



Mathematics: Dramatic Learning Outcomes

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ALEKS: Research Brought to Life

Research-Based Technology

ALEKS stands for “Assessment and LEarning in Knowledge Spaces.” ALEKS assessment and learning technologies were originally developed by a team of cognitive scientists, mathematicians, and software engineers at the University of California, Irvine, with major funding provided by the National Science Foundation. ALEKS is founded on over 20 years of extensive scientific research in a ground-breaking field of mathematical cognitive science known as Knowledge Space Theory. Through adaptive questioning, ALEKS accurately assesses a student's knowledge state and then delivers targeted instruction on the topics a student is most ready to learn.

Knowledge Space Theory provides a theoretical foundation for efficient knowledge assessment in various domains ranging from mathematics and the sciences, to appropriate topics in business and the social sciences. It is not intended for what are commonly referred to as “tests” and does not produce numerical measures of ability. Rather, Knowledge Space Theory supports the construction of efficient computer assessment procedures which allows for a precise graphical representation of the knowledge state of individuals.

The research behind ALEKS is briefly discussed in non-technical terms in “The Assessment of Knowledge in Theory and in Practice:”

http://www.aleks.com/about/Science_Behind_ALEKS.pdf.

View a list of key scientific research publications at:

http://www.aleks.com/about_aleks/publications_kst

School-to-Lab-to-Home Connection

ALEKS is Web-based and can be accessed from any computer with an Internet connection, whether from school, home, or a library. The ALEKS technical requirements are minimal,

requiring only an Internet browser and a downloadable plug-in. If the student logs off, or in the event of an unintended conclusion of a session (e.g. loss of Internet connection or computer system crash), the system will always take the student back to the same place she was working at the time the session ended.

Curriculum-Based Assessment

Instruction in ALEKS is based on a cycle of assessment and learning with recurring assessments of individual student knowledge in relation to the comprehensive set of curriculum goals.

ALEKS requires students to solve open-ended problems using realistic input tools. An initial assessment begins after the student learns to use the tools in a brief tutorial. During the initial assessment, ALEKS evaluates the student's current knowledge of the subject by asking a relatively small number of questions. ALEKS chooses each question on the basis of the student's answers to all the previous questions. Each set of assessment questions is unique to each student.

Assessment results are used to guide students to new material according to their preparedness, ensuring that students build on a solid foundation. Instructors and administrators have access at any time to the complete history of a student's assessment results and learning progress in ALEKS.

The ALEKS assessment module provides an efficient guide to learning, in that it differs in principle from any standardized test whose results merely represent the student's achievement as one or more numerical values. An ALEKS assessment determines exactly what a student knows, does not know, and what she is ready to learn next.

Some key features of the assessment module are:

- All problems require that the student produce authentic mathematical input.
- Assessment questions are generated from items based on curriculum standards.

- The assessment is adaptive; the choice of each new question is based on responses to all previous questions. As a result, the student's knowledge state can be found by asking only a relatively small subset of the possible questions in the curriculum.
- Assessment results are always framed relative to specified educational standards.
- The entire student system and all of the course contents are available in English and Spanish in assessment and learning mode; students can toggle easily between English and Spanish at any time (administrators can choose to remove the Spanish option).

Automatic Assessment Reports

Following the assessment, ALEKS delivers a color-keyed pie chart report that provides a detailed, graphic representation of the student's knowledge state. The pie chart is divided into slices, each of which corresponds to an area of the curriculum for the student's grade level. In the ALEKS system, a student's progress is shown by the portion of the slice that is filled in by solid color, whereas the lighter portion represents what the student has yet to learn.

As the mouse hovers over a selected slice, a list of items is displayed that reveals what the student is ready to learn. Clicking on any of these items gives the student access to the Learning Mode.

Individualized Instruction

The ALEKS Learning Mode is an interactive environment in which the student is able to choose from a list of mathematical topics for which she has demonstrated readiness. The student is able to work on problems to demonstrate mastery of new skills, and to move ahead toward fulfillment of curricular and state-standard goals.

While in the Learning Mode, students will be presented with a sequence of problems representing a series of concepts to be mastered. Tools offered in the Learning Mode include:

- Ability to toggle between English and Spanish at any time.

- Practice problems.
- Explanations of problems.
- Worksheets individualized for each student's knowledge state.
- ALEKS calculator (when appropriate).
- Feedback.
- Progress monitoring.
- Review of any problem previously mastered.

