120th ASEE Annual Conference & Exposition
FRANKLY, WE DO GIVE A D*MN
June 23-26, 2013

Paper ID #6940

Using MyMathLab for Learning Reinforcement in the Classroom and Attendance Data for Engineering Calculus

Dr. James E. Lewis, University of Louisville

Dr. James E. Lewis, Ph.D. is an Assistant Professor in the Department of Engineering Fundamentals in the J. B. Speed School of Engineering at the University of Louisville. His research interests include parallel and distributed computer systems, cryptography, engineering education, undergraduate retention, and technology (Tablet PCs) used in the classroom.

Jeffrey Lloyd Hieb, University of Louisville

Dr. Jeffrey L. Hieb is an Assistant Professor with the Department of Engineering Fundamentals. He teaches engineering mathematics to freshman and sophomore engineering students. His research interests include: computer security, cyber-security for industrial control systems, microkernel based operating systems and the use of technology in engineering education.

Using MyMathLab for Learning Reinforcement in the Classroom and Attendance Data for Engineering Calculus

Abstract

Since the amount of technology available in the engineering classroom is increasing, instructors are challenged to find unique and positive ways to incorporate this technology into their classrooms. For the Department of Engineering Fundamentals, which teaches the core engineering mathematics and graphics courses for the entire J.B. Speed School of Engineering at the University of Louisville, mathematics continues to be an area of focus for the adoption and incorporation of technology into the classroom. As part of its mission, the Department of Engineering Fundamentals has been challenged with improving retention of first year engineering students, and is exploring technology based approaches to improve student learning and success in the sequence of engineering analysis courses, *Engineering Analysis I, II, and III*.

In the *Engineering Analysis I* course, the department has long observed that students who attend class have a higher probability of succeeding. The use of paper-based, daily, in-class problems to help learning and attendance has been used for many years. A small amount of credit on weekly exams was given for completion of in-class problems. Work on in-class problems was not graded for accuracy since the problem was always worked by the instructor during class prior to the students submitting the problem. Since 2007, all incoming freshmen have been required to purchase a Tablet PC. Initial efforts to incorporate Tablet PC technology into the classroom were focused on the use of DyKnow™ [1,] including these in-class problems. Electronic collection of students' digital work on the in-class problems achieved an increase of efficiency (less time collecting and returning paper) and also encouraged students to embrace the use of their Tablet PC; however, grading for accuracy was still not possible in this scenario. Scoring via DyKnow was an improvement over the paper in-class problems, but was lacking the ability to check accuracy of the students' answers, which was a goal of using these in-class problems.

Most recently, the department started adopting the use of Pearson's MyMathLab™ [2], an online multimedia textbook with active content, including algorithmic problem generators and computer grading. Homework in MyMathLab has been well received; however, using the software for exams has been less favorably received by students, since it can cause students to struggle with how to interpret a question and how to properly format solutions. This past spring semester, MyMathLab was used to deliver and grade a daily in-class problem in *Engineering Analysis I*. Several benefits of this approach have been observed: (a) attendance data is collected and stored with little effort by the professor; (b) using MyMathLab in-class problems helps reinforce course learning concepts with immediate correctness feedback; (c) students receive a structured environment to practice dealing with exam-like problems.

Student response to the MyMathLab homework and in-class problem has been positive. Going forward, the in-class problems will be more tightly integrated with class notes. Because of the initial challenges with exams and MyMathLab, a hybrid approach will be used until the software technology matures.

1. Background

Successfully retaining first year engineering students is a major focus for the Department of Engineering Fundamentals. The department was established in 2007 and is responsible for teaching several core freshman and sophomore courses for the engineering school. Specifically the department teaches *Introduction to Engineering, Engineering Graphics,* and *Engineering Analysis I, II, and III*. The *Engineering Analysis I, II, and III* courses are a series of calculus based engineering mathematics courses.

