ESTRELLA MOUNTAIN COMMUNITY COLLEGE

# Creating Student Engagement in Mathematics : Integrating Technology In the Curriculum

## MIL 2008 – 2009 Fellow

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It is not uncommon for underprepared students to lack the proper study skills necessary to achieve success in their academic coursework, especially students who are enrolled in developmental mathematics courses. Students tend not to be motivated to study. If students would take the initiative to study throughout the semester, they would have a stronger foundation in the content area and be better prepared for the next sequence of courses in their academic program. The goal for this project was to improve the study skills of students enrolled in an Introductory Algebra course (MAT091). Participants in the study were 17 students who enrolled in MAT091 during the spring 2009 semester. These students were compared to a control group of 16 students enrolled in MAT091 during the fall 2008 semester. The use of different technological tools was implemented in the curriculum. The focus of the project was to engage students outside the classroom through the integration of technology. There was a difference in student engagement between the fall and spring semesters.

# Literature Review

The community college serves as a pathway to prepare students to either transfer to a university, assist students with the skills necessary to obtain employment, or update current skills for career advancement; "Besides offering academic coursework to earn a degree and occupational education or training, community colleges help students transfer to public 4-year postsecondary institutions with articulation agreements and provide many forms of noncredit activities, ranging from remedial coursework to community and support services" (NCES, 2008 ).

"One of the key educational tasks that has fallen to community colleges is to offer developmental or remedial education to prepare students who, for one reason or another, are not ready for college-level coursework" (National Center for Education Statistics, 2008). With an open admissions policy, an increase in enrollment of students with diverse academic preparedness is inevitable. There is an increase in students who are lacking the skills necessary to complete college level courses. "Each year, thousands of students graduate high school academically underprepared for college. As a result, approximately one-third of entering postsecondary students require remedial or developmental work before being allowed to take college-level courses" (Bettinger, 2008).

One of the content areas where students are under prepared is in mathematics. "Mathematics was the most common remedial course reported by beginning postsecondary students (15 percent) enrolled in remedial mathematics and by beginning community college students (22 percent) in 2004" (NCES, 2008). According to the Mathematics Special Professional Interest Network (SPIN) created by the National Association for Developmental Education (NADE), students enrolled in developmental education courses vary in characteristics. According to the NADE mathematics SPIN, five categories of characteristics of developmental mathematics students are presented. The first category defines students who have the ability to perform well mathematically but for some reason do not. "In the mathematics area, some are capable students who have simply fallen behind, not for lack of ability, but out of disinterest, insufficient effort, lack of seriousness, or some similar reason. If they apply themselves, these students will generally succeed irrespective of how developmental math programs are structured" (Stephens, 2003). The second category is one where students are "adequately prepared for college level study, but have a specific weakness in mathematics" (Stephens, 2003). According to Stephens, the third category describes students who are motivated to pursue a college education, but lack the necessary learning skills, which include math specific learning skills (2003). The

fourth category “involves students who have verifiable (usually documented) learning disabilities” (Stephens, 2003). The last category “is comprised of students who have a broad range of deficiencies in multiple areas including mathematical abilities, learning skills, motivation, organizational skills, and others” (Stephens, 2003). According to these characteristics, there is a need to assist students in preparing themselves for college level coursework whether it is in the content area or in another deficient area of their academic preparation.

One of the components of being underprepared for college is the lack of adequate study skills. “Analyses of students’ preparation for college level work show the weakness of core skills such as basic study habits and the ability to understand and manage complicated material” (Alliance For Education, 2006). When considering how to best assist students with their study skills, it is important to consider the learning styles of students enrolled in remedial courses. According to Boylan, et.al. “the use of a variety of instructional methods, particularly those using visual or hands on approaches to learning were more likely to appeal to the learning styles of students typically enrolled in remedial courses” (1999). One of the several research factors contributing to successful remediation is video based supplemental instruction. “Video based supplemental instruction uses videotapes of lectures to support the points made in small-group sessions. This technique is reported to be particularly effective with underprepared students” (Boylan, et. al., 1999).