ALEKS will at times offer advice in response to a student's answer. For example, if a student has answered a question in practice without adding the appropriate units, ALEKS may suggest that the student check the units. ALEKS may also propose that the student who continually answers a problem incorrectly temporarily abandon the problem at hand and work instead on a different problem.

When a student has demonstrated mastery of a particular item by repeatedly solving problems based on it, ALEKS will add that item to the student's pie, adjust the student's knowledge state (to make additional topics available where appropriate), and encourage the student to proceed to a new item.

Step-by-Step Explanations

A student working on a particular problem may ask for an explanation of that problem by clicking on "Explain." The explanation includes a step-by-step solution of the *exact* problem, meaning that the explanation adjusts to match the algorithmically generated problem. In many cases, an alternative or more detailed explanation is also available.

After reading the explanation(s), the student may return to the "Practice" section, where she will be presented with another problem based on the item or problem type just illustrated. If the student is successful in solving the problem, the system will offer more instances of the same item to make sure the student has mastered that problem type.

ALEKS Learning Rates

ALEKS keeps server statistics that measure learning success of all students, namely how often they succeed at learning a concept that ALEKS offers them as "ready to learn." When ALEKS determines that a student is ready to learn an item, the student is able to learn it a very high percentage of the time. In the small percentage of cases where the student is initially unsuccessful, the item is presented again to the student later on. Because of the artificial intelligence in ALEKS, students are almost always successful at learning the material ALEKS offers them (the level of instructor involvement does not affect this).

The Average Historical Student Learning Rates with ALEKS are ~90%.

State and Common Core State Standards Alignment

ALEKS course products are correlated to all 50 states' standards and the Common Core State Standards. ALEKS offers detailed PDF correlations with these standards. In addition, dynamic online reporting is available for all courses in all 50 states in grades 3-8 and in select courses for grades 9-12. These online reports provide teachers and administrators with a precise view of student, class, and school progress toward Common Core and state standards.

Comprehensive Teacher Module

The Teacher Module enables educators to easily and conveniently monitor student and class learning progress and to carry out administrative tasks. The two levels of users in the Teacher Module are teacher and administrator.

While in the Teacher Module, teachers can:

- View and print a report of an individual student's progress toward mathematics standards.
- View and print a summary of information for each student including assessment results, progress in the learning mode, and total time spent in ALEKS.

- View and print reports for an entire class, giving an overview of class strengths and weaknesses.
- Edit student registration data.
- Communicate with students through the ALEKS Message Center using ALEKS math input tools.

An administrator can perform everything above, plus:

- View, print, and edit the list of teachers and classes.
- View and edit the default content standards for any given class.
- Move students between classes and similar administrative tasks.

Quantitative Data for ALEKS

**MONTE VISTA ON-LINE ACADEMY - MONTE VISTA SCHOOL DISTRICT
MONTE VISTA, CO**

Implementation

ALEKS is used as the primary curriculum for both elementary and middle school students. Students differ in their usage of ALEKS with some using it exclusively online at home, while others use the program onsite at the school. Additionally, students vary in their supervision level while using the program with some needing direct supervision and others requiring little to no direct instruction from a teacher.

Students are given benchmarks in which they are expected to master a set number of concepts within a certain time period. In 2005, 15 students who had failed both math and English were placed into a remediation class with the goal of mastering 50 new math concepts in six weeks.