It is well documented that retention of engineering students is related to their first year GPA [3]. The engineering analysis courses contribute substantially to the GPA of freshman engineering students, and therefore the department has made it a priority to help students succeed in *Engineering Analysis I*. Department faculty have long held that class attendance is critical to success in the *Engineering Analysis* courses, and in general the importance of class attendance is regularly supported in literature [4]. Freshman often have a very different attitude about class attendance, due to rumors and other circumstances. Based on this long standing tradition in the department to encourage class attendance, the department uses daily in-class problems to help motivate freshman to come to class by making a few points on each weekly exam depend upon completion of in-class problems. In large enrollment courses like *Engineering Analysis I, II, and III* this reward works to combat any student impressions that instructors neither value nor pay attention to attendance.

As the department has worked to incorporate technology in to the classroom, in-class problems are one area where technological capabilities have been applied. This paper discusses how the authors worked to migrate paper in-class problems to computer based in-class problems using DyKnow and customized software, then transitioning from DyKnow to MyMathLab in-class problems. There have been several benefits of this effort: (a) increased efficiency of faculty effort; (b) student benefits, and (c) paper savings. Under the current scheme it is now possible to perform analysis on student performance and attendance. Initial analysis is presented in the results section. The conclusion and future directions section identifies potential ways to leverage and expand the current system.

2. Paper in-class Problems (up to 2008)

Engineering Analysis I, II, and III classes meet five days a week. Each week there is a 75 minute exam during one of the class meetings, and a 15 minute quiz during another. On the remaining three days, students are given a problem to work on paper. The problem is typically from the current homework assignment or similar to a problem that students appeared to have trouble with on the most recent exam.

Instructors traditionally worked the problem in front of the class, initially giving students a few minutes to work it on their own. Each student's work was collected, alphabetized, and separated by section. A small number of points on each weekly exam came from the collected work, scaling by the number of worked in-class problems completed by each student. This scoring was performed when exams were graded, and only the composite grade score was recorded.

During a typical semester there are six regular sections and three honors sections of *Engineering Analysis I*, with a combined enrollment of approximately 300. For an out of sequence or off – term semester, enrollment in three sections of *Engineering Analysis I* is approximately 200. For these levels of enrollment, collecting and alphabetizing three in-class problems each week represented a substantial amount of time and effort. During this period attendance data was not archived separately from the exam scores, so no data is available to determine exact attendance percentages or examine the connection between attendance and measures of course performance. Nonetheless, instructors' observations indicate that the approach was successful in keeping attendance near or above 80%.

3. Electronic in-class Problems using DyKnow (2008-2010)

Starting in 2007, all incoming freshman at the J.B. Speed School of Engineering were required to purchase a Tablet PC (a DyKnow server and licenses for students were also purchased). The Department of Engineering Fundamentals was one of the first departments to teach using the Tablet PCs at the University of Louisville, using Tablet PCs and DyKnow together to deliver lectures and distribute course material since the fall semester of 2007. After completing the first year using Tablet PCs and DyKnow, there was a strong desire of department faculty to move from collecting in-class problems on paper to doing in-class problems in DyKnow and collecting them electronically. It was anticipated this change would continue to provide a sufficient incentive for students to attend class, while also encouraging students to use their tablets for note taking, and improving the efficiency of collection and scoring of in-class work.

DyKnow has the ability to retrieve panels from each student in a session, and this feature is ideal for collecting an electronic in-class problem. Figure 1 shows a sample in-class problem, including student's work, retrieved as a panel in DyKnow (student answer is in blue).