Considering the learning styles of students enrolled in developmental courses and video based supplemental instruction, integrating a resource such as the Interactive Whiteboard (IWB) which encompasses these areas is a valuable teaching tool. At the present time, no studies have been found that document the use of the IWB with the adult learner population. Therefore, in this study references will be made regarding IWB use in primary and secondary settings. According to research conducted by Glover and Miller, “IWB use in both primary and secondary schools promotes pupil interest, more sustained concentration, and more effective learning where teachers are aware of the ways in which such technology can be used to support a variety of learning styles” (2007).

Through the use the IWB, the classroom environment will be changed from being a teacher-centered environment to a student-centered environment. According to Glover (2007), the findings of a research study conducted at Keele University revealed that the use of IWBs in primary and secondary schools result in three levels of learning: “supported didactic, interactive and enhanced interactivity.”
For adult learners, the use of an IWB in class is useful for students since it is possible to

refer to previous work in the same class session; instead of erasing information from a standard whiteboard, an instructor can refer back to previous pages in case a concept is not clear to students. According to Knight et. al, in a study of six primary classrooms that integrated the use of IWBs in their curriculum, it was observed that returning to previous pages created by the IWB software was useful in the enrichment of student learning (2005). "The ability to recall previous pages also contributes to inclusion. If a pupil needs to proceed at a slower pace and track back in the learning this is easily done. (2005) According to Knight's research the pages that were most often referred to and assisted students were those with "supporting images, worked examples and annotations of a mathematical process" (2005). Students can also refer to prior pages by printing out notes from their class sessions when these notes have been made available online. The IWB software is capable of saving class notes as a pdf file; it is also possible to record screen activity produced in class as a video. Students can refer to videos and notes created with the IWB outside of class for further review. The video resources and online notes will help students with their learning. Research indicates that students in developmental courses benefit most from visual teaching techniques and video supplemental instruction. These resources, which contain both visual and auditory elements will assist students enrolled in developmental courses.

## Method

In the spring 2009 study, there were 12 female and 5 male students who completed the course. Students enrolled in the spring 2009 semester had access to instructor created materials that were available online.

### Design

The design of this experiment is a quasi-experimental design. Students self selected their enrollment in Introductory Algebra (MAT091); therefore, no randomization was involved in the study. The four credit Introductory Algebra course focuses on linear behavior. Content such as graphing linear equations and inequalities, solving linear equations and an introduction to polynomials is presented.

A control group and treatment group were compared in the study. The control group consisted of students enrolled in the 8:50 A.M. section of the fall 2008 semester. The treatment group consisted of students enrolled in the 8:50 A.M. section of the spring 2009 semester.

The class environment of the control group was traditional lecture based instruction. Supplemental materials provided to this group were access to instructor office hours,

campus tutoring services and resources available by the publisher through the MyMathLab course management system by Pearson publishers.

The students in the treatment group had instructor created electronic resources available to them as well as instructor office hours, campus tutoring services and resources available through the MyMathLab course management system.

## Materials

An E-instruction Interwrite Pad, a portable interactive white board (IWB), was used in class. An IWB is a device that is wireless and provides the flexibility for integrating video, animations, internet sites and other tools into a lesson. This device also has the capability of recording desktop movement and converting it to a video that may be streamed asynchronously over the web. For more information regarding this product, please refer to http://www.einstruction.com/products/interactive_teaching/pad/ .

Students were required to create an account on Skype, a free intertelephony software. Through Skype, students communicated with their instructor online and received online tutoring to assist in clarifying questions regarding content covered in class. In order to assist the visual nature of explaining mathematical topics, students were connected with their instructor on Skype while simultaneously accessing www. imaginationcubed.com, a free interactive whiteboard that is visible by those individuals that are communicating with each other. Through the online whiteboard, both parties are able to change the content on the board simultaneously.

