Implementation of Web-Based Adaptive Learning Software

Robert I. Puhak
Rutgers University – Newark
Department of Mathematics and Computer Science
101 Warren Street, Newark NJ 07102
rpuhak@rutgers.edu

Background

A number of years ago, the Math Department at Rutgers University – Newark investigated the possibility of a ‘drop in’ computer-lab emporium, intended to supplement and support the learning needs of students in lower-level Math courses. Students would use adaptive-learning software which, by design, focuses on specific areas of an individual student’s need and develop appropriate learning paths for them to achieve proficiency goals. The lab would be staffed by an instructor or teaching assistant, who would be available for additional help. A grant application was submitted to fund the effort, but it was unsuccessful. Without the required funding, the project was unable to move forward.

About one year ago, the Chancellor’s office relayed knowledge regarding the use of adaptive-learning software in Math courses within the university’s Louis Stokes Alliance for Minority Participation (LSAMP) program and at a local community college (Essex County College). They conveyed that the implementation led to successful outcomes in those programs and suggested consideration of implementing adaptive-learning software in courses offered by our Math Department, in order to enhance related learning experiences and increase the number of successful outcomes. Further investigation was conducted to learn more about the specific implementation of adaptive-learning software in programs that employed that technology, as well as the needs which the new approach was meant to address in each of those program’s application.

The LSAMP program on campus implemented the use of ALEKS, an acronym for “Assessment and Learning in Knowledge Spaces”, a web-based artificially-intelligent assessment and learning software. The software was provided to LSAMP students in Precalculus and Calculus ‘gateway courses’, which served as prerequisites for other courses that the students needed in order to successfully achieve their desired degrees. The students had been impeded by gaps in their proficiency in that prerequisite material. Use of the adaptive-learning software was intended to identify specific gap areas and provide the necessary instruction and practice for the students to achieve the required mastery.

Students worked remotely and no instructor or teaching assistant was incorporated into the course delivery. The administrator overseeing the implementation regularly tracked student progress through the system. If they found that a student was not keeping up to date with their work, the student was 'called in' and required to work on campus until work goals were achieved. It was reported that students that worked through the material, mastered the 'gap material' and then moved on successfully through their higher-level Math course requirements.

Essex County College used ALEKS in developmental Math classes that met four days a week. For three of those days, students worked on the system in a computer lab with an instructor. One day a week, students met in a classroom to discuss problems as a group, and met one-on-one with the course instructor to develop a short-term individual work plan and review to what degree previous individual goals had been achieved. It was reported that initial outcomes were less successful than those of traditional lecture-style classes, but that modifications to subsequent implementation resulted in sufficient improvements.

As the two cited implementations used ALEKS, it was desirable to investigate a model that used a different adaptive-learning software. In line with Rutgers recent membership to the Committee on Institutional Cooperation (CIC), a related implementation at one of the other CIC membership school systems (University of Wisconsin) was selected for investigation.

"Hawkes Learning System" web-based educational system is used for developmental Math courses at the University of Wisconsin – Sheboygan. Students meet in a computer lab, staffed by an instructor and a tutor-assistant. The tutor-assistant is available to help with questions on specific problems. The instructor answers questions as they arise, discusses approaches to doing Math problems, and works one-on-one with students to develop individual work and assessment schedules. They reported that student outcomes were similar to their lecture-style course. They see that however as an improvement, as students in the web-based course came from more challenged backgrounds regarding Math proficiency, relative to the students in the lecture-style course.

A recurring consensus surfaced among the feedback for all three models, indicating advantages of the adaptive-learning approach to enable a more active learning experience of "doing Math" relative to the more passive nature of "watching someone else do Math", generally associated with the traditional lecture-style model.

In Spring 2015, a decision was made to pilot adaptive-learning software in an instructor-led hybrid model within the lower-level courses of the Math Department at Rutgers University – Newark. Two Summer 2015 programs within the university, but outside of the Math Department, required instruction for students across three-different levels (Intermediate Algebra, College Algebra, and Precalculus) of Math proficiency in a condensed time frame and with just one instructor. Those circumstances presented a situation that could benefit from the advantages of an instructor-led hybrid model which incorporated adaptive-learning software, while enabling a 'pre-pilot' environment for evaluating that model's use in a full semester course. The experience and results were positive. Furthermore, they provided value regarding considerations in designing a full semester hybrid course to be used in Fall 2015.

Introduction

A hybrid learning model, implementing

i) adaptive-learning web-based software (ALEKS), used in and outside of the class environment (i.e., a computer lab),
ii) adapted, instructor-led teaching as needed in class and out of class,
iii) instructor/student e-mail communication outside of class, and
iv) frequent instructor review (using the web-based software) of student progress,

was utilized in a Fall 2015 pilot program at Rutgers University – Newark, involving four out of the semester's eleven sections of Intermediate Algebra Intensive (Math 104). That course was normally taught using a traditional in-class lecture-style model that also allowed some opportunity for working in small groups and for student work at the whiteboard. In the hybrid model, assessments, driven by the software system at calculated time intervals and related to an individual student's progress, established individualized 'learning paths' for each student, and enabled monitoring of student learning and retention. Regular instructor-issued quizzes and exams were used for course grading. Student feedback, regarding aspects of this hybrid model, was collected. Ultimately student performance results were compared with related results from traditional lecture-style class sections of the same course taught during that same semester.

All class periods were conducted in a computer lab, with a faculty instructor present and engaged, and each student at an individual computer, working through a group of problems customized (by the adaptive-learning software) for their own needs. As questions came up, the instructor would survey the room for other students with similar need. Related instruction was then presented in a format based on the number of students requiring help with that topic at that time, e.g. individual instruction, small group instruction ('mini-lectures'), or class lectures.