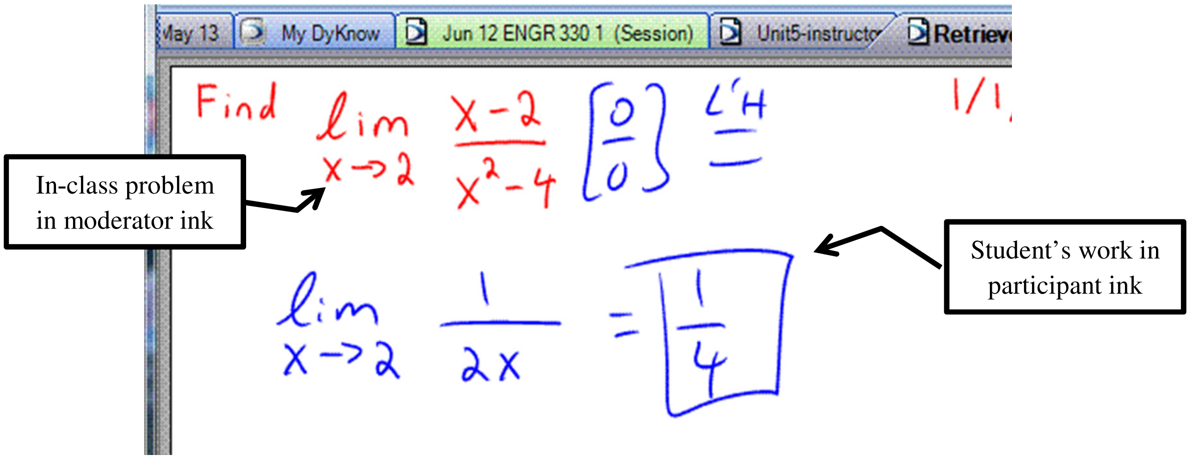

Figure 1: In-class Problem in DyKnow

During a class period, a single DyKnow session is created for the class and all students join this session. When the in-class problem is retrieved and stored in a DyKnow notebook, there is one panel for each student, similar to the panel shown in Figure 1 (instructors only worked problems that could be solved on a single panel). Each day's in-class problem could then be collected electronically, and stored in a DyKnow notebook, appropriately named to indicate the class, section, and date. For small classes, manual review and recording of in-class problems collected in DyKnow notebooks is reasonable; however, for multiple classes, each having between 50 to 100 students, manual review would be more time consuming than the review of paper in-class problems. This is not feasible due to the time it takes to switch from panel to panel, and the fact that a DyKnow notebook of retrieved panels cannot be sorted by student name, is not automatically stored in alphabetical order, and is not easily reordered.

To overcome the hurdle of having to manually look through each notebook and each panel to record a grade, it was decided to develop a software tool that could extract information from these DyKnow notebooks of retrieved panels. The tool, called DyKnow Panel eXtractor or DPX, would generate a report that could easily and quickly be used to determine the amount of credit each student should receive on their exam given one or more DyKnow notebooks containing retrieved in-class problems. The development of this software is discussed in more detail [5, 6], and is available http://code.google.com/p/dyknow-panel-extractor/downloads/list.

In the fall of 2008 the *Engineering Analysis I* course, which consists almost entirely of entering freshman, required that students do in-class problems on their tablets in DyKnow. DPX software was first used this semester and though the tool had some small bugs it was effectively used for the *Engineering Analysis I, II, and III* during the 2008-2010 semesters. Instructors were pleased with the outcome, and were able to compute weekly attendance data reports using DPX in just a few minutes, realizing the efficiency goals.

Though the DPX tool needed some revisions, the solution was very beneficial to instructors by reducing the amount of paper processed every semester; thus significantly reducing the time spent collecting and recording paper in-class problems. Prior to using the tool, based on average enrollments, a paper in-class problem collected 3 days a week for 14 weeks generated almost 15,000 sheets of paper for two classes alone (*Engineering I, and II*). The environmental benefit by itself is significant, not to mention that instructors and TA's no longer needed to collect, alphabetize, score and record, all those problems. Using these tools it would take one instructor a few seconds during class to retrieve the in-class problem, and no more than 10-15 minutes each week to produce a report that would be used to give credit on exams for in-class work.

Individual weekly reports were used to add points to each weekly exam, but cumulative attendance data was not collected or analyzed.

4. In-class problems in MyMathLab for Attendance and Practice (Spring 2012)

At the same time that DyKnow and Tablet PCs were being integrated further into the *Engineering Analysis* sequence, the department was also beginning to use MyMathLab for the homework component of the courses. MyMathLab is a multimedia on-line learning complement developed by Pearson, the publisher of the text book used in *Engineering Analyiss I, II and III.* MyMathLab provides algorithmically generated homework problems, which are graded automatically. It also includes quizzes and exams, which can be built by instructors using questions from the book, or by creating their own custom questions. Quizzes and exams may be password protected, preventing access to the quiz or exam without the password.