In order to create videos for out of class use, Jing, a free screen capture recording software, was used in conjunction with the IWB and IWB software. These recordings were then posted on www.screencast.com and made available through a link posted in the course management system. The screencast site has embedded security with the option of making the videos private and is only accessible to students enrolled in the spring course.

## Procedure

Electronic resources were developed by both the instructor and students:

Electronic resources developed by the instructor:

1) Notes stored as pdf files.
   Daily lessons were created using the Interwrite pad and Interwrite software. During class, the instructor projected the lesson on the whiteboard and moved around the classroom with the Interwrite pad in hand. Students were given the opportunity to use the board during class to explain the problem solving process to the rest of the class. Questions and comments made by students were written on the lesson through the use of the Interwrite pad. The lesson was then saved as a pdf file and immediately uploaded to the MyMathLab course management system.

2) A digital library was created.
   Every week an instructional video was created by the instructor through the use of the IWB, IWB software and Jing. Videos covered content that appeared to be of most difficulty to students. To ensure that students were reviewing the videos, assignments were embedded in the video with a specific deadline noted.

3) On line tutoring sessions.
   Students created a Skype account and were required to meet with their instructor online for a minimum of 15 minutes during the semester. Students made appointments with the instructor in advance. Both student and instructor connected through the use of Skype and the www.imaginationcubed.com website.

Electronic resources students created:

1) Video tutorials explaining the steps used to solve a particular mathematical problem that was provided by the instructor.

   Students created video tutorials. Students were provided with a list of topics that would be included on their cumulative final; the students then chose which topics would be used in the creation of a video tutorial. Students met with the instructor outside of class to create their video and post it in the course management system. Once the videos were created, all students in the treatment group had access to the videos for review on the final exam.

## Results

To measure student learning, performance on three exams and a cumulative final were recorded.

## Exam Results

According to a comparison between scores on the first exam, the treatment group scored higher than the fall semester students. Frequencies were used to compare the data. Students in the treatment group all earned a C or better on the first exam. The content covered on Exam 1 included symbols and sets of numbers, fractions, variable expressions and equations, operations on real numbers and properties of real numbers. Exam 1 results may be found in Figure 1 in the appendix.

Historically, students tend to have greater difficulty with the second course exam; this is evident in Figure 2. Both classes performed similarly on this exam. This part of the course was the first time students had been introduced to variables. Content covered on this exam included simplifying algebraic expressions, addition and multiplication properties of equality, solving linear equations, evaluating and solving formulas, mixture problems and solving linear inequalities.

Figure 3 demonstrates exam performance between groups. The control group scored higher than the treatment group. Eighty-four percent of the students in the control group earned a C or better on exam 3. In comparison, only 65% of the students in the treatment group earned a grade of C or better. The content covered on this exam is related to graphing linear equations. Graphing is quite challenging for students. The following topics are covered on exam 3: reading graphs, the rectangular coordinate system, graphing linear equations, intercepts, slope and rate of change, and functions.

The final exam was a cumulative exam that covered all content present on the three exams during the semester as well as the following topics: solving systems of linear equations, solving systems of linear inequalities, exponents, operations on polynomials, exponents, negative exponents, and scientific notation.

As illustrated by Figure 4, the treatment group scored higher than the control group with 53% earning a C or better compared to the control group of 32% earning a C or better on the final. Of the 11 students that earned an F on the final in the control group, two students did not take the final and earned a zero for their exam score. Of the seven students that earned an F on the final in the treatment group, three students did not take the final and earned a zero for their exam score.

Once all assignments, quizzes and project scores were combined with the scores on all

exams, the graph in Figure 5 demonstrates a comparison between overall grades in both courses. The treatment group performed better in comparison to the control group with 76% of the students earning a C or better for the course. The three students that earned F grades in the treatment group did not take the final and did not attend class weeks prior to final exam week. The passing rate of the control group was 38%, where passing rate is defined as those students earning a C or better in the course. Of the six students in the control group who earned an F in the course, two students did not take the final and did not attend class weeks prior to the final exam.