The instructor would also use the software system to frequently monitor student progress, enabling the instructor to determine a measure of the amount of work that a student had completed, as well as what individual problems that student had attempted, how many attempts were made, and which attempts were successful or not. Additionally, the instructor would meet with students individually to review their progress and develop personalized short-term and long-term action plans to learn and master course curriculum. Those individual plans were re-visited regularly via one-on-one meetings of the instructor with each individual student, during which short-term goal completion (or lack thereof) was assessed and new short-term goals were set.

Quizzes and one midterm exam were taken on a computer using the adaptive-learning software. A second midterm was given on paper. A paper exam was used because students would need to take the paper-based common final exam that is given to all students in Intermediate Algebra Intensive, whether they had taken the hybrid (adaptive-learning software) class or the traditional lecture-style class.

Three instructors taught with the hybrid model and met at least weekly as a group that semester to discuss their experience and share information, including areas of challenge and areas of success. Based on related experiences and observations, the hybrid model was slightly modified for future use. The implementation was expanded in Spring 2016 to include four of the five sections of Intermediate Algebra Intensive and three of the four sections of Intermediate Algebra (Math 105) being offered by the Math department that semester. The three instructors from Fall 2015 each taught one of the Spring 2016 classes that used the hybrid model. Four additional instructors were trained to each teach one of the other four sections that used the hybrid model.

Related data was collected from the Fall 2015 and the Spring 2016 implementations, up through the first midterm exam of Spring 2016[1]. Outcomes for the hybrid model were compared with outcomes from the traditional lecture-style course delivery model. Observations were made and conclusions were drawn from the results.

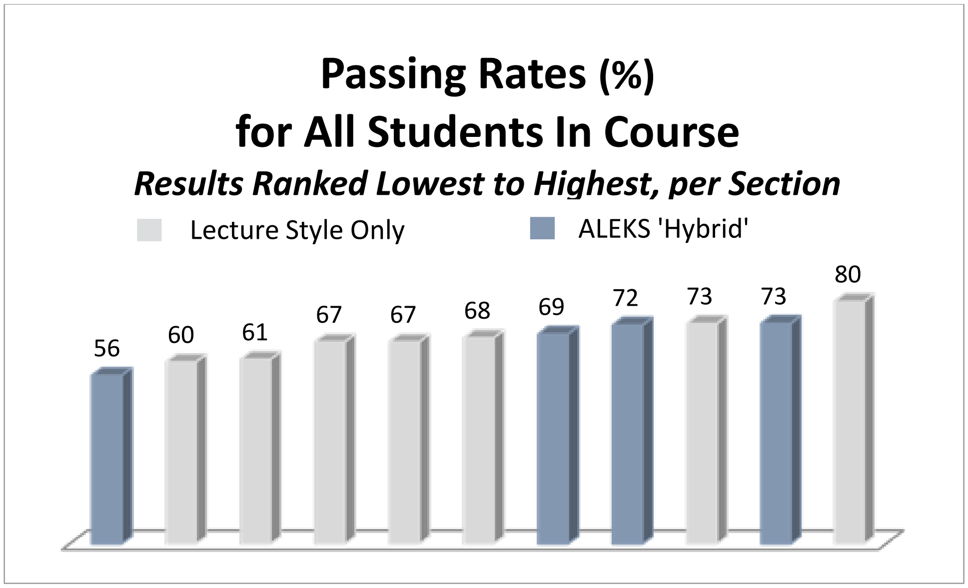
Results

Comparison Among All Sections of Math 104 – Fall 2015

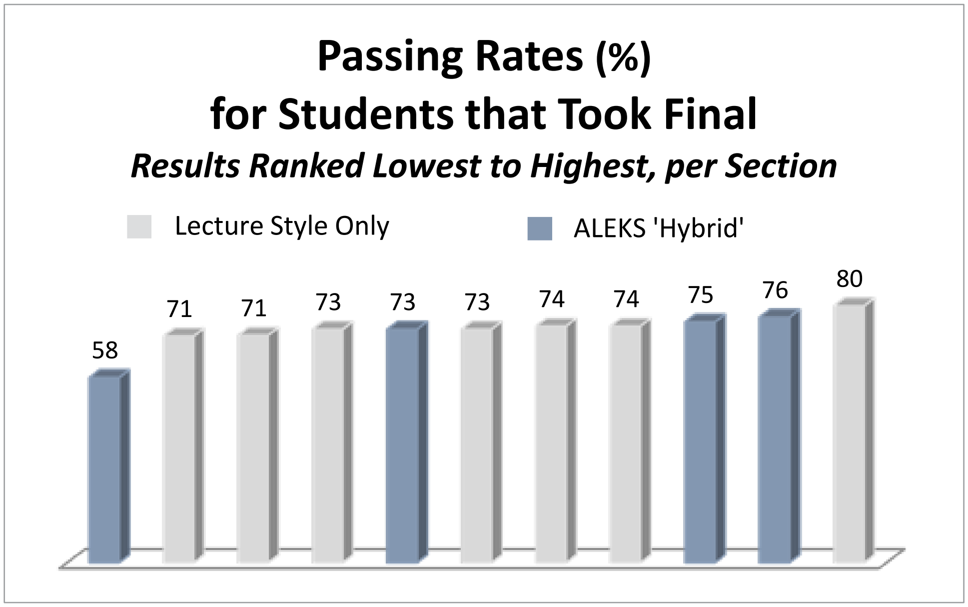
The two graphics in Figure 1 provide an initial snapshot regarding passing rates[2] for each of the Fall 2015 sections of Math 104.