In the Spring Semester of 2012, the authors taught an off-term or out of sequence *Engineering Analysis I* course, with a total enrollment of 180 students. During this semester MyMathLab quizzes were used for the in-class problem instead of using DyKnow panels. This required students to change from DyKnow to their web browser and log into the MyMathLab website during class. MyMathLab presents the in-class problem to the students through the web browser, and they submit their solution online. The password feature was used to prevent unauthorized access to the daily in-class problem, as well as deter students from logging into the website if they were not actually in class. Figure 2 shows an example in-class problem, using a MyMathLab problem displayed inside of a DyKnow panel so that the students could see an instructor worked solution on their Tablet PCs during class. The problems selected for in-class problems were based on material that had been covered the prior day or material that had subpar performance on the exam. Many of the problems selected were algorithmic, so the students would not just copy the instructor's answer as their own.

ICP: 10.3
Password: Shodan HQ

$$= \frac{1}{3} \sec(3x-5) + C$$

OR

$u = 3x - 5$
$du = 3dx$

$$= \frac{1}{3}\int \sec u \tan u \, du$$

$$= \frac{1}{3} \sec u + C$$

$$= \frac{1}{3} \sec(3x-5) + C$$

Evaluate the integral.

$$\int \mathbf{sec}\,(3x-5)\,\mathbf{tan}\,(3x-5)\,dx$$

$$\int \mathbf{sec}\,(3x-5)\,\mathbf{tan}\,(3x-5)\,dx = \square$$

(Use C as the arbitrary constant.)

Figure 2: Example in-class Problem

Also, instead of counting the in-class problem as a small percentage of the exam grade, the in-class problem grade was a part of the total weighted average for the course. The in-class problems counted 5% of the overall grade in the course, which matched the previous weight given to the in-class problems on exams. The 5% was broken down into two subparts: (a) attendance (4%); and (b) correctness (1%). This was to follow the primary goal of providing an incentive for the students to be present for class, but it also rewarded the students who got the problem correct.

One of the benefits of this approach is the ease with which attendance data can be collected. MyMathLab stores all of the results and allows for the data to be downloaded to excel. The major time requirement is in the selection of appropriate problems. This attendance data allows for some basic analysis to provide evidence to students to support the benefits of regular class attendance. In addition, it was assumed that having the in-class problems as a part of the total weighted average for the course would increase student awareness to the importance of class attendance.

5. Results

The total enrollment in the three sections of *Engineering Analysis I* was 186 students. Of those, 21 students withdrew from the course and their data were removed before analysis, leaving 165 students. There were a total of 37 days across the semester when an in-class problem was given. Figure 3 shows the class attendance throughout the semester. The highest attendance was 90.3%, in late January. The lowest attendance was 50.91% occurred in March preceding the

University's spring break. The average attendance through-out the semester was 75.51%. Figure 3 also clearly shows a decrease in attendance in the latter half of the semester. To examine the connection between class attendance and course performance, students were