The primary goal of this study was to attempt to get students to become more engaged outside of class with the content they were learning in MAT091. According to the graph in Figure 6, the treatment group surpassed the amount of engagement outside of class in comparison to the control group. The frequencies below were obtained by recording the number of times students accessed various content areas provided in the MyMathLab course management system. The greatest areas accessed by students in the treatment group were the weekly documents followed by the online textbook. The weekly documents area was the area where all instructor created videos, student created videos and class notes produced with the IWB were made available to the treatment group. It is also noteworthy to mention that students accessed the weekly documents during class for one class period only. The graph indicates that all other hits to the course management system were made outside of class. The number of total hits for the semester demonstrates that there was an average of approximately 217 hits per student during the spring semester. The range of hits per individual by semester is as follows: fall 2008 semester (0 – 66 hits), spring 2009 semester (15 – 428 hits).

## Math and Technology Survey Results

At the end of the semester, both sections were administered a six question survey regarding accessibility to technology and attitudes toward technology and mathematics. On a rating scale from 1 to 5 where 1 is the least comfortable and 5 is the most comfortable, students were asked how comfortable they were with technology. For the control group the average rating was 4.1 and the average rating for the treatment group was 3.7. When asked whether they had access to a computer at home, 96% of the students in the control group indicated that they owned a computer while 100% of the treatment group indicated computer ownership. When asked about internet access outside of school, 96% of the control group indicated that they had internet access and 93% of the treatment group indicated access to the internet outside of school. With respect to type of internet service available, 79% of

the control group had high speed internet and 82% of the treatment group had high speed internet. In reviewing information regarding where students access the internet, the largest percentage of students access the internet at home. Sixty percent of the control group used the internet at home while sixty-eight percent of the treatment group accessed the internet at home. Both groups mentioned the following options regarding internet access: access at school, work, personal laptop and combinations of these three options.

When asked when they last enrolled in a math class, responses for the control group were divided into two categories: 1) two years ago or more and 2) one year ago. Forty-eight percent of the students in the control group had taken their last math class at least two years ago with the remaining students taking their last math class one year ago. Responses for the treatment group were divided into three categories: 1) two years ago or more, 2) one year ago, and 3) less than one year ago. Approximately 36% of the students in this group took a math course two years ago or more, approximately 29% took a math course one year ago, and approximately 36% took a math class less than one year ago.

When asked about feelings toward mathematics, 56% of the students in the control group had negative feelings toward mathematics and approximately 61% of the treatment group had negative feelings toward mathematics.

## IWB Survey Results

Students in the treatment group were asked six questions regarding their opinions on the integration of the IWB in the course. When asked whether they felt the IWB was useful in their learning approximately 86% of the students indicated that in their opinion the IWB was useful. One of the most repeated comments was that students liked the ability to view their notes online in case they missed something during class.

When asked whether they used the instructor or student created videos, only 4 students responded that they did not use the videos. Of these four, one student commented that they preferred to use the videos that came with the textbook.

One question asked whether students used the instructor created videos or the student created videos the most.

Students were asked how they felt about creating their own video and posting it. Only three students mentioned that they did not like creating their own video. A common

student response was that they liked to know that they were sharing something with their classmates.

When asked what they would change about the class format, overall the consensus was that nothing would be changed.

Lastly, students were asked what they felt was the most useful portion of the class. The responses to this question varied, with several comments mentioning the digital resources available to them. One common thread in student responses was that the instructor made a difference in their learning.

## Discussion

The two groups who participated in this project were diverse in academic behavior. The difference in the amount of communication that occurred outside of class between the instructor and students was very noticeable. Students in the control group only sent a total of 49 emails to the instructor over the period of a semester. The treatment group sent a total of 198 emails to the instructor during the semester. The content in email communication differed between the two groups. The control group sent emails regarding absences. The treatment group sent emails regarding absences, questions regarding specific homework problems, questions regarding videos, the desire to make appointments with the instructor on Skype, working out problems on the imagination cubed website, the desire to make an appointment with the instructor, clarification regarding content covered in class, and the desire for additional practice problems. This is in alignment with Boylan's research regarding visual approaches to learning.