[1] This paper was presented shortly thereafter, but the effort to collect related data continued throughout the remainder of that semester.

[2] Each student that passes the comprehensive final exam, passes the course; while each student that does not pass the final exam, does not pass the course.



a. All Students in Course



b. Students that Took Final Exam

Figure 1. Fall 2015 Final-Exam/Course Passing Rates for All Sections of Math 104

Each bar represents an individual section and indicates the passing rate for that section. The bars are arranged left to right in ascending order of pass rates. Gray bars are used for the traditional lecture-style class. Blue bars are used for the hybrid sections that implemented ALEKS adaptive-learning software.

Figure 1a depicts the data for all students in the course at the time of the final exam. Figure 1b depicts data for just those students that took the final exam. Note, although the vast majority of the students that were still in the course at the time of the final exam did take the exam, there was a small percentage of students that did not take the final exam.

Comparison of Each Instructor's Sections Over Time

Figure 2. Math 104 Pass Rates per Instructor from Fall 2013 thru Fall 2015

The graphics in Figure 2 each depict course passing rates for sections of Math 104 (ALEKS 'hybrid' or Traditional Lecture Style) that were taught from Fall 2013 through Fall 2015[3] by the instructors that used ALEKS in Fall 2015. Each of the three graphics shows the results for one of the three instructors. For each graphic, results are presented lowest to highest, left to right, with gray bars indicating lecture-style classes and blue bars indicating hybrid sections that implemented ALEKS adaptive-learning software.

Student Feedback – Fall 2015

Throughout the Fall 2015 semester, and across all four sections of the hybrid course, instructors regularly reported that unsolicited student feedback, regarding the use of adaptive-learning software, was positive. To facilitate a more structured approach for gathering and analyzing student feedback, questions were added to the surveys of the

[3] Modifications to the Math 104 final-exam format were made just prior to Fall 2013. With the intention of maintaining a consistent frame of reference in which to compare performance results for each section over time, it was decided to use results back through Fall 2013, as opposed to earlier semesters.

Student Instructional Rating Survey (SIRS)[4] system for each of the Fall 2015 Math 104 sections that used the hybrid course model.

The additional questions inquired about aspects of the hybrid course which were directly related to the use of the adaptive-learning software. Six of those questions were added to the 'rating scale'[5] portion of the survey and two questions were added to the 'open ended' portion of the survey. 48 of the 90 students that finished the course responded to the survey, yielding a 53% response rate, which is believed to be higher than the norm.

The open-ended questions, i.e.,

> *"If you could change anything regarding the use of ALEKS in this course, what would it/they be?"*
>
> *"Any other comments regarding the use of ALEKS in this course?"*

received varied responses, but there was no trending response that seemed to indicate a problem with the implementation of the adaptive-learning software and/or the hybrid-course model. The most common theme seemed to be related to the number and frequency of 'Knowledge Checks', i.e., system related assessments issued to determine retention of previously learned material.

The nature of free-form responses to the open-ended questions makes it impractical to present them in tabular form here. However, they can be viewed in Appendix A, which contains the results of the open-ended questions and the rating-scale questions for all four sections. Appendix A further contains an 'aggregate[6] profile' regarding the results of the rating-scale statements for all four sections. That aggregate profile is also presented in Table 1 here.

[4] Rutgers University's "Center for Teaching Advancement & Assessment Research" (CTAAR) regularly issues electronic surveys at the end of each semester (including Winter and Summer sessions) to every student in every class being taught during that semester. Students receive individual surveys for each course they are taking that semester. The surveys are anonymous, with no identifying material included in the results that are reported to the respective department and instructor.

[5] The SIRS surveys use two models of questions. The 'rating scale' method presents a statement that requires students to choose a numeral from 1 to 5, where "1" indicates "strong disagreement" with the presented statement and "5" indicates "strong agreement" with the statement. The 'open-ended' questions allowed for a free-form response.

[6] Aggregate data for the rating-scale feedback was calculated as follows: For a particular rating-scale statement and a specific rating-scale response (e.g. "3") to that particular statement, the number of those specific responses (e.g., the number of students that chose "3" for that particular statement) was tallied across all four sections, and the related sum was then recorded for that specific response to the particular statement. After each of possible responses for each of the questions was tallied and recorded, weighted averages were calculated for each of the six rating-scale statements.

Table 1. Aggregate Student Feedback to Survey Questions (Fall 2015 Math 104 ALEKS Sections)

Survey Questions & Results
Rating Scale Questions - "1 to 5"
"1"= Strongly Disagree "5"= Strongly Agree

Question	Average Response
The explanations provided by ALEKS were helpful in learning the required Math concepts.	4
Having an instructor in my ALEKS-based course substantially benefited my learning.	4
Using ALEKS enabled me to accomplish more work outside of the classroom than I would have been able to accomplish if this had been a traditional lecture-style course.	4
The increased independence in working and learning (enabled by using ALEKS) benefited my progress in the course.	4
Overall ALEKS was helpful in learning the Math concepts in this course.	4
In the future, if given the choice between an ALEKS-based Math course versus a traditional lecture-style Math course, I would choose the ALEKS-based Math course.	4

Spring 2016 Midterm Exam 1

As indicated earlier, the implementation of the hybrid model was expanded for a second semester of use[7]. At the time of the first midterm exam[8] data was gathered across all of the seven sections that used the hybrid model and included i) the percentage of work[9]

[7] In Fall 2015, the implementation involved four out of eleven sections of Math 104 and three instructors; in Spring 2016, the implementation involved four out of five sections of Math 104, three out of four sections of Math 105, and a total of seven instructors. These seven instructors included the three instructors from Fall 2015 and four other instructors that were teaching in the model for the first time. Those four new instructors received training from one of the instructors that had taught in the Fall 2015 pilot and in the pre-pilot sessions. That same Fall 2015 instructor had designed the hybrid model in use. The training occurred before and during the Spring 2016 semester, as well as outside of class and in class.

