module exams and the total number of minutes students took to complete them was 7541. So on average, a student took 7541/291, or 26 minutes per exam. Recall that a module exam had about 20 questions and a time limit of 60 minutes.
- Final exam. The online final exam was administered to 19 students for 977 minutes in total. So a student took 52 minutes on average to complete the final. The final exam had 40 questions and a time limit of 90 minutes.
- Improving one's passing score. Additionally, 12 module exams cumulatively were administered to 5 students who wanted to improve an already passing score on an exam taken (for a joint total of 202 proctoring minutes or 17 minutes per exam on average).

The online course exams were implemented in a proctored computer lab available 1.5 hours 2 times a week for 15 weeks using 20 computers, with usually 10–15 computers being occupied. Thus, on average, 15 minutes were used for testing on each computer per one lab session (8720 total testing minutes/20 computers/30 lab sessions).

There were 291 attempts made by the students in the course on 218 different module exams. Thus, on average, a student made only 1.33 attempts per exam, which is great news considering the students were given an unlimited number of attempts. In particular, there were nine students who passed all eight exams by taking the ''Free Shot'' Exams only. On the other hand, one student needed as

many as three attempts on an exam (but less than three on others), one student needed four attempts on two exams (but less than four on others), and one student needed two attempts on Exam 1 and six attempts on Exam 2 never passing the latter. The remaining students in the online course made one or two attempts on their exams, with one attempt per exam as a prevailing record.

4.4. Time Spent on the Course

Figure 5 is a scatter plot diagram showing the number of hours a student spent doing work in the online course in Fall 2006 (combined time spent on homework, quiz, and exams) versus the grade he or she received. MyMathLab software was able to keep track of those hours. The scatter plot shows data from 23 students who took the final exam with one outlier being taken out.

Here are our observations:

- Students who did the best in the course (course averages of 95% and 94%) spent only 28 and 11 hours of work, respectively, on the course in the entire semester.
- The two students who spent the longest amount of time on the course still only spent on it 48 hours out of the whole semester.
- The vast majority of students (18 out of 23) who took the final exam spent less than 30 hours in the entire semester working on the online course and succeeded. One the other hand, an in-class student spends 3 hours a week

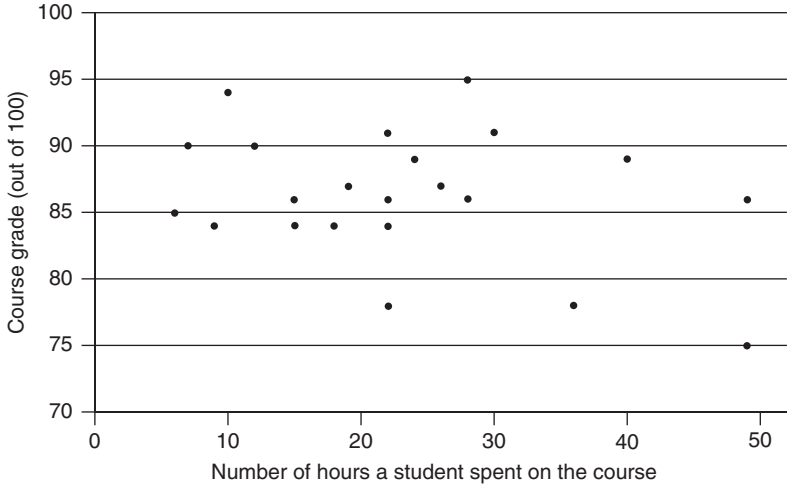

Figure 5. Time spent on the course vs. course grade.

for 14 weeks, or 42 hours, in a classroom alone, and spends plenty of additional time doing homework and studying. Thus, students save a significant amount of time by taking this non-credit review-like course online (while in-class students are exposed to more varieties of learning styles and may be learning important concepts not being tested in an online course).