In observing the two classes, the classroom environment was quite different for each group. The instructor played the role of facilitator in the treatment group whereas the instructor played the role of lecturer in the control group. There was a significant amount of communication that occurred between instructor and students and between students and students. The amount of communication during class was quite limited in the control group. Student communication was limited to communication that occurred between students that were seated together. The same students asked and answered questions in the control group, whereas in the treatment group, all students participated and a sense of community was the overall feeling in the classroom.

It was also observed that the students in the treatment group were always prepared with questions at the beginning of class. These students were also prepared when meeting with the instructor online and during office hours. In comparison, few

students in the control group attended office hours in the math lab and only two students went to the instructor's office for additional assistance.

With the treatment group, different levels of learning were observed with the use of the IWB. The first phase was the level of wonderment. The students were intrigued by the IWB and the process of using the whiteboard was a novelty. After two weeks of using the IWB, a few students reached what was appeared to be the passive learning stage. During this stage, there were students who did not take notes. Although these students did not write anything in their notebooks, they were consistent in their class attendance. Overall class attendance did not decline, even though notes were always made available immediately after class. Students who were absent during the semester mentioned to other students and the instructor the usefulness of having class notes and videos available to them online. These students mentioned that this was vital to them, so that they did not fall behind in class. It was also observed that students printed out class notes and stored these notes in their notebooks. Even the students who took notes in class, printed out the class notes.

With respect to exam results, students in the treatment group performed better on exam 1, exam 2 and the final exam. These results may be because the students were in constant communication with the instructor and had their questions answered within 24 hours.

When working with students online, it was observed that students that never spoke in class were very talkative online either through meetings or through instant messaging on Skype. These same students would come to class the next day after meeting online and would not say a word in class.

As the instructor moved around the classroom with the IWB, it was common for students to ask the instructor questions when the instructor was standing close by. This was one method of receiving instant feedback and affirming what they knew with respect to the content. The instructor's mobility throughout the classroom was also a method of classroom management. In the treatment group there were no conversations between students that did not involve mathematics since the instructor was traveling throughout the room and students would be more attentive to what was happening in class. Class sessions often had to be paused in the control group since students would frequently have conversations among themselves that would be disruptive to others. In the control group, the instructor was more connected to the whiteboard and not mobile. The accessibility of the instructor in and out of class may be a factor that contributed to the differences between the two groups.

It is believed that the amount of communication for the treatment group was noticeable because the instructor broke down barriers between herself and the students. The instructor was available to students and there was constant communication between students and instructor throughout the semester. It is also believed that the classroom environment was different because the instructor developed a bond of trust with the students. The instructor allowed the students to use the IWB during and outside of class. The instructor also gave an explanation of why the IWB was being used and why the students would be creating their own videos.

Even though there was not a difference between retention and grade achievement among the two groups, what was noteworthy was that students in the treatment group worked diligently on the course content outside of class.

This project has allowed me to think about questions that need further investigation. One of the reasons the Interwrite Pad was selected as opposed to its competitors, is that seven Interwrite Pads may be connected simultaneously. An exploration would be to investigate a new product by the eInstruction corporation which is an updated version of the Interwrite Pad. This updated product is called the Interwrite Mobi. The advantages to the Mobi is that it can connect to nine different Mobi pads and both instructor and students can contribute simultaneously to the digital content being presented in class. The Mobi can also be used with a personal response system (PRS) developed by eInstruction. A future exploration of the use of the Interwrite Mobi in the classroom would be to obtain eight more Interwrite Pads for student use. Students could be placed in eight different learning groups and interact with each other during class on mathematical content. Students could then look at different ways other students developed their problem solving strategies in order to work on assigned problems. This problem solving approach would assist in the community building of students within the classroom.