[8] The first midterm exam was given online using the ALEKS system, with which students already had experience taking assessments (quizzes). The course instructor was present to proctor the exam. Additionally, from the instructor's computer monitor, the instructor was also able to monitor the activity on each of the students' computer monitor.

[9] Percent work completed on the ALEKS system was measured by dividing i) the sum of the 'topics' "learned" and the topics "mastered" in that part of the course by ii) the total number of topics in that part of the course. ALEKS uses the term "learned" in association with a student's successful completion of three consecutive problems on the same topic. ALEKS uses the term "mastered" in association with a student's demonstration of retention regarding a "learned" topic, tested by presenting a problem on a "learned" topic during a "Knowledge Check" that is issued by the system at a later date. If the student fails to demonstrate retention on a given topic, the topic is then removed from the number of topics "learned", and is re-introduced to the student as a "Ready to Learn" topic. Conversely, if the student

completed by each student in that section at the time of their exam and ii) their percent score on the exam. Graphic profiles, containing related measures ('percent score on midterm exam' relative to 'percent topics completed') for each student, were compiled for each section of the hybrid course. Correlation coefficients between 'percent score on exam' and 'percent of total topics completed' were calculated for each class.

Appendix B contains individual graphic profiles for each of the seven sections, as well as each section's corresponding correlation coefficient. As a sample of those results, Figure 3 (which is Figure B1 from Appendix B) is presented here and depicts the profile for one of the seven sections (Math 104, Section 01).

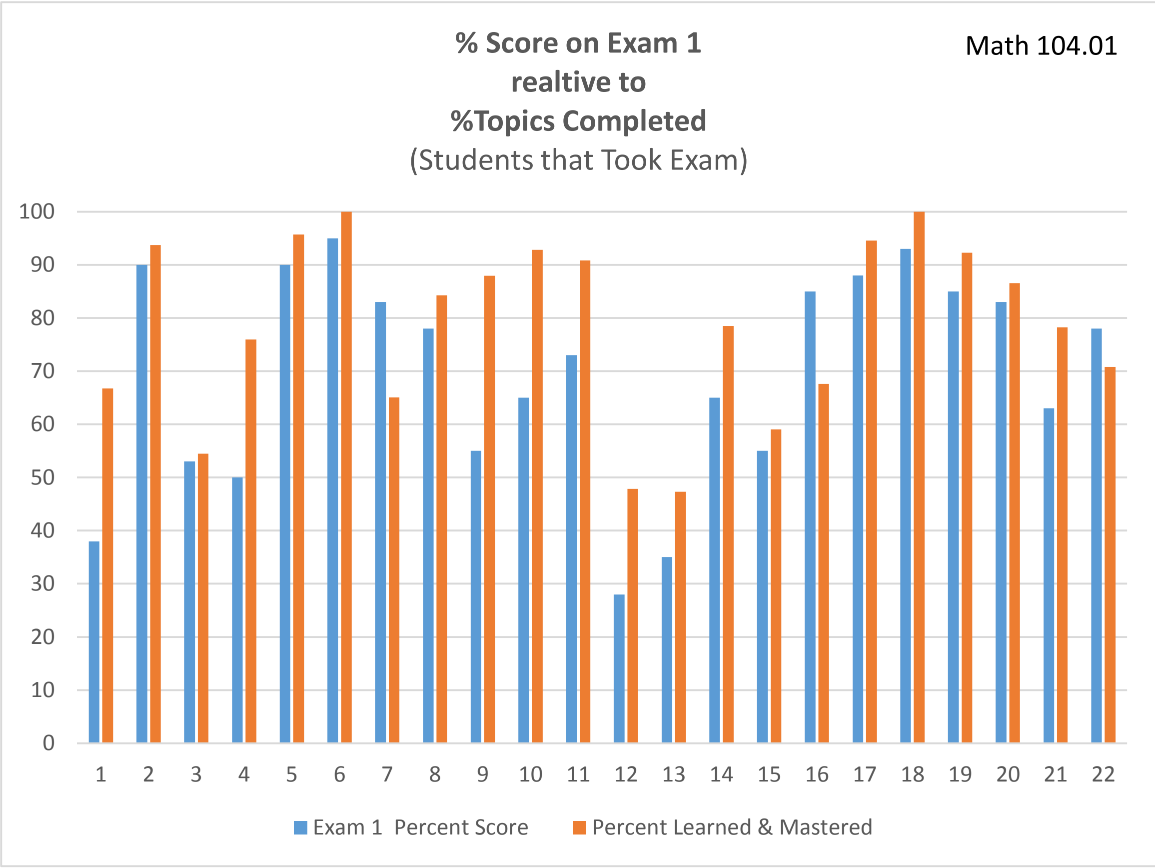


Figure 3. Spring 2016 – Midterm Exam Results
"Exam Results vs. Work Completed"
Math 104, Section 01, Correlation Coefficient $\cong$ 0.8
(each set of bars represents one student in the class)

demonstrates retention on a given topic, the topic is removed from the number of topics "learned" and moved to the number of topics "mastered".

