Abstract. Data from the ALEKS-based placement program at the University of Illinois is presented visually in several ways. The placement exam (an ALEKS assessment) contains precise item-specific information and the data show many interesting properties of the student populations of the placement courses, which include Precalculus, Calculus, and Business Calculus, as well as two courses outside of the placement program (College Algebra and Elementary Linear Algebra). Visual correlations between student knowledge in particular categories defined by the assessment, such as trigonometry, are given along with the knowledge acquisition of students completing precalculus. Comparisons with the previous placement mechanism (ACT Math) are given briefly.

1. Introduction

In 2007 the Mathematics Department at the University of Illinois at Urbana-Champaign began a new placement program based on ALEKS [8], an assessment and learning mechanism based on the theory of knowledge and learning spaces. Each student completes an adaptive ALEKS assessment to determine their knowledge state, which is a set of items (such as the ability to graph an exponential function or to solve an equation involving rational expressions) that the student has demonstrated mastery over. ALEKS assessments are available at many grade levels ranging from basic topics in elementary education up to precalculus in higher education. For the placement program, the Preparation for Calculus ALEKS assessment was chosen because of the high degree of overlap between the assessment items and the syllabi of the courses which the placement program governs. A listing of the items in the domain covered by the assessment is available on the ALEKS website [4].

Students at the University of Illinois come from many geographic locations and schools (including public, private, and preparatory schools) with very different mathematical backgrounds. What constitutes precalculus at the various feeding institutions varies greatly, as do the grading procedures used by different high schools and instructors, and so there is a need to evaluate preparedness precisely. Research has suggested that ALEKS can serve as a preparedness measure [3]. The underlying hypotheses of the placement program at the University of Illinois are that an ALEKS assessment accurately measures knowledge and that initial knowledge at the start of a course should be indicative of student performance in that course.

Student performance on standardized testing (primarily the ACT and AP Calculus exams, if available) was used for placement prior to the introduction of the ALEKS based program and was found to correlate poorly with student performance. Many students do not take a mathematics course in the final year of high school because it is not required by the state of Illinois, so traditional measures of student preparedness, such as grades and standardized college entrance exam scores, may suffer from age because students have either acquired new knowledge or forgotten previously mastered material in the intervening time since the last evaluation. Hence it was decided that students would take a placement exam (eventually decided to be an ALEKS assessment) within four months of the start of courses in a given semester. To compensate for the option to change schedule up to the add/drop date of a semester, students must achieve the cutscore prior to the 5th day of the course. (Otherwise they are automatically removed from the course, and if possible, placed into another course.) No other method of entry into a course is permitted, including a passing grade in a prerequisite course. The placement program also gives students the choice to remediate using the
learning mechanisms within ALEKS after the initial assessment, possibly improving their placement. The assessments are taken online at a location chosen by the student and are unproctored. Assessments typically take approximately ninety minutes, though times range from less than one hour to over two hours. Students answer approximately thirty questions and the questions will differ depending on student responses.

A significant change to the standard precalculus course at Illinois also occurred in the first year of the placement program. Precalculus was changed to be a preparatory course for calculus rather than a terminal course. Students needing credit in mathematics courses but not intending to continue to calculus are encouraged to take other (terminal) mathematics courses. Precalculus was renamed Preparation for Calculus accordingly.

The four courses in the placement program are Preparation for Calculus (PreCalc), Business Calculus (BusCalc), Calculus I (Calc), and Calculus I for Calculus-experienced students (CalcExp). BusCalc is an application-based course and does not require trigonometry. PreCalc and BusCalc have the same prerequisite. More information for these courses is available at http://go.illinois.edu/CourseExplorer/. The course numbers are 115, 234, 220, and 221.

For more information on ALEKS, the theory of knowledge spaces underlying it, and its algorithms and mechanisms, see [7], [9], [6], [8], and the upcoming [5]. For information about the ACT Math exam and its construction, see the ACT Technical Manual [1].