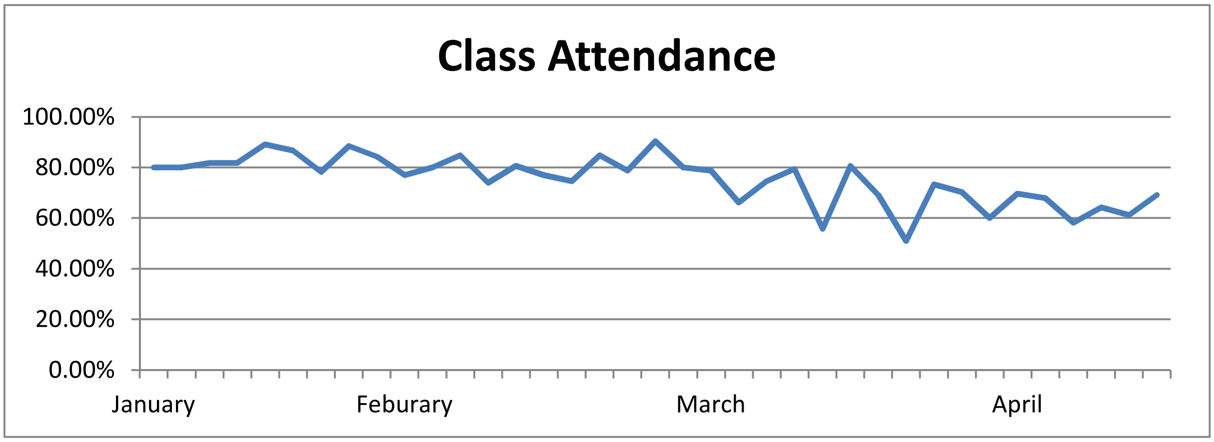

Figure 3: Class Attendance

grouped into one of four categories based on the number of classes attended. Students who attended nine or less classes were assigned to category one, students who attended less than 20 classes but more than nine classes were placed in category two, students who attended 20 or more classes but less than 33 classes were assigned to category three, and students who attended 33 or more classes were assigned to category four. Table 1 shows these assignments, with the number of students in each category and the class attendance percentage associated with each category. The exam average of the students in each category was then computed. These exam averages are also shown in Table 1. Figure 4 shows the 95% confidence intervals for the mean exam average of each category using a pooled standard deviation.

Table 1: Attendance Percentages

Category	Lower bound	Upper bound	Attendance percentage	Number of students	Exam average
1	0	9	0% – 27.03%	8	30.95%
2	10	19	27.03% – 74.07%	22	42.24%
3	20	32	74.07% – 89.19%	63	51.11%
4	33	37	89.19% – 100%	72	64.32%

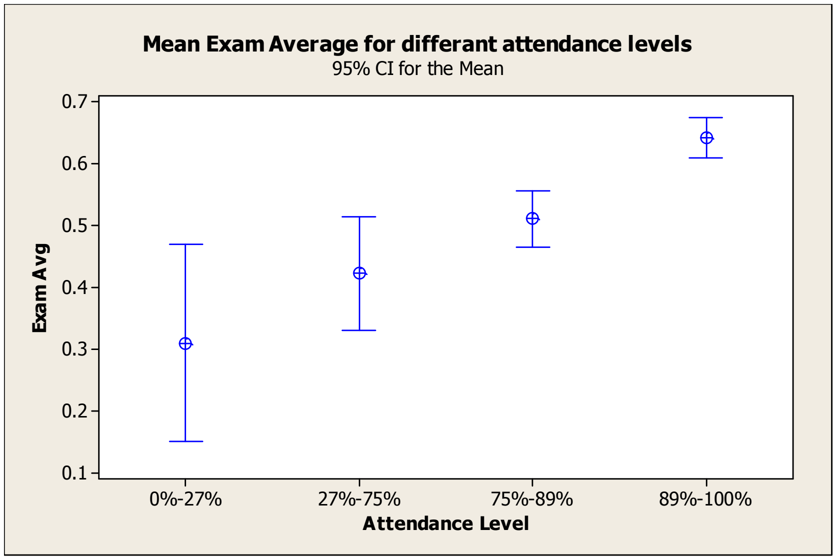

Figure 4: Mean Exam Average Based on Attendance Levels

6. Discussion

While department instructors have long encouraged students to attend class regularly under the assumption that regularly attending students will perform better in the course, it is advantageous to have evidence that supports this assumption. What constitutes "regular" attendance can be debated, but in the analysis presented, attending at least 90% of the lectures was considered regular attendance. This allows a student to miss four classes and still be considered attending class regularly. In a 14 week semester a student could miss one class every three to four weeks. These are students in category four, attending between 89.19% and 100% of classes. The mean exam average of these students was 64.32%. This average was not as high as instructors would have hoped, but is a 'C' according to the grade scale used in this class. More significantly, category four's mean exam average is significantly higher (more than 10 points) with a relatively small 95% confidence interval compared to the other mean exam averages.