4.5. Surveys

There was a survey administered at the end of our Fall 2006 online course to all 23 remaining students in the course. Each question was given four possible answer choices: Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD) with point values of 4, 3, 2, and 1, respectively, assigned to them. All questions were posed with an orientation in which the answer of Strongly Agree indicated favorable response to the online course. Based on all 15 non-open-ended questions, the average received from the survey was 3.05, which is a success. Some of the survey questions with a summary of student responses are shown in Table 3.

Table 3. Survey Results

Survey statement	SA%	A%	D%	SD%
The available tutoring was adequate for me.	16	72	8	4
The available academic support (technical) was adequate for me.	20	76	0	4
The testing procedure was clear to me.	54	38	4	4
The testing times were convenient for me.	46	42	8	4
I liked taking the course on a computer.	23	31	23	23
I liked taking the test on a computer.	27	38	15	19
I would recommend this course to others.	28	36	16	20
I believe my mathematical abilities have improved as a result of taking the online course.	23	50	15	12
Computer gave me a useful feedback on my work in the course.	23	42	31	4
There were enough examples to clarify the material.	42	38	15	4
The methods of evaluation provided an adequate opportunity to demonstrate my grasp of the subject matter.	15	69	12	4
Computer presented the material in an organized manner.	35	62	4	0

Most of the student verbal comments from the survey were positive. Some of the comments were:

- I learned time management because it was not in a scheduled weekly class. I learned responsibility. I knew if I didn't complete the homework, do the practice tests, read the chapters, and teach myself the material, I wasn't going to finish the work or pass the class.
- It made me more confident in my math skills. I've always relied on a calculator or the ability to ask questions in class, while these were still available to me, they were not what I wanted to use. I wanted to really grasp the concepts for myself, and I think I really did.
- Can be done at own pace. I was able to do the lessons when it was convenient for me. I was also able to finish the course in the beginning of November which now leaves me with more free time & more time to devote to my other classes.
- I really had to learn the material so it pushed me to work harder.
- Teaching myself the math improved my knowledge and mathematical skills.
- It was nice to have the option of taking the tests over again.
- Easy to slack off.
- On other tests you get points taken of if you forgot a negative sign, here it takes of full credit which kinda stinks.
- It was hard to actually learn the math that I didn't know.
- Make it compatible for apple computers.

5. SUMMARY

Although computer instruction cannot replace face-to-face instruction, the benefits of offering an online course such as the one described in this article seem to outweigh its shortcomings for certain types of courses.

The main drawbacks include:

- Not all homework exercises from the texts are available online yet. (According to Prentice-Hall, such a project may take about 10 years to complete.)
- Since students can only enter the final answers to the computer in their online homework or exams, written communication using the language of mathematics is not reinforced, and neither is the usage of proper mathematical notation. However, this is not the worst situation since most questions are at least short response and not multiple choice questions; secondly, they come from the material students already learned in high school or earlier, and thirdly, the correct notation is presented by the computer (but seeing it is not the same as writing it).

- Because written mathematical communication and proper notation cannot be reinforced in such an online course, its setup should only be recommended for developmental mathematics classes, in which students are re learning material learned in high school or earlier.
- CourseCompass.com is not compatible with Mac machines and with browsers other than Internet Explorer.
- Assignment prerequisites can only follow a linear order, otherwise manual checking is required.

The advantages include:

- Students do learn mathematics from it.
- It is self-paced.
- Students can work when they want to.
- It is an online course, so students can mostly work from home.
- Students can complete the course early.
- It is economical for students ($40 kit).
- It can be easily set up with no specific knowledge of computers required.
- It frees up classroom space (three sections can be offered online with only one proctor needed instead of three in-class sections, each being taught by an adjunct instructor).
- The hired proctor does not need to be a person with mathematical training (for instance, a college testing center employee).
- It reduces dependence on adjunct instructors and thus changes reputation of the college.
- It saves money for the college.

Overall, offering developmental mathematics through an online course such as the one described in this article is beneficial. I recommend it to faculty at other colleges. I hope that they will find the information provided in this article helpful and inspiring.

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