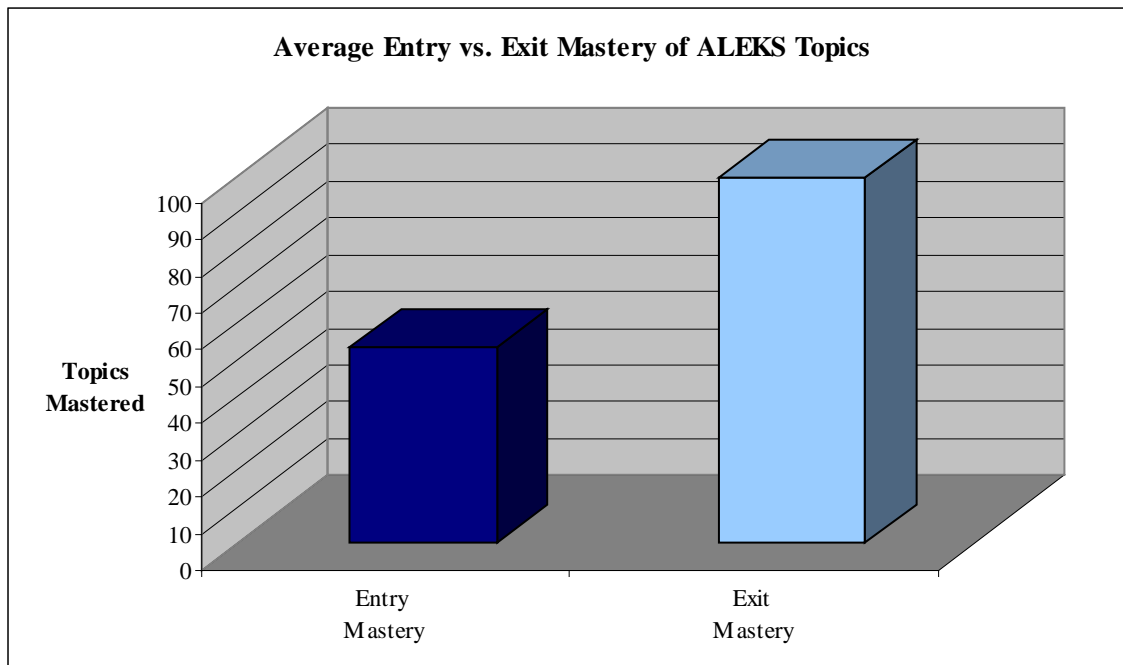
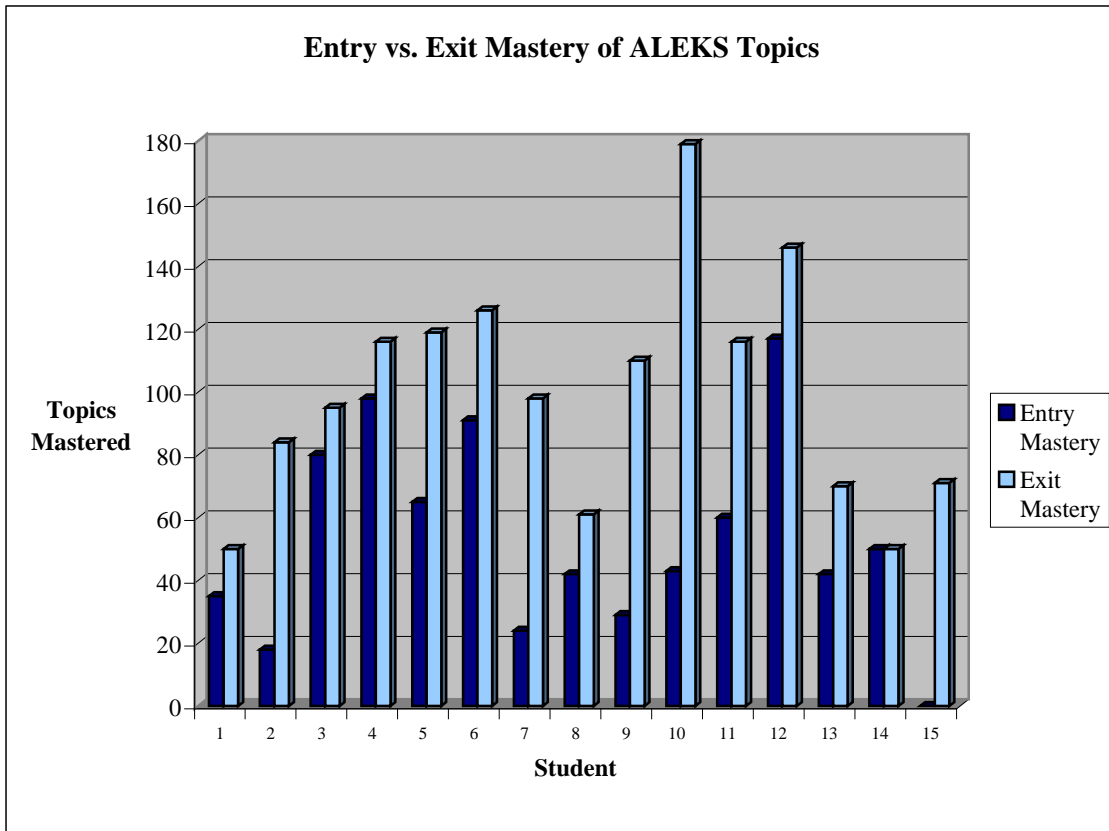
Results

