WHAT WE LEARNED FROM INTRODUCING LEARNING SOFTWARE INTO A CLASSROOM

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Introduction. It is known that faculty members and administrators in higher education institutions are looking for ways and means to improve success rates in college entry-level mathematics courses. Specifically, this has been the case for college algebra courses. In recent years, much focus has been given to these courses. The introduction of software tools and other hybrid structures have been used and resulted in some partial success (Kinney, 2001). It was widely known that the technology makes a difference in college mathematics teaching (Adams, 1997). In addition, it is also learned from Hodges study (Hodges, 1998) that a critical factor in making the placement fair is that the prerequisite classes need to be valid and effective. If the prerequisite necessary for college algebra does not prepare students to be successful in college algebra, then the system needs to be revisited, some remedial actions to be planned and early intervention must be taken.

This paper briefly describes, among other things, details of the implemented components for College Algebra courses at Texas A&M International University in which learning software applications, supplementary instruction (SI) and tutoring services provided by The Center for Advancement of Scholastic Achievement (CASA), and common evaluation instruments have been embedded into the course delivery. Finally, the extent of this implementation will be elaborated in the sections to follow.

Synopsis of the Program. Altogether, there were ten sections of college algebra courses party to the implementation of this program during fall of 2008. They all had a common syllabus. All assessments were scheduled to be taken in this lab under supervision of lab personnel as proctors.

Figure 1 shows all components in place to assist in students' learning endeavor in College Algebra during fall 2008 at TAMIU. Selection of textbook and software, designing course syllabus, and preparing exams are collectively done by the faculty who teach these course sections. A course coordinator appointed by the department chair is in charge of these activities and selection of assessment topics and homework problems for students. Weekly meetings of faculty have been held throughout the semester in order to make sure the program needs are met and to make timely adjustments simultaneously in all sections. In addition, there has been a university-wide ad-hoc committee on college algebra which makes strategic policy decisions with regard to the course delivery. They met on a biweekly basis.

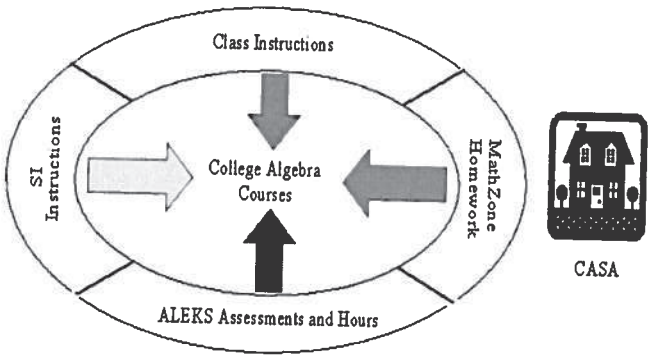


Figure 1: Model used to make mathematics learning possible

Software Applications. The use of mathematics software to enhance student thinking and development has been a topic of much discussion lately. Five categories of tool-based mathematics software have been identified that can be effectively used in a mathematics curriculum: (a) review and practice, (b) general, (c) specific, (d) environment, and (e) communication from building basic skills to exploring mathematical applications (Kurz, Middleton, & Yanik, 2005).

Two items of software are included in this endeavor. ALEKS has been used for tutorials and assessments, while MathZone provided online homework assignments.

ALEKS is a web-based, artificially intelligent assessment and learning system. ALEKS uses adaptive questioning to quickly and accurately determine exactly what a student knows and doesn't know from a course material. ALEKS then instructs the student on the topics the student is most ready to learn. As a student works through a course, ALEKS periodically reassesses the student to ensure that topics learned are also retained. ALEKS courses are very complete in their topic coverage, and ALEKS avoids multiple choice questions.

MathZone is a complete online homework system for mathematics and statistics with a powerful student assessment diagnostic tool. MathZone is customizable to suit instructor needs and offers students high-level individualized study tools designed to improve engagement, motivation and grades. MathZone's automatic grading and reporting feature saves instructors valuable hours scoring homework, quizzes, and tests.