There are many possible reasons for higher exam averages besides class attendance, and this analysis provides no further insight for these possibilities. It could be that responsible, hardworking, and motivated students come to class, and do well on exams due largely to their own efforts. Possibly students who do not attend class regularly lack the discipline needed to adequately prepare for exams. Certainly instructors would like to believe that their lectures contribute to the improved performance on exams. There may even be other valid explanations. While this initial data analysis does not offer any insight into explaining why attendance leads to better exam performance, it clearly shows that students who attend class regularly (above 90%) did significantly better on exams than those who did not.

The decrease in class attendance that was observed around the beginning of March (as seen in Figure 3) is disturbing but not surprising. Part of this decline may be attributed to students who did not withdraw before the drop date, and either stopped attending or stopped attending regularly. It also may indicate a point in the course where a number of students begin to experience fatigue or frustration.

The use of MyMathLab for daily in-class problems was reported by students on their mid-semester feedback [7] exercise as an overwhelmingly positive factor in their learning. Students reported that the opportunity to practice problems using MyMathLab under simulated test conditions was a positive course experience and helped their learning. The fact that the students reported seeing value in these daily exercises supports using MyMathLab in-class problems versus a more straight-forward attendance check.

7. Conclusions and Future Directions

The department has a long history of using a few points on weekly exams to encourage students to attend class. While this is certainly an obvious and logical perspective, there are freshman who dismiss instructors' advice and encouragement and do not attend class regularly. The results of this analysis are consistent with instructors' assumptions about attendance. While more data needs to be collected from multiple semesters, the results support continuing to encourage attendance. This and additional data may prove useful in convincing students of the importance of attending class.

Future plans include on-going collection of attendance data and exploring when and how to present the analysis results to students. While this study looked at using MyMathLab in-class problems to record attendance, the mid-semester feedback from students indicates that the additional practice in MyMathLab had value on its own, and the department plans to investigate this in greater detail in the future. Part of the motivation for encouraging and rewarding attendance has been the belief that if the *Engineering Analysis* sequence of courses can help students develop good study habits, including good class attendance habits, this would persist into upper level courses when specific rewards for attendance are not given. The authors hope to investigate this in the future by following a group of students throughout the *Engineering Analysis* sequence of courses, tracking their attendance, and continue tracking their attendance in several core upper level engineering courses.

8. Bibliography

1. DyKnow - Classroom Management and Interactive Education Software. http://dyknow.com/ (accessed December 13, 2012).

2. MyMathLab by Pearson Publishing. http://www.mymathlab.com/ (accessed January 4, 2013).

3. Budny, D.; LeBold, W.; Bjedov, G. Assessment of the Impact of the Freshman Engineering Courses. *Journal of Engineering Education* 1998, No. October, 405-411.

4. Moore, R.; Jensen, M.; Hatch, J.; Duranczyk, I.; Staats, S.; Koch, L. Showing Up: The Importance of Class Attendance for Academic Success in Introductory Science Courses. *The American Biology Teacher* 2003, *65* (5), 325-329.

5. Hatfield, J.; Hieb, J. Using Retrieved Panels from DyKnow in Large Classes. In *The Impact of Tablet PCs and Pen-Based Technology on Education;* Reed, R., Berque, D., Prey, J., Eds.; Purdue University Press: West Lafayette, Indiana, 2009.

6. Hatfield, J. *CLUSTERING DIGITAL INK CONTENT TO ASSIST WITH THE GRADING OF STUDENT WORK;* Univeristy of Louisville Masters of Engineering Thesis: Louisville, KY, 2010.

7. Lewis, K. G. Using Midsemester Student Feedback and Responding to It. In *Techniques and Strategies for Interpreting Student Evaluations: New Directions for Teaching and Learning;* Lewis, K. G., Ed.; Wiley Publishing, 2001; Chapter 4, Vol. 87, p 33.