When students entered the program, their average mastery was approximately 53 concepts. After the six-week period, results demonstrate that students made significant gains in learning. Seven students reached or surpassed the goal of mastering 50 new concepts, with four of those students completing the entire course by mastering over 100 topics. Additionally, four students mastered more than 70 topics during the program. The average gain by students during the six-week period was 46 additional topics mastered and students exited the program with an average mastery of almost 100 topics.

Monte Vista On-Line Academy Quantitative Data

Name	Grade	Login Hours	Entry Mastery	Exit Mastery	Additional Topics Mastered
Student 1	5	3	35	50	15
Student 2	4	4	18	84	66
Student 3	4	4.5	80	95	15
Student 4	4	3	98	116	18
Student 5	4	6	65	119	54
Student 6	4	5	91	126	35
Student 7	4	4	24	98	74
Student 8	5	3.5	42	61	19
Student 9	4	4	29	110	81
Student 10	3	4	43	179	136
Student 11	5	7	60	116	56
Student 12	4	3.5	117	146	29
Student 13	5	6	42	70	28
Student 14	5	7	50	50	0
Student 15	2	4.5	0	71	71
Averages		4.6	52.9	99.4	Average Increase: 46.5

Monte Vista On-Line Academy Quantitative Data



**IRVINE UNIFIED SCHOOL DISTRICT
IRVINE, CA**

Implementation

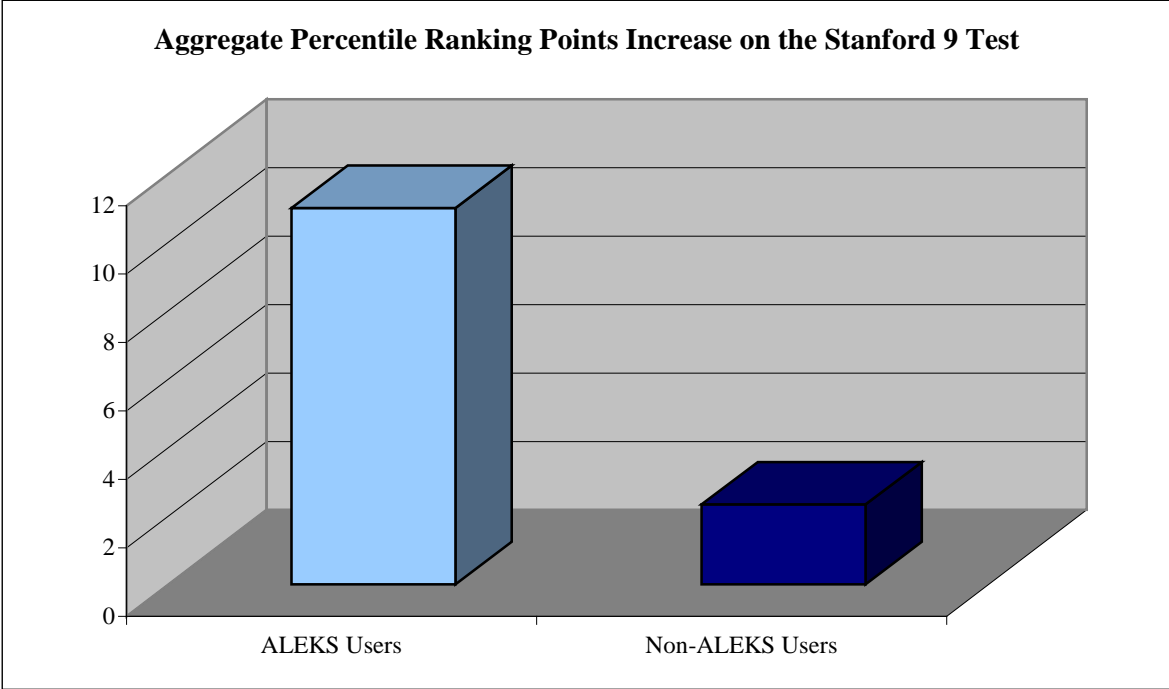
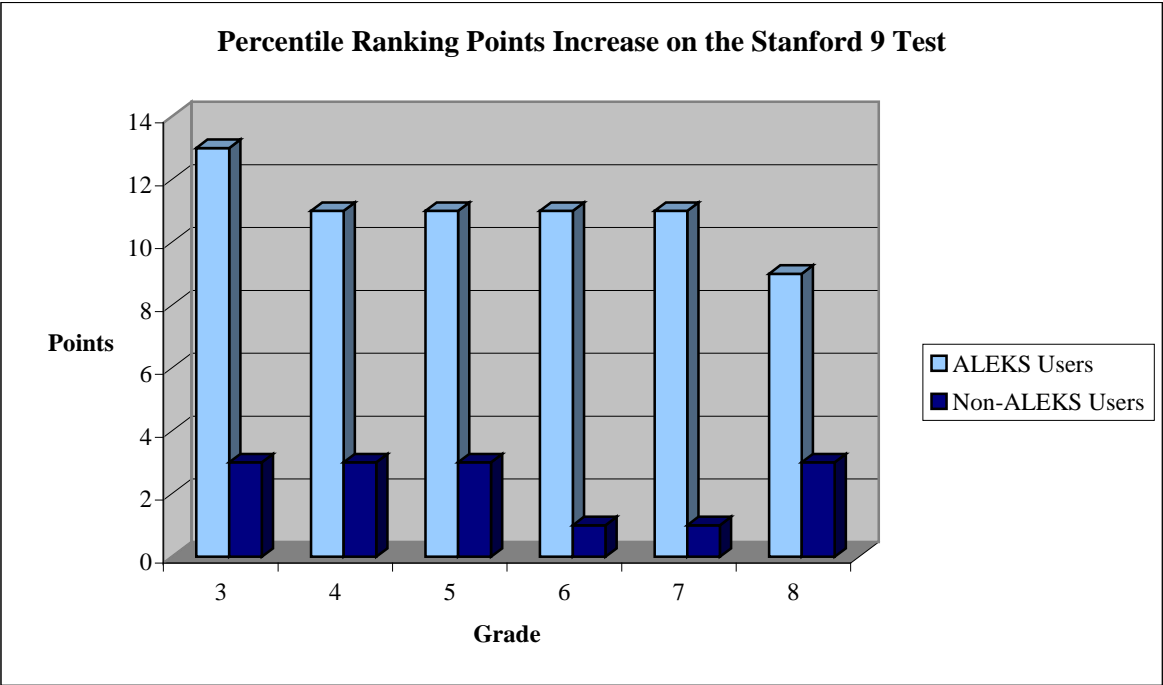
ALEKS is used as a supplement to traditional classroom-based teaching in various mathematics classes throughout the district. Students are supervised while using the program and receive one-on-one instruction from teachers when assessments show that a student does not understand certain concepts. Teachers use the assessments to track student progress and pinpoint exact concepts that students are struggling with.

Students who use ALEKS are encouraged to use the program 2-3 times per week for 8-12 weeks. The program is used by teachers and administrators to prepare students for standardized testing, such as the Stanford 9 test and the California High School Exit Exam (CAHSEE).

Results

Students who use ALEKS show an increase of 12 national percentage ranking points on the Stanford 9 test, while non-ALEKS students gain less than four points. The greatest improvements are found in students who fell between the 20th and 75th percentile. Additionally, the largest gains are found in schools that use ALEKS for 2 or more sessions per week during a period of 8-12 weeks.

Irvine Unified School District Quantitative Data



**WESTVIEW HIGH SCHOOL - TOLLESON UNION HIGH SCHOOL DISTRICT
AVONDALE, AZ**

Implementation

ALEKS is used as the primary form of instruction in the Integrated Algebra Laboratory's Integrated Algebra 1A/1B course, which is a two-year Algebra 1 program. Students are generally placed into the class because they are unsuccessful in a traditional classroom environment, are special education or late-entry students, or the class was determined to be the appropriate placement. While the majority of the students are currently in Algebra 1, many students lack Pre-Algebra credit and few are ready to advance to Algebra 2. The class period is team-taught and divided into a classroom block and a computer lab block. Students spend approximately half the period in each block.