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Appendix

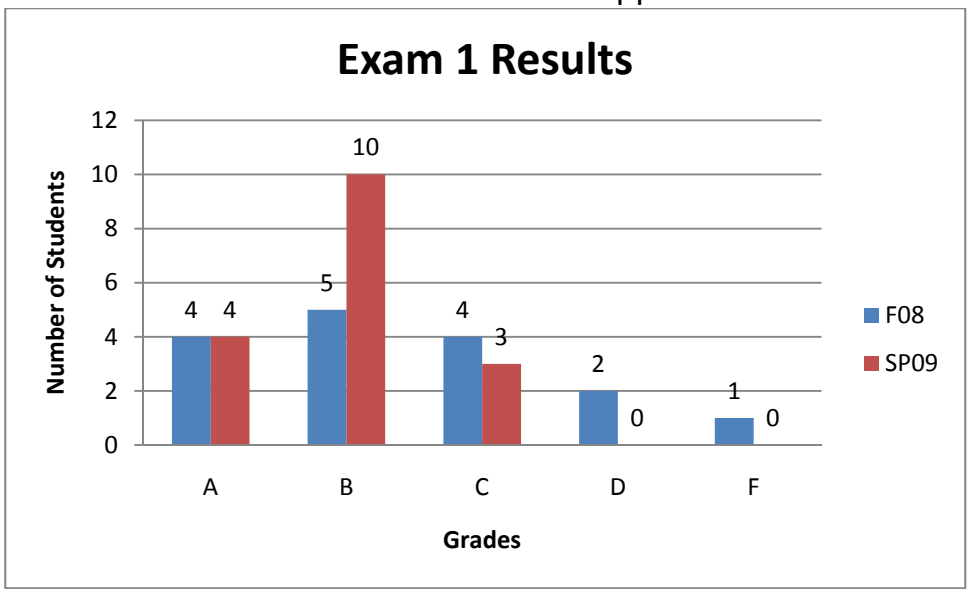


Figure 1

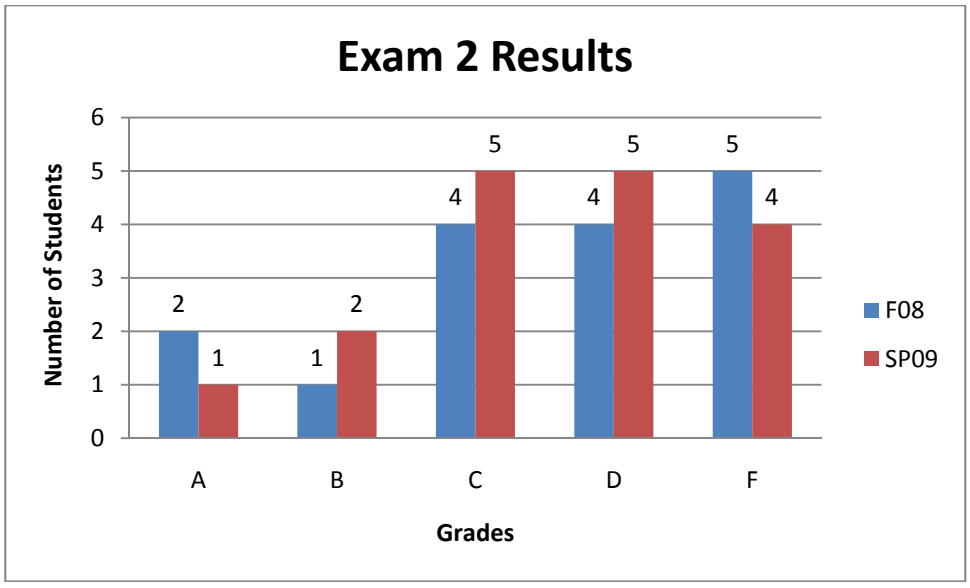