2. Placement Mechanisms

There exist many placement exams in higher education: many institutions have developed local paper and pencil examinations with specific lists of questions that are given to students each year; there are several commercial products that have a variety of features, which we briefly describe, though we will discuss the ACT Math test in more detail since it was the basis of the previous placement program at Illinois. A non-exhaustive list of commercial online placement tests includes Accuplacer by College Board, MyMathTest by Pearson, Compass by ACT, and Maple TA MAA Math Placement Test Suite. These mechanisms have various enhancements and design features such as test banks of various sizes, algorithmically generated variables in test questions, reporting features which analyze results of specific questions, and other placement-oriented features. These examinations produce a score or placement recommendation based on student responses. Additionally, many institutions use the results of standardized tests to place students, using the existing test scores generated by students for the purpose of admissions, such as the ACT or SAT, or using more specific subject tests in some cases, such as an SAT II subject test in mathematics. While some placement exams are relatively static in the choice of questions, some are adaptive, and others have substantially different questions for each student or each test season, such as the SAT and ACT. In the case of the ACT, questions are chosen based on correlations with the results of previous exams, with future questions embedded as experimental questions in current versions of the test [1].

To what extent any of these examinations measures specific skills or are predictive of later student success is debatable and there is relatively little comparative data publicly available. For instance, some studies have found very weak or negative correlations between the SAT and student outcomes [2]. While test designers may choose questions to target specific skills, the results of a particular examination can be difficult to interpret beyond simply correlating test scores with student success. We focus temporarily on the ACT Math examination because it is in the dataset described in this paper. In the ACT Technical manual, ranges of scores on the ACT are associated with particular skill subsets [1]. These descriptions range from very precise, such as “Recognize equivalent fractions and fractions in lowest terms” for an ACT math score of 13-15, to more vague statements such as “Draw conclusions based on a set of conditions” for a score of 33-36, in the categories Numbers: Concepts & Properties and Properties of Plane Figures, respectively. It may be the case that such scores and interpretations are sufficient to place students effectively at some institutions. For placement at Illinois, a more precise mapping to clearly defined student skills was desired.

Perhaps generating a list of specific skills that a student has demonstrated is a hard problem for a short placement exam. After all, how much information can be derived from a test ranging in length from 10 to 40 or so questions? Although a longer examination could surely produce more specific results, the practicality of implementation and student fatigue make longer examinations unrealistic. Nevertheless, there are surely correlations between the ability to solve a specific problem and the ability to solve other specific problems, at least some of which are logically intuitive, as evidenced by common sequences of presentations in textbooks.
and lectures. In principle it should be possible to exploit these correlations to derive a significantly larger amount of information on the abilities of a particular student.

ALEKS is a system designed to use such correlations, empirically derived by the performances of previous students and expert knowledge, to assess the knowledge of a student [9]. Not initially designed as a placement examination, an ALEKS assessment is part of a learning system in which the initial assessment of a student’s knowledge is used to prime the learning system to give a customized learning experience. Earlier research indicated that an ALEKS assessment could be used for readiness evaluations [3]. The result of an ALEKS assessment is a list of items that a student has demonstrated mastery over through a process of inference on the set of responses given by the student [9]. (In the customized domain used for this specific placement examination, the assessment covers 182 items.) The rationale for an ALEKS assessment driven placement mechanism is that a precise measurement of initial student knowledge should be a strong indication of eventual student performance on average. Whether or not an ALEKS assessment gives a more precise measurement of the specific abilities of a student than other placement examinations which are designed to have questions that correlate well with student performance is a question we address with data.

As a placement examination, an ALEKS assessment differs from the other described placement examinations in that it is adaptive (as is Accuplacer), is almost exclusively free response rather than multiple choice (because careless errors and lucky guesses by students can affect the accuracy of inferences [7]), and attempts to precisely reconstruct the knowledge state of a student. It should be noted that there exist other implementations of knowledge space theory (see [7] for an extensive list).