Students are initially divided into two groups based on their abilities. A third group has been developed for select students who demonstrate an ability to work and learn on their own. The groups are designated "A" (low-basic math skills), "B" (medium-basic math skills), and "C" (low-algebra skills). "C" group students are assigned full-time to the computer lab

Results

In the fall of 2002, 20 students who were performing extremely well were placed into the "C" group and expected to work on ALEKS for the entire period. These students show weekly gains and average an approximate five percent gain on each assessment.

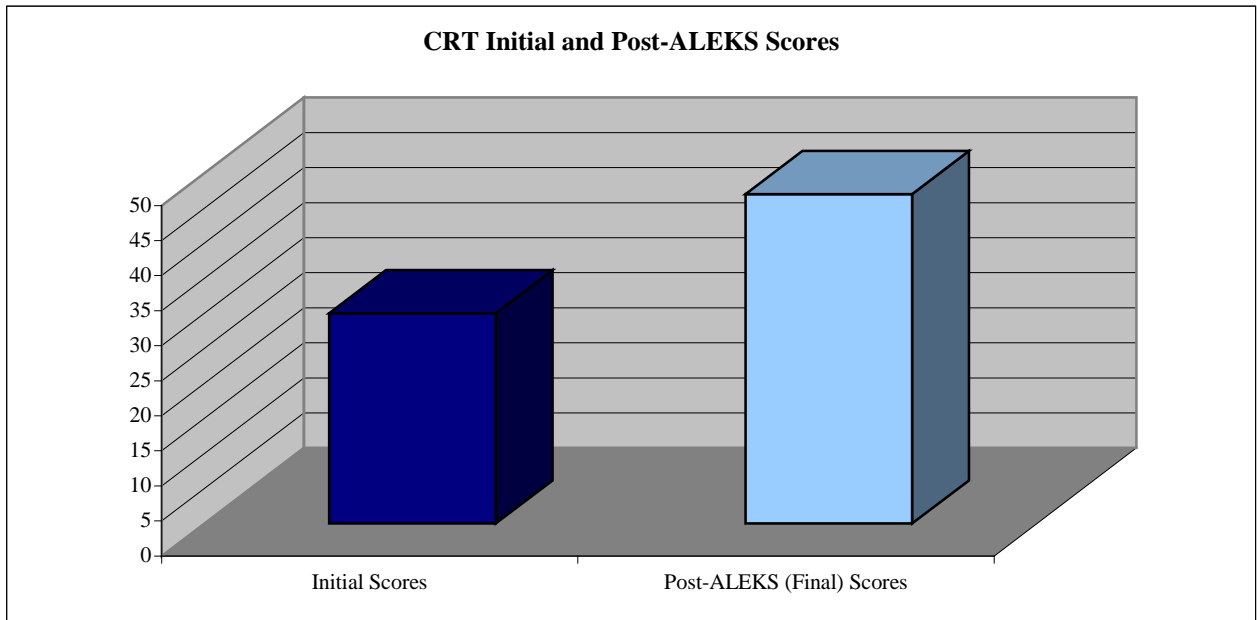
During the second semester in the spring of 2003, the program experienced a slight change and a third ALEKS class was created. Most of the "C" group students were placed into this new class, with other students from the "B" group also being assigned to this full-time lab class. The additional spaces in the original classes were filled with students who failed the first semester of Algebra 1 during the current school year.

Results indicate that students who begin the school year in ALEKS are more likely to master the

Pre-Algebra level and are now working on Algebra 1 topics.

All students were pre-tested using the district's Criterion Reference Test (CRT) for Algebra 1 at the beginning of the semester. The initial CRT scores show an average mastery of 30 percent and the final CRT scores show an average mastery of 47 percent. The average individual student gain is 89 percent, with the average gain on the Pre-Algebra assessment being 9 percent, and an average gain on the Algebra 1 assessment being 10 percent.

Westview High School Quantitative Data



**LA JOYA COMMUNITY HIGH SCHOOL - TOLLESON UNION HIGH SCHOOL DISTRICT
AVONDALE, AZ**

Implementation

ALEKS is used as the main curriculum for the Algebra 1 class. Students are required to use ALEKS for 60 minutes, five days per week, in addition to one hour per week of at-home use. Since students do not use a textbook, they are required to complete the initial ALEKS tutorial and assessment and then complete the course according to ALEKS' suggestions and guidance.

Students' grades are comprised of 80 percent ALEKS usage and the remaining 20 percent is based on class participation. ALEKS is also responsible for 76 to 100 percent of a student's homework responsibilities in the course.