Figure 2

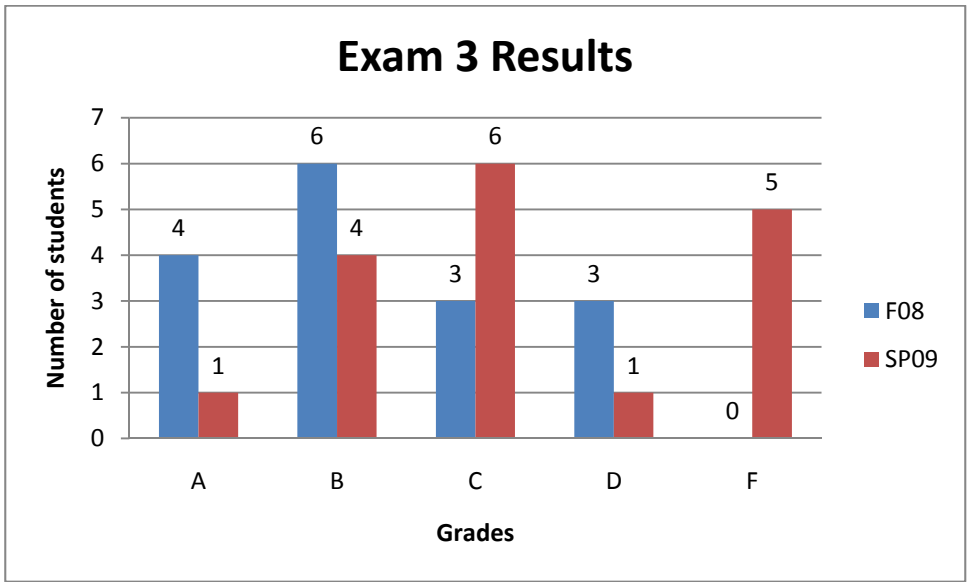


Figure 3

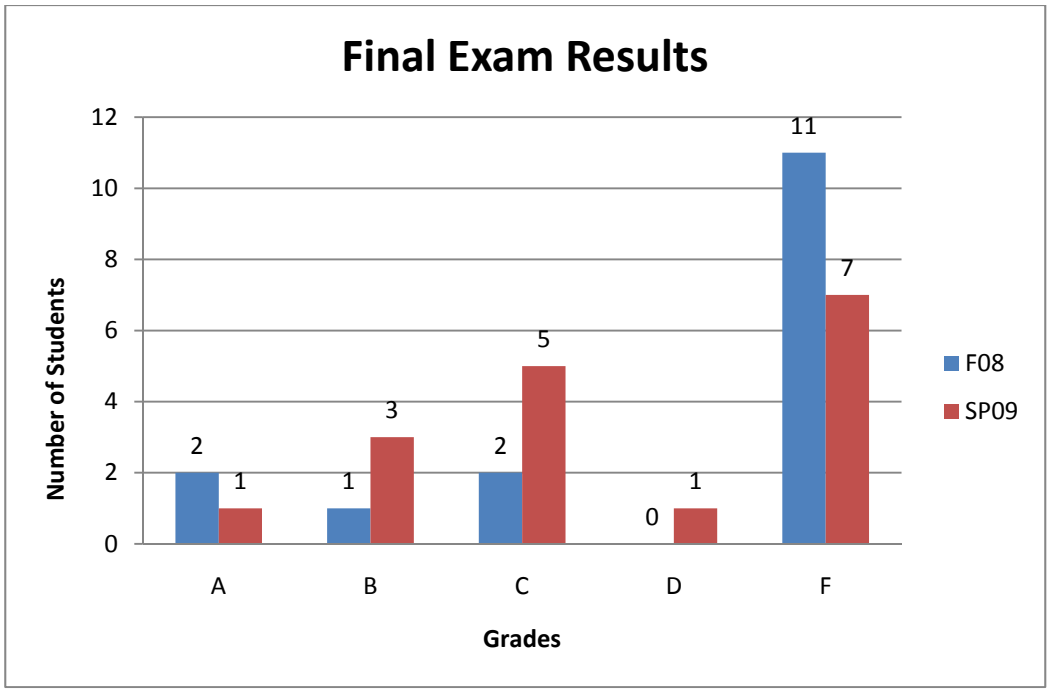


Figure 4

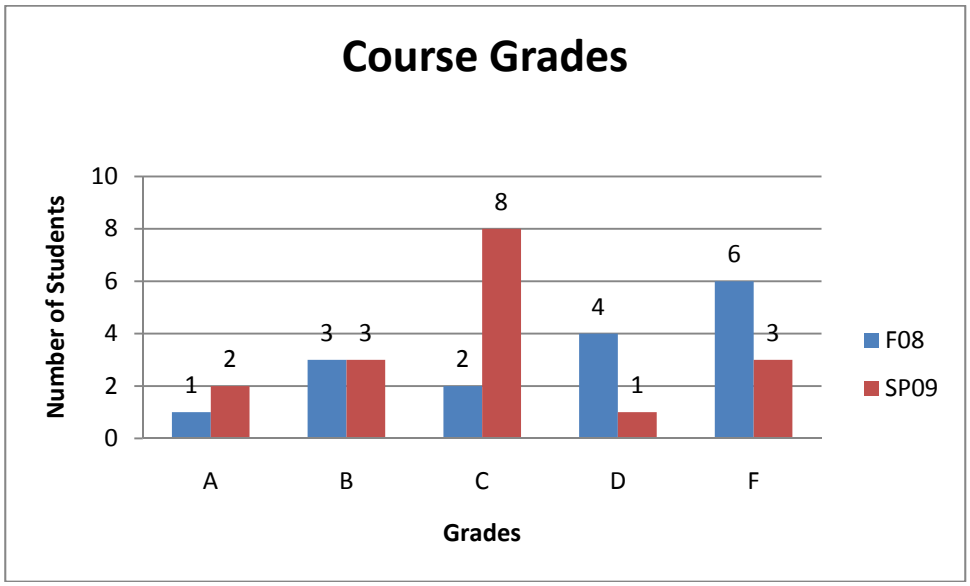