3. Description of Data

We will visually compare two placement mechanisms, the ACT Math score and an ALEKS assessment, by graphically demonstrating the relationship between placement scores and grades. Further, we will take a closer look at the relationship between ALEKS scores and grades. The data presented in this article are from three years of the placement program (2008-2010). There were significant changes in the placement cutscores and enforcement after the first year (2007). No changes to the program were made in 2008, and the placement program produced three years of consistent data between 2008 and 2010. Because the populations of students in the fall semesters differ from those in the spring semesters in terms of size (fall courses have substantially more students), experience, and other factors, and the fact not all courses are offered in spring semesters, we focus on the fall semesters. Several thousand students have taken over ten thousand assessments. Most students supply ACT scores during admissions but for a small subset of students in each course, recent ACT scores were not available. (Students were previously placed based on a conversion of SAT to ACT scores if they only supplied an SAT score; this conversion is not used at all in this paper.) Hence there are some differences in the sample sizes for the two mechanisms, and these are indicated in the captions for each plot when appropriate.

Grades are given as letters (e.g. A+, A, A-, B+, etc.) and converted to numerical value on a standard 4 point scale. Withdraws are assigned zero, the same score as F. (Note that only withdraws that occurred after drop date are used, and due to the manner in which the data was received from the registrar, some withdraws are not available.) Students are allowed to retake the ALEKS assessment as many times as desired and to use the remediation functionality, so the assessment with the highest score within four months of enrollment is used for placement. Fewer than 20% of students took more than three assessments, though note that the learning module gives periodic “progress assessments” that are not included in this proportion.

The result of an assessment is a knowledge state, which is a subset of the 182 total items used in the customization of the ALEKS product. Although in principle it may be possible to use knowledge states in sophisticated ways for placement, the placement program at Illinois reduces an assessment to the proportion of items demonstrated, which is referred to hereafter as the score. We note that two students with the same score may have very different knowledge states just as any two students with the same score on another examination may have correctly answered substantially different subsets of the questions. Several subcategories of items are defined by an ALEKS assessment, and the (visual) correlation of these subcategories with grades is also examined in some cases. The minimum percentage for entry into PreCalc and BusCalc is 50% and into Calc and CalcExp is 70%. Although there are three years of data, the results are qualitatively and quantitatively very similar from year to year, and while we will present data from each of the years 2008, 2009, and 2010, for brevity we will not repeat every plot of data for every year.
From an experimental design perspective, many factors that would be desirable to control are practically impossible to manage. For instance, consistent instructors and common midterm exams from year-to-year would be good experimental design but are impractical due to standard difficulties such as finding adequately large space for common exams in very large courses, as well as uncontrollable events such as students retaining and distributing old exams. Hence the data are all presented as collected and utilized by the placement program, aggregated by course over various instructors and class sizes, with different grading procedures and examination questions.

Strict enforcement of placement cutscores is challenging. In some cases students may have remained in a course without achieving the minimum placement score on an assessment for various reasons. These students have been filtered out of the data analysis in all courses presented in this paper. In 2008, such students constituted less than five percent of students overall. Better automated detection subsequently improved enforcement to nearly 100%.

4. Evaluating Placement Mechanisms

A common goal of a placement program is to reduce the proportion of student failures and withdraws. As such, a reasonable way to assess a placement mechanism is by the decrease in students failing or withdrawing from a course (hereafter called the DFW proportion). Additionally, it is reasonable to expect that a higher placement score indicates a higher likelihood of passing, or alternatively a lower likelihood of failing. More generally, it may be useful to evaluate a mechanism based on student success where success may mean passing a course or perhaps passing the next course in a sequence. To investigate the connection between placement score and the proportion of students that pass or fail a course, it is useful to compute two conditional probabilities: for a given placement pivot, consider the conditional probability of passing of students with scores greater than the pivot and the conditional probability of failing for students with scores less than the pivot. A good placement mechanism should be increasing in the former and decreasing in the latter, with small variations due to sampling and noise.