Each pair/set of bars represents the individual results for a particular student. The blue bar corresponds to that student's percentage score on Exam 1; the red bar represents the percentage of topics learned or mastered by that student at the time of the exam.

Figure 4 presents the correlation coefficients (regarding topics learned/mastered and subsequent exam performance) for each of the sections, enabling visual comparison among the sections. Bars 1 thru 4 correspond to the four sections of Math 104. Bars 5 thru 7 respectively represent the three sections of Math 105.

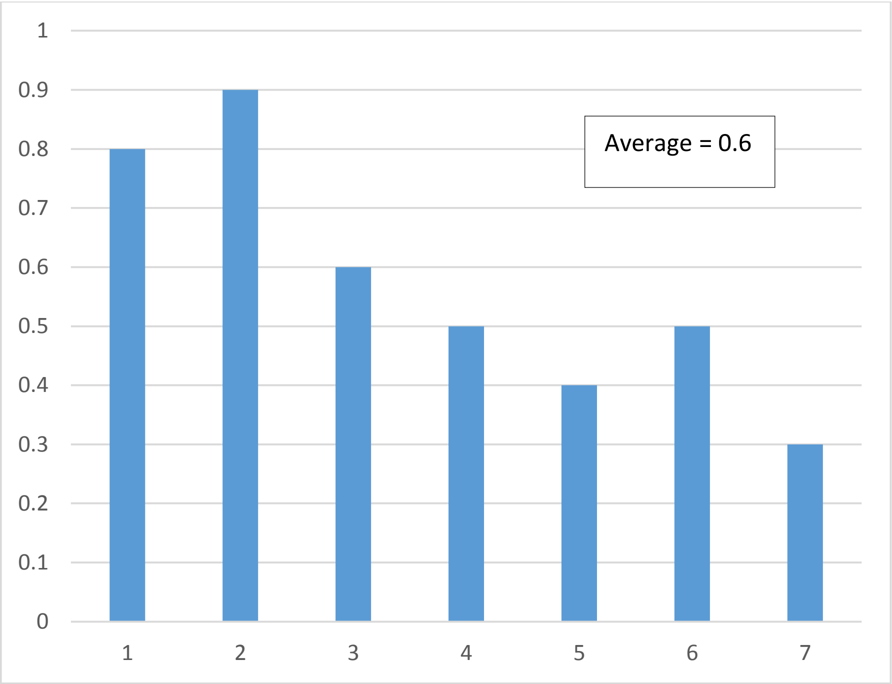


Figure 4. Correlation Coefficients of "Midterm Exam Score" to "Work Done" for Each Section – Spring 2016 Math 104 and Math 105

For each of the seven sections, an average exam score (average percent scores) was determined, as well as an average amount of topics learned/mastered (average percent topics completed). Figure 5 depicts related profiles for each of the seven sections.

The average exam score for a particular class is depicted by that section's blue bar, while the average amount of work completed (average percent topics learned or mastered) within that class is depicted by its red bar. Visual correlations between the two bars for a given section offer some perspective on the related relationship between work invested and subsequent performance. Yet the nature of the calculation warrants some scrutiny as discussed in the next section, "Observations".

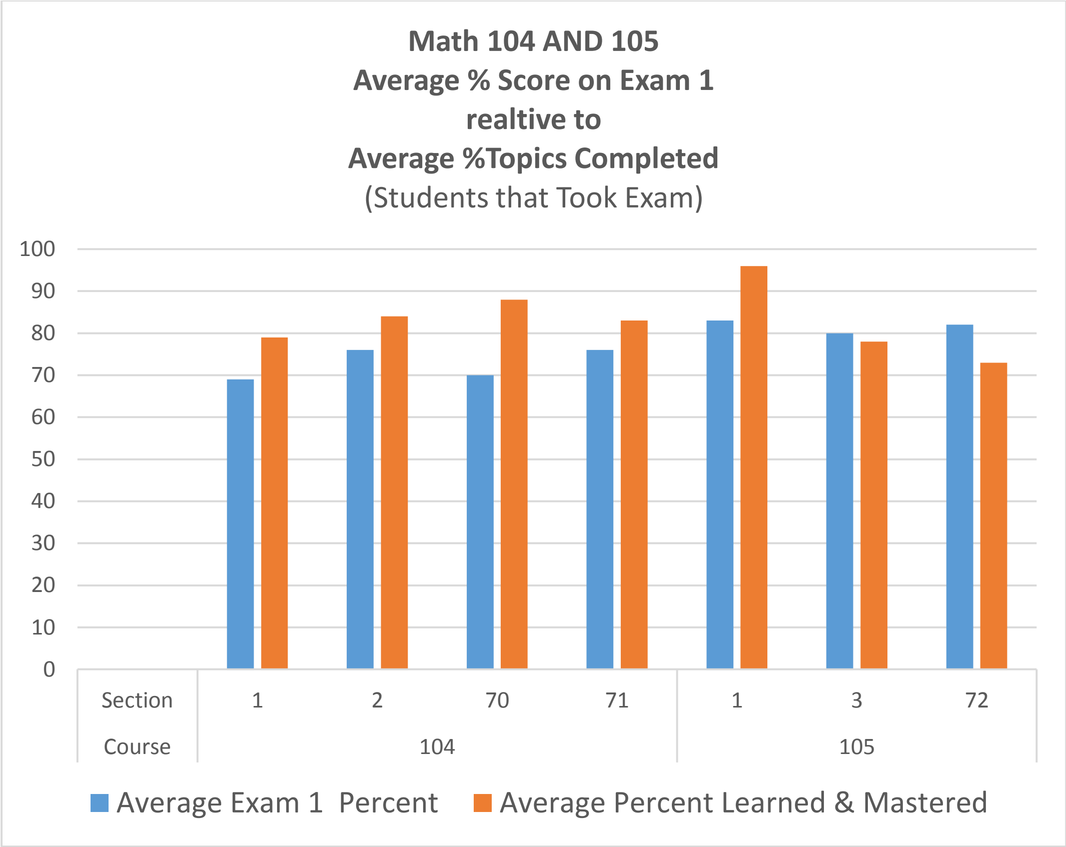


Figure 5. Spring 2016 – Math 104 and Math 105 – Midterm Exam Results re: "Exam Results vs. Work Completed" (each set of bars represents one class section)