Results

Students have improved their standardized test scores by approximately 20 percent. Students have also improved their letter grades by one to two letters.

**KEYSTONE AREA EDUCATIONAL AGENCY
ELKADER, IA**

Implementation

ALEKS is used as part of an intervention model for schools within the Keystone Area Educational Agency (AEA). The intervention model is three-pronged and focuses on improving professional development, supporting self-generating changes in classroom instruction, and promoting professional development activities that foster student achievement in learning communities.

Elementary and middle school mathematics are two primary targets of the intervention model. The AEA uses ALEKS to target mathematical deficiencies in students in the elementary area. An action plan developed by the consortium focuses on buying necessary technology and materials, and providing teachers with four days of professional development training that prepares them to identify and target student deficiencies in the elementary grade levels.

In addition to providing training for teachers, the AEA also developed “Family Math Nights” in schools that have a high implementation rate. The nights have a large attendance and have contributed to more positive attitudes toward math from both parents and students. The nights are highly successful in high-poverty schools and also feature community involvement that includes door prizes for attendees, dinner, and Spanish translators for attendees who require them.

Results

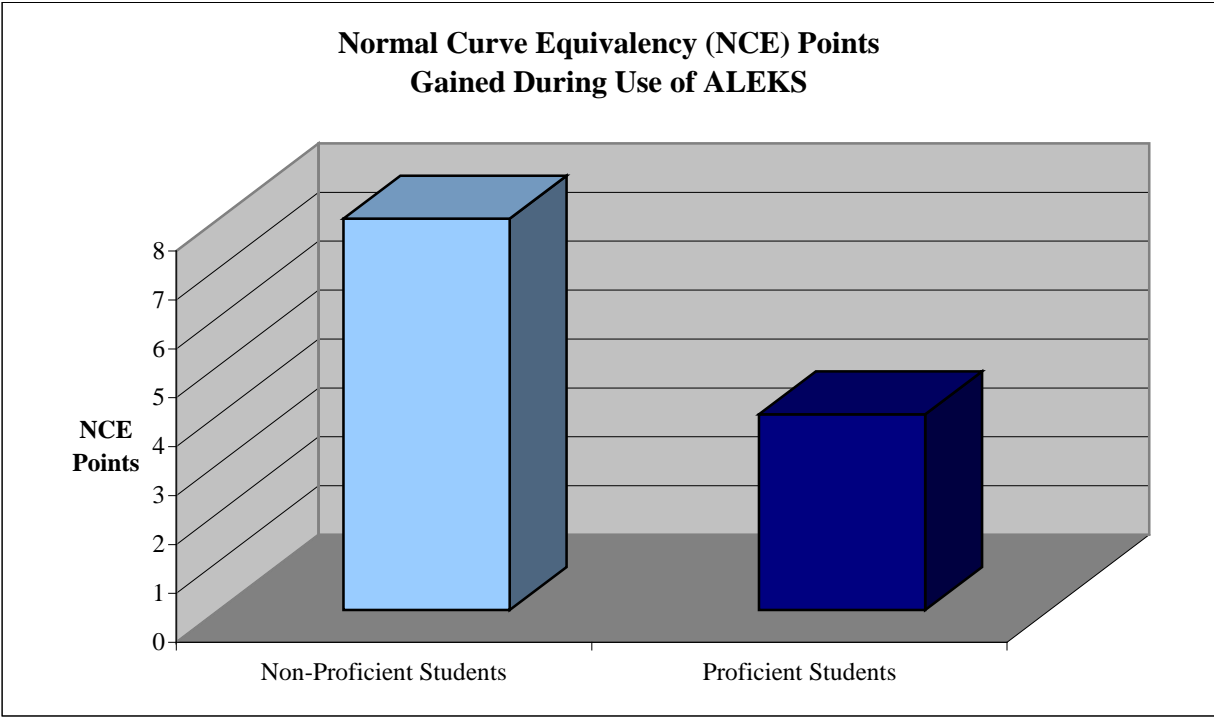
Keystone AEA teachers and students have become skilled in using ALEKS to improve student learning rates. Teachers use ALEKS to make instructional decisions through the use of ALEKS reports, as well as using the assessment feature to gauge student progress.