4.1. College Algebra. A particularly interesting example is that of College Algebra at Illinois. Although placement is not enforced for College Algebra (the cutscore of 30 is only a recommendation since it is the lowest course offered), all incoming students are required to take the placement exam, so data are available for these students. Figure 1 shows the two conditional probabilities described in the preceding paragraph. The recommended placement score of 30 is a compromise between minimizing failures (overplacement) and underplacement since below 30 the proportion of students that fail increases sharply. Nearly all students in this course have scores less than 50 (in which case they would take PreCalc or another mathematics course). Conditionals for the other courses in our data set are similar (though with different cutscores) and are omitted for brevity.
4.2. Correlations between placement score and student outcomes. While it is not the purpose of a placement examination to predict students’ eventual grades, it is reasonable to expect some correlation between the placement mechanism and student performance. Unfortunately this is difficult to make precise in an unbiased manner, and many seem to approach this notion of evaluating a placement mechanism by calculating a correlation coefficient between student grades and placement scores. This is a flawed methodology for several reasons, of which we mention the following. (1) Students fail and withdraw from courses for many reasons unrelated to their initial knowledge, including problems in interpersonal relationships, problems due to financial or medical hardship, stresses from external factors such as other courses, extracurricular activities, and the challenges of living away from their long-time homes (particularly in the case of first-year students). These instances – obvious to any educator – introduce significant outliers, such as when a well-prepared student fails for other reasons, which drastically affect measures such as correlation coefficients. (3) Similarly, students may perform below their ability on placement examinations due to illness, stress, or other reason(s), which also introduces more outliers, because students are performing poorly on placement but nevertheless succeeding in their classes. Moreover, students may intentionally perform poorly on a placement examination so as to take a presumably easier course and there is no easy way to control for this. Students may also cheat, though there is not significant evidence of systemic cheating in the data presented in this paper. (4) Placement mechanisms (attempt to) assess readiness; they are not intended to precisely predict grades and do not incorporate any information regarding grading procedures, population-based effects on relative grades and curves due to a wide range of student abilities within the same course, or any other information pertaining to the manner in which grades are assigned. If instructors use attendance or other non-performance based measure to assign +/- grades this can also confound traditional correlation coefficients of initial knowledge and student outcomes.

Accordingly, a naively performed correlation between final grades and initial outcomes is a potentially very inaccurate measure of a placement mechanism since these exceptional students are statistical outliers and may have a dramatic effect on a correlation coefficient. Nevertheless, there should be a connection between student outcomes and placement scores for otherwise placement programs would be pointless. To avoid some of these confounding effects, one can instead look at all the students that earn a particular grade and compare the average placement score of those students to the average scores of students earning other grades. While this is a reasonable approach, there is an issue regarding the number of students earning a particular grade. For instance, depending on how grades are assigned, relatively few students may receive grades of + or -, and presumably more students will receive a grade of C than of a grade of B or D, especially if exams and other graded assignments are curved. Hence comparisons of average placement score for particular grade may be inconsistent and derived from subsets of data of significantly variable size. Moreover, it is
certainly not always the case that a student with more initial knowledge performs better in a course. There may be other students that devote more time and effort to the course and achieve a higher grade, and so expecting predictive differences between nearby grades such as B+ and A- is probably unrealistic without very careful and difficult experimental controls. Placement examinations traditionally do not attempt to measure such so-called intangible qualities of students. Nevertheless, our data sets are large and so we will present some data in this format graphically with the caveat that there is often substantial noise, but we will not give numerical estimates of correlation due to the possibilities of misuse and statistical invalidity. We will also group students together with nearby scores and look at the resulting grade distributions, which is less susceptible to such effects.

