# Learning with ALEKS: The Impact of Students' Attendance in a Mathematics After-School Program

Scotty D. Craig[1], Celia Anderson[1], Anna Bargagloitti[1], Arthur C. Graesser[1], Theresa Okwumabua[1], Allan Sterbinsky[2], and Xiangen Hu[1,*]

[1] University of Memphis, Memphis, TN, 38152, USA
[2] Jackson-Madison County School System, 310 North Parkway, Jackson, TN, 38305, USA
{scraig,croussea,brggltti,a-graesser,tokwumab,xhu}@memphis.edu,
adsterbinsky@jmcss.org

**Abstract.** We examined the effectiveness of using the Assessment and LEarning in Knowledge Spaces (ALEKS) system as a method of strategic intervention in after-school settings to improve the mathematical skills of struggling students. The study randomly assigned students into a classroom that either worked with the ALEKS system individually on computers or were taught by teachers in an interactive classroom. Results from year one revealed that students randomly assigned to the ALEKS condition significantly out performed students assigned to the teacher condition on a state assessment test (TCAP). However, this was only if the students received sufficient exposure to the program.

**Keywords:** After-school program, ALEKS, Mathematics education.

## 1 Introduction

Given the growing deficiency in mathematics education [1, 2], it is worthwhile to implement and test alternative computer technologies to help raise student performance in mathematics.

Technology is generally believed to have a positive impact on student learning in mathematics. Nevertheless, the research on using technology to improve performance in mathematics has provided some mixed results when evaluated in K–12. Some of the news is positive. In a review of research on the effects of technology on student's mathematics gains, Schacter [3] reviewed over 700 empirical research studies in which students had exposure to computer-assisted instruction. The students showed overall positive gains in achievement on tests that spanned researcher-conducted tests, standardized state tests, and national tests. However, Dynarski et al., [4] reviewed software products for first grade reading, fourth grade reading, sixth grade math, and algebra founding no significant test score differences between the groups of students. Similarly, the report of the National Mathematics Advisory Panel [2] points to mixed results in the research on computer-based tutorials. Therefore, our study was conducted to test ALEKS for 6th graders in an after-school setting at 4 schools.

* Corresponding author.

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ALEKS uses Bayesian networks to adaptively select the next skill for a student to work on. The Bayesian networks of the knowledge space model attempts to fill learning deficits and correct misconceptions adaptively and dynamically using Knowledge space theory [5]. It tracks the knowledge states of learners in fine detail and adaptively responds with assignments that are sensitive to these knowledge states.

## 2 Methods

Participants (291 sixth grade students in a west Tennessee school district) who volunteered for our after-school program were randomly assigned to one of two conditions (ALEKS & Teacher). They attended the program two days a week for two hours a day over 25 weeks. The two hour sessions were divided into five 20-minutes segments with ten minute periods for start-up and dismissal. The students received three 20 minute instruction sessions. The instruction sessions were separated by two 20 minute *down-time* sessions during which students received snacks and played games. In the ALEKS condition, during each of the 20 minutes instructional periods, students interact with the program. The three learning phases in the teacher classrooms followed a Lecture, group application and practice schedule. The topics covered in both conditions are guided by the state performance indicators (SPIs).

For both the ALEKS and teacher conditions the outcome measure of performance was the Tennessee Comprehensive Assessment Program (TCAP), the states yearly student achievement measure. The scores of the 5$^{th}$ grade TCAP were used to assess students' pre program mathematics knowledge whereas the scores of the 6$^{th}$ grade TCAP were used as the posttest.

## 3 Results and Discussion

A series of t-tests were conducted on student's TCAP scores from the 5$^{th}$ (before the program, 2009 TCAP) and 6$^{th}$ grade (after the program, 2010 TCAP). These two tests are not equivalent pretest and posttest measures because they are testing different information and have a different range. However, these tests do provide information on the student's mathematics proficiency. The maximum score for each test was 900. However, the state of Tennessee modified the testing requirements between the 2009 and the 2010 TCAP. There were two primary changes. The first was proficiency levels. The 2009 TCAP had levels of 500 Below Basic, 657 Basic, 712 Proficient and 752 Advanced. The 2010 TCAP has level cutoffs of 600 Below Basic, 703 Basic, 755 Proficient and 791 Advanced. More importantly for the current project, the 2010 TCAP modification included more advanced topics requiring our 6$^{th}$ grade students to know math topics that were previously on 7$^{th}$ and 8$^{th}$ grade tests. These changes reflected attempts to aligned with national standards of NAEP.

One of our major problems observed in the first year was attrition. Of the 291 students starting the program, less than 30% completed our program. Of these only 24 showed consistent performance. Because of this, we analyzed our data at two "dosage" levels. If students signed up for the program and started attending they were in the "Any dosage" level ($n$ = 291). Those 24 students with excellent attendance were

included in the "full dosage" level. There were no significant differences between students in either condition for the two dosage levels on 5th grade TCAP performance. However, less accomplished students persisted (See Table 1).

No significant differences were observed on student performance between groups at the *any dosage* ($t(289) = .79$, $p = .22$, $d = .09$) level. However, a significant difference was observed on student's TCAP mathematics ability at the full dosage level ($t(22) = 1.41$, $p = 0.08$; $d = .47$).

**Table 1.** Student's means and standard deviations for TCAP by year and condition

| | 5th grade TCAP Mathematics subscore | | | | 6th grade TCAP Mathematics subscore | | | |
|---|---|---|---|---|---|---|---|---|
| | *Teacher* | | *ALEKS* | | *Teacher* | | *ALEKS* | |
| | *Mean* | *ST Dev* | *Mean* | *ST Dev* | *Mean* | *ST Dev* | *Mean* | *ST Dev* |
| Any dosage | 487.38 | 25.57 | 488.39 | 27.15 | 702.90 | 95.58 | 711.75 | 93.58 |
| Full dosage | 469.33 | 38.08 | 483.28 | 18.93 | 667.67 | 167.50 | 723.59 | 17.74 |

Several conclusions can be drawn from these findings. First, from looking at the 5th grade TCAP means, our subject population was below the scale rankings, not even reaching the lowest cutoff score of 500. After our program the students increased two categories on average to the basic level. So, it appears that both of our after-school programs (ALEKS and Teacher conditions) were helpful to our students.

Another conclusion is that dosage matters. While the small sample size of the full dosage level weakens this finding, the significant difference and medium effect size indicate that the ALEKS after-school program could be significantly better than certified mathematics teachers. However, replication is needed in future years.

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