At the conclusion of the initial study determining the efficacy of ALEKS, students who were categorized as being non-proficient in math have shown impressive gains of nearly 8 Normal

Curve Equivalency (NCE) points. Additionally, students who were categorized as proficient in math have shown gains of over 4 NCE points.

At Wings Park Elementary School, teachers have seen significant gains in students' Iowa Test of Basic Skills (ITBS) Computational scores among not only individual students, but classes as a whole.

Keystone Area Educational Agency Quantitative Data



**HILLTOP MIDDLE SCHOOL - SWEETWATER UNION HIGH SCHOOL DISTRICT
CHULA VISTA, CA**

Implementation

ALEKS is used as a supplement to a traditional K-12 curriculum. Students are given “warm-ups” and quizzes at the start of their class to assist with concepts that they are learning in their non-ALEKS math classes. In addition, ALEKS is also used in conjunction with a textbook to follow district guidelines and to prepare students in mastering state standards. Students use ALEKS within the classroom three days per week for 50 minutes per class period.

Students are also sent home with printed ALEKS reports, which provide data on what the student’s strengths and weaknesses are within the course.

Results

Students who were previously receiving an “F” in a previous math class now demonstrate a 90% success rate of achieving a “C” or better by the end of the course. Of these students, a percentage achieved an “A” while others reached mastery of the entire course. Additionally, one student mastered 85% of Algebra without ever having been enrolled in an Algebra class. Furthermore, English as a Second Language (ESL) students also saw gains in improvement while using ALEKS due to the program’s bilingual capabilities.

**RANCHO DEL REY MIDDLE SCHOOL - SWEETWATER UNION HIGH SCHOOL DISTRICT
CHULA VISTA, CA**

Implementation

ALEKS is used as a supplement in remedial Math 8 classes within the school. Students are required to use ALEKS for two hours per week for a total of 32 hours per term. Students are also required to complete at least one quiz per week with an 80 percent score or better. If students do not score well on the quizzes, they must retake the quiz until they score at least 80 percent or better.

Students are required to use ALEKS at home, in addition to using it at school. Parental involvement is cultivated through phone calls and parent-teacher conferences to ensure that students are using ALEKS at least one hour per night at home. Additionally, ALEKS is discussed at the school's open house and as part of students' Individualized Education Programs (IEPs).

ALEKS is assigned as part of the students' homework and counts as 30 percent of their overall grade. The weekly quizzes are counted as part of the students' quiz grades for the week and students also receive an additional 30 percent grade for their work completed within the course.

Results

All students who previously scored Far Below Basic (FBB) or Below Basic (BB) on the California Standard Test scored Proficient or Advanced in Math 8 after using ALEKS for a year.

Current ALEKS K-12 Course Products

ELEMENTARY SCHOOL

- QuickTables
- Mathematics – LV 3 (with QuickTables) *
- Mathematics – LV 4 (with QuickTables) *
- Mathematics – LV 5 (with QuickTables) *
- Mathematics – MS/LV 6 *
- Arithmetic (with QuickTables) *
- Algebra 1 *
- CA Algebra 1 *
- Algebra 1 – Core *
- High School Geometry *
- Algebra 2 *
- Algebra 2 with Trigonometry *

MIDDLE SCHOOL

- Mathematics – MS/LV 6 *
- Middle School Math Course 1 *
- Middle School Math Course 2 *
- Middle School Math Course 3 *
- Algebra Readiness *
- Pre-Algebra *
- Algebra 1 *
- CA Algebra 1 *
- Algebra 1 – Core *
- Essential Mathematics (with QuickTables) *
- RtI 6 *
- RtI 7 *
- RtI 8 *
- MS RtI Tier 3 *
- MS RtI Screening Assessment *
- PreCalculus
- Trigonometry
- High School Preparation for Algebra 1 *
- Foundations of High School Math *

SPECIALIZED

- Math Prep for California High School Exit Exam *
- Math Prep for TAKS -- HS Exit Exam *
- Math for College Success *
- Prep for GED Mathematics *
- High School Prep for Statistics
- AP Statistics (Quantitative)
- Math Review for AP Calculus *
- Math Review for AP Physics *
- Chemistry
- Fundamentals of Accounting (Sole Proprietorship)
- Fundamentals of Accounting (Corporation)
- Business Math
- Algebra Readiness *
- Pre-Algebra *

(*) Fully Bilingual Course – English and Spanish