5. COMPARISON OF ALEKS AND ACT Math scores

5.1. ALEKS and ACT Math vs. Final Grades, Fall 2008. Figures 2, 3, 4, and 5 show the correspondence between ALEKS assessment scores and final grades in the placement courses for the Fall semester of 2008. The box plots give distributions of the ALEKS and ACT Math scores of students for each letter grade. Notice that in these figures the median scores (center lines of each box plot) and interquartile ranges (the box itself) are typically increasing for the ALEKS scores whereas the ACT Math score medians are more varied overall, particularly for courses other than PreCalc. The smallest course is PreCalc, so it being the noisiest is not unexpected; also, ACT Math scores were not available for as many students as ALEKS scores were. Nevertheless, each course has hundreds of students with both ALEKS and ACT Math scores. More precisely, in some cases the relative amount of +/- grades is significantly smaller and this may introduce noise. (The plots for other years are similar but ACT data was only obtained for 2008, so 2008 is used for both placement mechanisms in this section.)

**Figure 2.** PreCalc Fall 2008: ALEKS Assessments and Grades

(a) ALEKS Score Distribution per Grade (334 students)

(b) ACT Math Distribution per Grade (258 students)
Figure 3. BusCalc Fall 2008: ALEKS Assessments and Grades

(a) ALEKS Score Distribution per Grade (393 students)

(b) ACT Math Distribution per Grade (323 students)

Figure 4. Calc Fall 2008: ALEKS Assessments and Grades

(a) ALEKS Score Distribution per Grade (535 students)

(b) ACT Math Distribution per Grade (455 students)
5.2. Distributions of ALEKS Scores vs. Final Grades, Fall 2009. Plotting grade distributions for ALEKS scores reveals interesting correlations in the data. Students are grouped by ALEKS score into approximately 10 groups by merging adjacent scores into the same group (in so far as the data allows without splitting students having the same score), and the grade distribution of students with these scores are plotted in Figure 6, with grades corresponding to the following colors (bottom to top): red, F; yellow D-/D/D+; purple C-/C/C+; blue B-/B/B+; green A-/A/A+. The number of groups is arbitrary other than to maintain a minimal amount of students per group. From these figures, it is readily apparent that students with higher placement scores tend to have better grades on average. Moreover, not only does the proportion of failing students decrease as placement scores increase, so do the proportions of students scoring less than a B-. For non-terminal courses, it may be better to define success in a course as a B- or better rather than a C- or better, and from these figures it is clear that higher cutscores could be chosen to reduce the number of students failing to meet either definition of success.

We have also included two additional courses that are outside of the placement program but nevertheless have a large proportion of students that have taken ALEKS assessments (since all incoming students are required to take an assessment): College Algebra (Math 012) and Elementary Linear Algebra (for Business Students) (Math 125) in Figure 7. The latter course is restricted to students in the College of Business which has relatively stringent entry requirements and despite the name, BusCalc is not exclusively for students in the College of Business. The same general connection between better grades for higher ALEKS scores is present in these courses as well (data from 2010), even for the relatively small amount of data for College Algebra.

In all courses shown in Figures 6 and 7, generally as placement scores increase, so do the proportions of students with grades of C- or better, with one interesting exception. In PreCalc, having a score above 70% (which would place into courses sequentially beyond PreCalc), did not lead to higher grades for this \( \approx 10\% \) of students. This effect replicates in 2008 and 2010 (though less dramatically), and so warrants an explanation. Students scoring above 70% in PreCalc are apparently underplaced but nevertheless fail to perform as expected. The authors hypothesize that some students scoring 70 or above who elect to take PreCalc are expecting an easier course, and by failing to follow the course in the beginning (since the material is largely known to the student), the students eventually fall behind and perform poorly later in the course as they struggle to catch up. This could be somewhat specific to PreCalc at Illinois since it covers elementary derivatives and areas under curves (hence the name Preparation for Calculus rather than Precalculus). Another explanation is that these students may have had an incentive to cheat on their placement exam because College Algebra is not a credit-earning course at Illinois (for the purposes of graduation), and so these students may not have been able to place into PreCalc without assistance of some kind on the placement exam.
exam. We note that this does not appear to be the case in any of the other courses examined in this study, and is unique to this course, because the only course available to students scoring less than 50% is College Algebra (other than courses outside of the sequence leading to Calculus).