The main components used for course evaluation are : ALEKS initial assessment (0%), First midterm exam (15%), ALEKS midterm assessment (10%), Second midterm exam (15%), ALEKS final assessment (10%), Final exam (25%), ALEKS work hours (7.5%), Adding items in ALEKS pie (a pie chart consists of various lesson plans) (7.5%), and Problem-solving on MathZone (10%).

Impact of Software Use. It is anticipated that the students' use of software will

contribute to high performance in their classes. Software has been used for many components: ALEKS assessments, tutorial hours, added items, and MathZone assignments, thus totaling 45% of the students' grades. The aggregate of these will impact on their learning. This aggregate is compared with their semester grades to determine impact of software use in learning. For preliminary results, a scatterplot is drawn for a course section. Figure 2 shows that there is a strong linear correlation between the aggregate use of software (ALEKS assessments, hours, added items, and MathZone assignments) and the final grades received by students indicating that students' use of software heavily contributed to their final grades in the course.

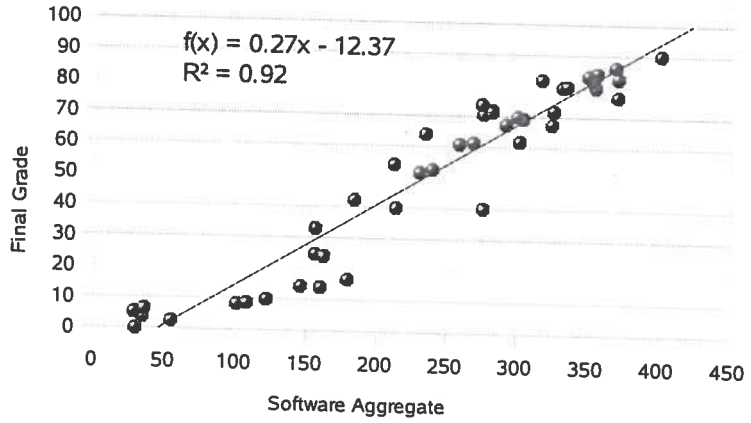


Figure 2: Scatterplot for use of software contributed to final grades of students

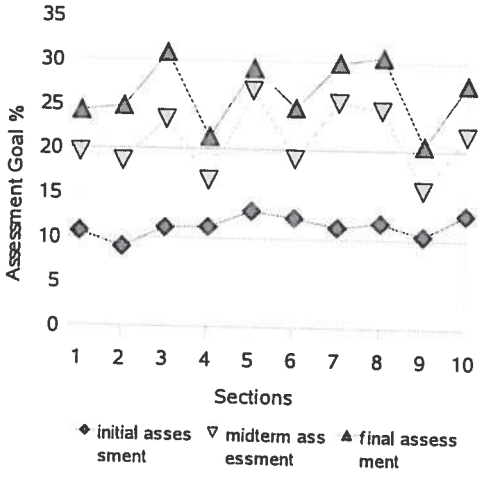


Figure 3 Assessment Progress

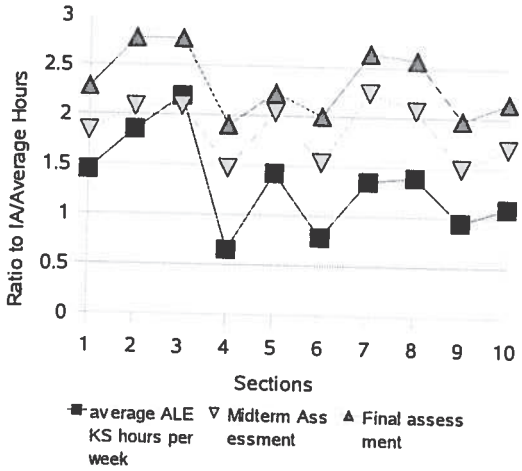


Figure 4 Progress Ratio and Hours

ALEKS. An assessment pertains to coverage of all materials in a typical college algebra course in accordance with common course syllabus. It is assumed that the students will be able to learn these materials by the end of their coursework. Figure 3 is a line graph

drawn using averages for ALEKS initial assessment scores, midterm assessment scores, and final assessment scores obtained by students in each section. Figure 4 is a line graph drawn using ratios of midterm assessment scores and final assessment scores to initial assessment scores and average hours students worked on ALEKS per week. Figure 3 suggests that those who completed the final ALEKS assessment received higher initial assessment scores compared to that of all students together for most of the course sections. However, as is evident from Figure 4, ALEKS learning hours have contributed to achievements on midterm and final assessments.