Observations

Comparison Among All Sections of Math 104 – Fall 2015

Considering the outcomes for all students still in the course at the time of the final exam[10], Figure 1a indicates that the passing rates for the ALEKS hybrid sections generally trended higher than the sections using the traditional lecture-style format. At the same time, the figure shows that the lowest performing section used the ALEKS hybrid model. It is worth noting however that issues regarding 'an unusual lack of student engagement and response' became evident in that section from the first day of class and were reported continually through the semester.

[10] The underlying data for either graphic in Figure 1 does not include students that withdrew earlier in the semester.

In Figure1b, which reflects the passing-rate data for just those students that took the final exam[11], two of the ALEKS hybrid classes trended toward the top, one toward the middle, and one at the bottom. While that dynamic shows half the ALEKS sections experiencing higher-end outcome, it also indicates a broad range of outcomes.

In either case, if the highest and lowest outcomes were left out, the ALEKS hybrid sections would trend higher for passing rates (relative to the lecture-style classes), but would not appear to be far out of range with most outcomes of the lecture-style sections.

Comparison of Each Instructor's Sections Over Time

Figure 2 demonstrates that (over the period of Fall 2013 thru Fall 2015), per instructor, the performance results of their ALEKS hybrid class fell within the range of performance results for their lecture-style sections. For Instructors 1 and 3, the magnitude of the passing rate for their ALEKS hybrid section(s) was very near the magnitude of their highest passing rate for Math 104 during that period of time.

For Instructor 2, the magnitude of the passing rate for their ALEKS hybrid class, although within the midrange of passing-rate outcomes, was closer to the lower magnitude than the highest magnitude. (Perhaps also important to consider, as stated above, issues regarding 'an unusual lack of student engagement and response' became evident in that section from the first day of class and were reported continually through the semester.)

Student Feedback – Fall 2015

Table 1 exhibits results regarding the six rating-scale statements that addressed aspects of the ALEKS hybrid course, i.e.,

1. *The explanations provided by ALEKS were helpful in learning the required Math concepts*
2. *Having an instructor in my ALEKS-based course substantially benefited my learning*
3. *Using ALEKS enabled me to accomplish more work outside of the classroom than I would have been able to accomplish if this had been a traditional lecture-style course*
4. *The increased independence in working and learning (enabled by using ALEKS) benefited my progress in the course*
5. *Overall ALEKS was helpful in learning the Math concepts in this course*
6. *In the future, if given the choice between an ALEKS-based Math course versus a traditional lecture-style Math course, I would choose the ALEKS-based Math course*

[11] Again, of the students still registered for the class at the end of the semester, a small percentage of them did not take the final exam.

The table shows an average weighted mean of “4” out of “5” for each of the six statements, indicating that average student feedback was in agreement[12] with all six statements. That positive sentiment aligned with the unsolicited student feedback that the three Fall 2015 instructors regularly reported receiving throughout the semester.

The underlying data for Table 1 varies from student to student of course. That data is contained in Appendix A, as indicated earlier. Related data for two of the four ALEKS sections indicate that nearly every student in those two sections responded to all six statements as either “Uncertain”, “Agree”, or “Strongly Agree”, with the least responses being “Uncertain” and the majority of responses being either “Agree” or “Strongly Agree”. Across all six questions and across all students (that responded to the survey) from those two sections, there was just one response to just one statement indicating “Disagree”. There were no students from those two sections that indicated “Strongly Disagree” to any of the six statements.

The remaining two sections had a broader range of responses, ranging across all five options for feedback, i.e., from “Strongly Disagree” thru “Strongly Agree” (corresponding to numeric values 1 thru 5 respectively). Yet weighted averages for each statement, across those two sections, ranged from 3.46 (corresponding to somewhere between “Uncertain” and “Agree”) to 4.00, (corresponding to “Agree”).

As indicated in the “Results” section, student feedback to the two open-ended questions varied as would be expected, but there was no trending response that would indicate a problem with the implementation of the adaptive-learning software and/or the hybrid-course model. It seemed the most common theme had to do with student concerns regarding the number and frequency of Knowledge Checks issued by the system to determine retention.

Spring 2016 Midterm Exam 1

Figure 3 depicts “Exam Results vs. Work Completed” for each of the students in one of the seven classes that used ALEKS during Spring 2016. The graphic provides a direct visual comparison per student between i) the topics they completed (i.e., “topics completed” meaning those topics learned or mastered, as detailed in footnote #9 in the “Results” section) and ii) their performance on the course’s first[13] midterm exam. With some exception for individual students, visual inspection of the results and the related

---

[12] That part of the student survey asked students to respond to the rating-scale statements, by selecting a number aligned with the following key:

1- Strongly Disagree
2- Disagree
3- Uncertain
4- Agree
5- Strongly Agree

[13] Both Math 104 and Math 105 ultimately had two midterm exams. At the time this report was initially written and presented, just one midterm had been given. A subsequent report is expected to cover results of the second midterm exam and final exam.

correlation coefficient of 0.8 indicate that the amount of work a student completed in ALEKS corresponded to their performance on the exam.