Figure 5

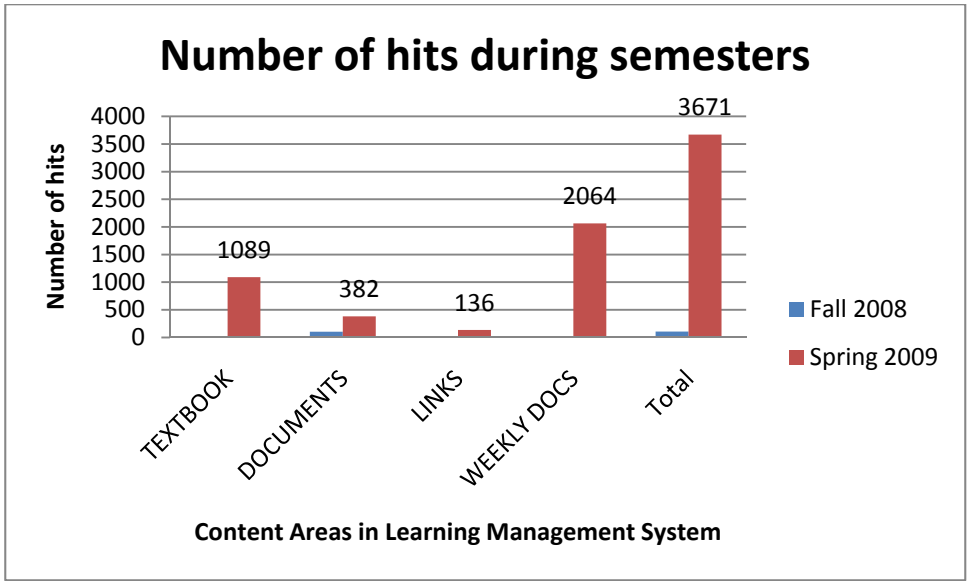


Figure 6

**Not applicable. The control group did not have access to these materials.