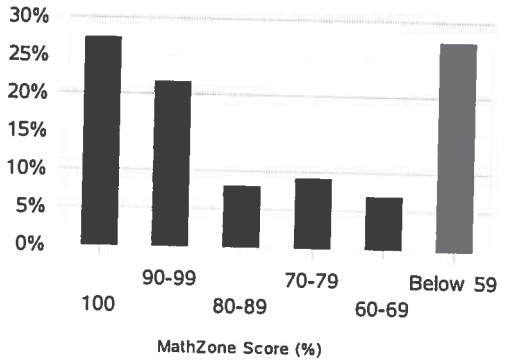


Figure 5 MathZone Score Distribution

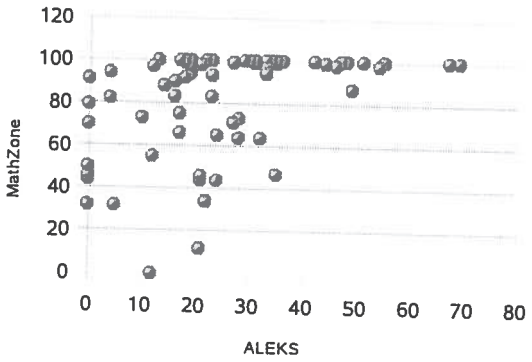
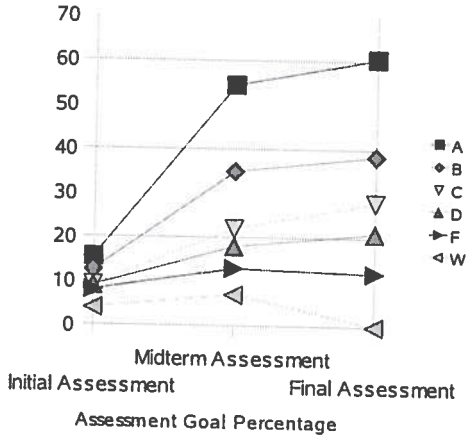


Figure 6 ALEKS-MathZone Scores

MathZone. Figure 5 shows percentage of students who completed the MathZone for each grade range. It says that almost half of our students completed MathZone with 90% or higher. Figure 6 is a scatter plot of ALEKS final assessment and MathZone scores. It shows that more students worked MathZone than ALEKS.



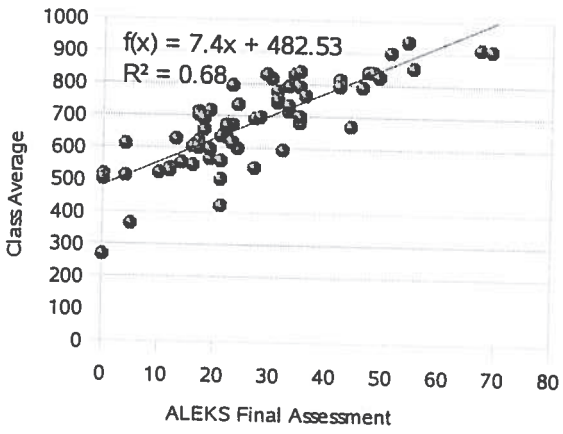


Figure 7: ALEKS Assessment vs Grade Figure 8: ALEKS Final Assessment vs Average

Each line of Figure 7 shows the change of average ALEKS Assessment scores of each grade. The average ALEKS final assessment scores of students whose grade is C or higher is 38%, whereas that of students whose grade is D or lower is 16%. Figure 8

suggests that there is a linear correlation between ALEKS final assessment and the course grade.

Tables 1-4 show score ranges of ALEKS Initial Assessment, ALEKS Hours per semester, ALEKS Final Assessment, and MathZone Scores for each letter grade.