Appendix B provides the profiles and related correlation coefficient for each of the seven sections. Subsequent correlation coefficients for each section vary. Figure 4 portrays those values side by side. They range from 0.3 to 0.9, with a mean average of ~0.6 and a median of 0.5. Bars 1 thru 4 represent the four sections of Math 104, while bars 5 thru 6 represent the three sections of Math 105. The results indicate a stronger correlation (i.e., between work completed in ALEKS and performance on exam) for Math 104 relative to Math 105. Correlation coefficients for the sections of Math 104 range from 0.5 to 0.9, with a mean average and a median both being 0.7. While correlation coefficients for the sections of Math 105 range from 0.3 to 0.5, with a mean average and a median both being 0.45.

Figure 5 illustrates the average exam score and the average percentage of work completed for each of the seven sections. Visual inspection suggests a strong correlation between amount of work completed in ALEKS relative to performance on the exam. That perception can be potentially misleading to some extent, when one considers the following.

For a given section, the unique set of bars for each student (one bar for performance on the exam and the other bar for percentage work completed) varies from each particular student to the next. For one student, percentage score on the exam may be lower than percentage of work completed. For another student, the effect may be reversed, i.e., percentage score on the exam may be higher than percentage of work completed. When averages are calculated for those two students, those contrasting numeric results can have a 'cancelling effect'. That potential effect could possibly produce a result in which it might falsely appear that percentage of work completed is close to percentage score on the exam. Hence a cautionary warning here for careful scrutiny and understanding of the underlying data when observing and interpreting those particular results.

Summary and Conclusions

Adaptive learning software was used within a hybrid model to teach some sections of Math 104 "Intermediate Algebra Intensive" and Math 105 "Intermediate Algebra". The specific product used was ALEKS. Classes were held in a computer lab. The hybrid model involved an instructor present and interactive in class at all times, and interactive with students online at various times outside of regular class. Related details are provided earlier in this document.

The model was implemented in four of the eleven sections of Math 104 during Fall 2015. Three instructors were involved in the effort. Use of the model was expanded in Spring 2016, involving the three original instructors and four additional instructors. The model was used for four of five sections of Math 104 and three of four sections of Math 105. Related data was collected for Fall 2015, and up through Exam 1 for Spring 2016. (A subsequent report is expected to cover the remainder of Spring 2016.)

Results from the hybrid model were compared with results from the traditional lecture-style classes for Fall 2015. Although overall pass rates for the hybrid and traditional lecture-style classes were generally within the same range, the hybrid model seemed to 'trend somewhat higher' within the range, yet also had the section with the lowest pass rate. It was noted however that, that particular section had 'student engagement issues' (detailed earlier in this document) from the first day of class and throughout the semester.

Pass rates of the Fall 2015 implementation were compared per instructor for the previous two years. Their pass rates using ALEKS were in line with their pass rates using a traditional lecture-style model, yet their pass rates using ALEKS generally trended toward the higher end. Student feedback, regarding the use of ALEKS, was collected through a survey at the end of Fall 2015. In general, response was definitively favorable.

During Spring 2016, data regarding performance on the first midterm exam was compared with work completed in ALEKS up to that point in the semester. Evaluation of results was conducted for each section, at the level of each individual student within a given section. In general, positive correlation was exhibited between work completed and performance results on the midterm exam, but varied across sections. Correlation was stronger overall for Math 104, relative to Math 105.

Data for remainder of Spring 2016 will be collected, reviewed, and analyzed. Next steps include investigation of other adaptive learning software on the market. In the long term, related options include i) commit to current hybrid model using adaptive-learning software, ii) pilot related product(s), or iii) return to traditional lecture-style model.

In regards to any potential commitment to the current hybrid model using adaptive learning software, considerations will be made regarding implementation of videos. Advantages include further enhanced instruction outside of the classroom. Disadvantages include increased cost for students and some students report that additional content-delivery can become excessive and confusing at times.

Acknowledgements

- Douglas Walcerz, Vice President of Planning, Research and Assessment, Essex County College
- Janette Miller, Senior Lecturer, Administrative Program Manager, University of Wisconsin-Sheboygan
- Alec Gates, Executive Director of Garden State Louis Stokes Alliance for Minority Participation (GS-LSAMP) program
- John Gunkel, Vice Chancellor of Academic Programs and Services, Rutgers University – Newark
- Rutgers University – Newark
- ALEKS – McGraw-Hill Education

<u>Appendix A:</u> Student Feedback from Additional SIRS Survey Questions - Math 104 with ALEKS – Fall 2015

<u>Section 01</u> *(10 responded; 24 students finished course; 26 students started course)*

	Strongly disagree 1	Disagree	Uncertain	Agree	Strongly agree 5		
25. The explanations provided by ALEKS were helpful in learning the required Math concepts.	0	0	1	2	7	0	4.60
26. Having an instructor in my ALEKS-based course substantially benefited my learning.	0	0	1	2	7	0	4.60
27. Using ALEKS enabled me to accomplish more work outside of the classroom than I would have been able to accomplish if this had been a traditional lecture-style course.	0	0	1	2	7	0	4.60
28. The increased independence in working and learning (enabled by using ALEKS) benefited my progress in the course.	0	0	1	3	6	0	4.50
29. Overall ALEKS was helpful in learning the Math concepts in this course.	0	0	1	2	7	0	4.60
30. In the future, if given the choice between an ALEKS-based Math course versus a traditional lecture-style Math course, I would choose the ALEKS-based Math course.	0	0	1	0	9	0	4.80

If you could change any anything regarding the use of ALEKS in this course, what would it/they be?