6. ALEKS Subcategories and Grades

ALEKS defines eight subcategories, each of approximately 20 - 50 items: Real Numbers, Equations and Inequalities, Linear and Quadratic Functions, Exponents and Polynomials, Rational Expressions, Radical Expressions, Exponentials and Logarithms, Geometry and Trigonometry. The distributions of subscores in the Fall 2009 semester are given in Figure 8. Note that Calc and CalcExp are similar, with the CalcExp students showing higher overall scores, and similarly for PreCalc and BusCalc.
Figure 6. Distributions for Placement Courses: ALEKS Assessments and Grades (2009). Each column represents the grade distribution of students with ALEKS score in the group, where the range of scores in the group is given below the column. The single number below the range is the number of students in the group.

Legend:
- A-/A
- B-/B/B+
- C-/C/C+
- D-/D/D+
- F/W

(a) PreCalc (402 students)  
(b) BusCalc (469 students)  
(c) Calc (654 students)  
(d) CalcExp (964 students)
Although (some of) the subcategories mirror the correlation of the total score to the final grade, there is significant correlation between some of the subcategories themselves. This is not unexpected because of the structure of ALEKS and the correlation between exposure to topics by students (i.e. high school algebra courses commonly cover both trigonometry and logarithms) in previous course work. Nevertheless, it may be possible to improve the placement program’s effectiveness by using the subcategory data in determining readiness for particular courses.

6.1. **Real Numbers.** The subcategory Real Numbers consists of the most basic items in Preparation for Calculus and dips into topics from algebra and intermediate algebra. In all the placement courses, this category was the least informative because nearly all students had all or nearly all of the items in the subcategory in their knowledge states. See Figure 8.

6.2. **Exponentials and Logarithms.** Students performed most poorly in this subcategory in all the placement courses (see Figure 8). The authors believe that poor performance in this category is reflective of a systematic weakness in the ability to manipulate logarithms and exponentials, confirming anecdotal observations of student difficulty understanding exponentials (because of composition in the exponent) and general lack of understanding of logarithms. On the other hand, this is the smallest subcategory and contains some of the most difficult items.
6.3. **Functions; Trigonometry.** In all courses, the subscores in the subcategories Linear and Quadratic Functions and Geometry and Trigonometry were the most informative of the distribution of final grades. It is curious that the trigonometry subcategory correlates highly with final grades in BusCalc, which does not use trigonometry (see Figures 9 and 10). The authors believe that mastery of items in the Geometry and Trigonometry subcategory are reflective of relative mathematical maturity among students in BusCalc. Note that the Geometry and Trigonometry subcategory is the largest, containing approximately 50 items.

**Figure 9.** BusCalc Fall 2009: Geometry and Trigonometry Subscore per Grade

![Box plot showing Geometry and Trigonometry Subscore per Grade for BusCalc Fall 2009.](image)

**Figure 10.** CalcExp Fall 2009: Geometry and Trigonometry Subscore per Grade

![Box plot showing Geometry and Trigonometry Subscore per Grade for CalcExp Fall 2009.](image)