Course Grade	ALEKS Initial Assessment (%)			
	max	min	median	**mean**
A	22	10	15.5	**15.8**
B	23	2	12.5	**12.2**
C	21	0	9.0	**9.9**
D	20	2	9.0	**10.2**
F	16	0	8.0	**7.1**
W	24	0	4.0	**6.0**

Table 1 ALEKS Initial Assessment

Course Grade	ALEKS Hours			
	max	min	median	**mean**
A	58.6	39	43.3	**45.5**
B	70.5	8	28.8	**35.0**
C	83.7	4	21.8	**26.0**
D	36.7	4	15.7	**19.3**
F	17.5	1	7.5	**8.0**
W	35.8	1	7.3	**7.8**

Table 2 ALEKS Hours Per Semester

Course Grade	ALEKS final Assessment (%)			
	max	min	median	**mean**
A	69	51	60.5	**60.3**
B	55	23	38.5	**39.1**
C	36	17	28.0	**26.6**
D	44	0	21.0	**21.3**
F	27	0	12.0	**10.8**
W	12	0	0.0	**4.0**

Table 3 ALEKS Final Assessment

Course Grade	MathZone Scores (%)			
	max	min	median	**mean**
A	100	98	100.0	**99.5**
B	100	87	100.0	**98.6**
C	100	47	96.5	**85.9**
D	100	44	94.0	**82.2**
F	100	12	79.0	**32.1**
W	83	0	27.0	**34.0**

Table 4 MathZone Scores

Survey. CASA conducted a survey at the middle of the semester. They asked students which was the most helpful resource to complete College Algebra successfully among ALEKS, MathZone, SI, class, review, and CASA. Students chose more than one resource. 253 response were collected. More than two-thirds of students thought that MathZone was the most helpful. The main reason was that MathZone is aligned with the textbook. However, some pointed out that students could cheat the work in MathZone very easily. On the other hands, 38% of students felt that ALEKS is the most helpful. This number is the second lowest. Most students thought ALEKS was not directly related to the textbook. They also felt that ALEKS load, including the minimum 3-hours-per-week requirement, is heavy. Several students pointed out they could not access the items of ALEKS that were covered in class. But quite a few of students answered that ALEKS was helpful in recalling the prerequisite materials.

Change in Spring 2009. Based on the results from 2008 and the survey, we changed the common syllabus as follows: (1) Reduced the weight of ALEKS grade to 25%, (2) one point per hour for ALEKS tutorial, (3) No ALEKS midterm assessment, (4) Stopped using MathZone for homework, splitting homework into traditional paper-and-pencil and using ALEKS.

Conclusions. The data from the semester-long teaching of the course in this hybrid fashion suggests that there is a strong linear correlation between the aggregate use of software (ALEKS assessments, ALEKS learning hours, and MathZone assignments) and the final grades received by students indicating that students' use of software heavily contributed to their final grades in the course. The SI sessions as embedded into the course instruction have greatly contributed to keeping students from the courses. Accordingly, students not only benefited from use of software, but also decided to stay in the course. However, more and lengthier studies are needed before any meaningful conclusions are drawn.

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References.

[1] Adams, Thomasenia Lott (1997). Technology Makes A Difference In Community College Mathematics Teaching, *Community College Journal of Research and Practice,* 21:5, 481-491 to link to this Article: DOI: 10.1080/1066892970210502 URL: http://dx.doi.org/10.1080/1066892970210502

[2] Hodges, D. (1998). Evaluating placement and developmental studies programs at a technical institute: Using ACT's under-prepared student follow-up report, *Community College Review*, 26(2), 57-66.

[3] Kinney, D. Patrick (2001). Implementation Models for Interactive Multimedia Software in Developmental Mathematics, *Nade Selected Conference Papers,* Volume 7, 2001

[4] Kurz, T. L., Middleton, J. A., & Yanik, H. B. (2005). A taxonomy of software for mathematics instruction, *Contemporary Issues in Technology and Teacher Education* [Online serial], 5(2). Available: http://www.citejournal.org/vol5/iss2/mathematics/article1.cfm

[5] ALEKS, http://www.aleks.com

[6] MathZone, McGraw-Hill, https://www.mhhe.com/math/mathzone/