6.4. **Rational Expressions; Radical Expressions; Equations and Inequalities, Exponents and Polynomials.** These subcategories also broadly correlate with performance, perhaps unsurprisingly given the content of the courses. The Exponents and Polynomials subcategory is the weakest of these four, though in for some courses it is fairly strong, while the other three are fairly evenly informative across courses. See Figures 11 and 12 for a few examples.
Students wishing to take Calc must pass the placement exam with a score of 70% even if they have passed the prerequisite course (PreCalc). This means that for some students who progressed through PreCalc to Calc there is an entry assessment (from placement into PreCalc) and essentially an exit assessment (from placement into Calc). Tracking these students allows the effectiveness of PreCalc as a preparatory course for Calculus to be measured by examining the aggregate knowledge acquisition of students in this population. The improvement in student knowledge resulting in the successful completion of PreCalc is shown in Figure 13.
Compare the distributions of the students entering Calc from Precal (Figure 13 (b)) with the students entering Calc (Figure 8 (c)) that did not take PreCalc. Students who went through PreCalc and entered Calc are similar overall (as measured by ALEKS) to their peers who went straight into Calc.

8. Discussion

Student populations in higher education are frequently changing, as is the level of preparation delivered by high school curricula. For these reasons and others described throughout this paper, ALEKS assessments were chosen as the placement mechanism at Illinois assuming that precise evaluations of student ability should function well for placement. It is possible that at some institutions this hypothesis is not valid. For instance, if an institution had one or more very demanding courses, it might be the case that work-ethic, perseverance, and an ability to cope effectively with stress and frustration are more predictive of student success than measures of initial knowledge. The data presented here from the University of Illinois indicates that ALEKS assessments are strongly linked to student performance in entry-level mathematics courses.

Data from the placement program in the years 2008 - 2010 indicate that the knowledge-measuring ability of the ALEKS assessment provides a strong foundation for placement. Initial student assessments in ALEKS correlate well with course grades in all courses examined, and the correlation is a significant improvement over the former placement score, the ACT Math exam. The relatively poor correlation of final grades with the ACT Math score is not surprising in light of well-known results for the SAT [2]. There are many possible reasons for the difference in placement effectiveness between ALEKS and the ACT Math exam, including the proximity of assessment to enrollment, which is within four months for ALEKS and likely more than a year for the ACT, because students typically take the ACT during the junior year of high school. To be fair, there are confounding factors other than just the examinations themselves. ACT scores recorded in a similar time period as the ALEKS scores (e.g. within a few months of the start of a course) may be a better indicator of student performance than ACT scores taken earlier. Other possible explanations include differences in examination execution: ALEKS is free-response, adaptive, designed to target specific items, and based on knowledge space theory; the ACT is a fixed-length examination with varying multiple-choice problem types chosen for high statistical correlations with the overall ACT Math score, normalized nationally [1]. The placement program at the University of Illinois was not designed to determine which of the many differences affect the correlation of initial score with final grade (or how and why they do); rather the placement program was designed primarily to reduce unsuccessful student outcomes.

Subcategory data from ALEKS allows the identification of population-wide strengths and weakness and also provides valuable data for instructors and course designers to determine which topics need greater emphasis. Subcategory scores often correlate well with final grade, depending on the course. Assessments...
from ALEKS yield more specific differentiation and locality, providing item specific data, as opposed to standardized exams, which are normalized nationally and difficult to interpret precisely. Comparison with other placement-specific examinations may be similarly interesting. Following students through PreCalc into Calc allows the measurement of knowledge gain as students progress through the program. These data were presented in aggregated form as changes in the distributions of scores of ALEKS subcategories. It is possible to determine the specific items acquired by students in a particular course, providing more data relevant to course design. This enables the evaluation of whether precalculus courses actually prepare students for calculus, in the sense of improving readiness.

Data from this study indicated that ALEKS assessments are a useful measure of readiness. Interestingly, the Preparation for Calculus domain was not designed for placement and the reduction of assessments to a score raises several questions. Many knowledge states produce the same score (i.e. have the same number of items but not necessarily the same set of items). Two students entering a trigonometry-heavy calculus course with the same score may have substantially different scores on the items concerning trigonometry, so the subcategory scores may be able to substantially improve placement outcomes by taking the items within knowledge states into account. This suggests that there may be substantial information loss in the reduction of a knowledge state to a score, and if so, it may be possible to use the additional information within knowledge states to place more precisely.

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