- Nothing
- No more knowledge checks
- Knowledge Check , it takes you back way too much
- show work so we get partial credit.
- Nothing
- Knowledge test,
- I wouldn't change anything about the ALEKS course.
- nothing
- I wouldn't change a things.
- It is essential to decrease the number of topics because it does not give us the chance to master a topic because we know that we must finish multiple questions in a timely manner.

Any other comments regarding the use of ALEKS in this course?

- none
- It's awesome I hope to use this in my Math 109 class!!
- I liked it
- Good program.
- good course.
- none
- Nope!
- Nope

Section 02 *(14 responded; 26 students finished course; 27 students started course)*

	Strongly disagree 1	Disagree	Uncertain	Agree	Strongly agree 5		
25. The explanations provided by ALEKS were helpful in learning the required Math concepts.	0	3	2	4	5	0	3.79
26. Having an instructor in my ALEKS-based course substantially benefited my learning.	0	1	5	1	7	0	4.00
27. Using ALEKS enabled me to accomplish more work outside of the classroom than I would have been able to accomplish if this had been a traditional lecture-style course.	0	2	6	1	5	0	3.64
28. The increased independence in working and learning (enabled by using ALEKS) benefited my progress in the course.	0	3	4	1	6	0	3.71
29. Overall ALEKS was helpful in learning the Math concepts in this course.	1	1	3	1	8	0	4.00
30. In the future, if given the choice between an ALEKS-based Math course versus a traditional lecture-style Math course, I would choose the ALEKS-based Math course.	2	1	3	2	6	0	3.64

If you could change any anything regarding the use of ALEKS in this course, what would it/they be?

- Less redundant questions and building access in getting feedback from users.
- Maybe not make the knowledge checks so frequent lol.
- Aleks should let you work at your own pace , Having a time line or a due date, that is too stressful. Also Aleks could show videos on the topic.
- number of questions on the knowledge checks
- They give too many knowledge checks and I would like them to only come once an awhile instead of every 4 hours.
- When we wouldn't understand something on Aleks it would only have one explanation so it didn't help. Sending us back if we do bad on a knowledge check wasted time a I still didn't understand the material sometimes.
- Nothing
- To have less knowledge checks
- calculators should be allowed at all time. The use of a calculator can give more confidence with the final result of a problem

Any other comments regarding the use of ALEKS in this course?

- The Aleks system was a good learning tool, but could use more changes in the future.
- It was a great source of helping me learn.
- The use of aleks in this course works incredibly well with the professor in the room to help maintain students in the right track so they do not procrastinate too much and not fall behind. I would definitely take an aleks based course over the lecture style, because I fail to keep up in a traditional lecture.
- Good Software

Section 04 *(13 responded; 22 students finished course; 22 students started course)*

	Strongly disagree 1	Disagree	Uncertain	Agree	Strongly agree 5		
25. The explanations provided by ALEKS were helpful in learning the required Math concepts.	2	1	3	2	5	0	3.54
26. Having an instructor in my ALEKS-based course substantially benefited my learning.	3	1	1	1	7	0	3.62
27. Using ALEKS enabled me to accomplish more work outside of the classroom than I would have been able to accomplish if this had been a traditional lecture-style course.	2	1	2	3	5	0	3.62
28. The increased independence in working and learning (enabled by using ALEKS) benefited my progress in the course.	2	3	0	3	5	0	3.46
29. Overall ALEKS was helpful in learning the Math concepts in this course.	2	1	2	1	7	0	3.77
30. In the future, if given the choice between an ALEKS-based Math course versus a traditional lecture-style Math course, I would choose the ALEKS-based Math course.	4	0	1	2	6	0	3.46

If you could change any anything regarding the use of ALEKS in this course, what would it/they be?

- I would probably limit the amount of problems per topic. It would get stressful because I would enter the answer wrong by mistake , even though I thoroughly knew the topic, and it would cause me to be on that one topic for an hour sometimes .
- Going over more of the problems
- Aleks is a great help!
- Computer setting
- Some topics do not go in depth enough when explaining how to do them. This makes learning topics difficult especially when there was over 400 topics to be learned in just one semester. Students are not trying to learn the topics at that point and they are just trying to get through them.
- Nothing
- I would not make it an online course
- Nothing
- Nothing
- the explanations are awful

Any other comments regarding the use of ALEKS in this course?

- nope
- None
- n/a
- I believe the use of ALEKS will help any student struggling with math

<u>Section 07</u> (11 responded; 18 students finished course; 22 students started course)

	Strongly disagree 1	Disagree	Uncertain	Agree	Strongly agree 5		
25. The explanations provided by ALEKS were helpful in learning the required Math concepts.	0	0	2	4	5	0	4.27
26. Having an instructor in my ALEKS-based course substantially benefited my learning.	0	0	1	4	6	0	4.45
27. Using ALEKS enabled me to accomplish more work outside of the classroom than I would have been able to accomplish if this had been a traditional lecture-style course.	0	0	0	4	6	1	4.60
28. The increased independence in working and learning (enabled by using ALEKS) benefited my progress in the course.	0	0	3	2	6	0	4.27
29. Overall ALEKS was helpful in learning the Math concepts in this course.	0	1	2	3	5	0	4.09
30. In the future, if given the choice between an ALEKS-based Math course versus a traditional lecture-style Math course, I would choose the ALEKS-based Math course.	0	0	2	4	5	0	4.27

If you could change any anything regarding the use of ALEKS in this course, what would it/they be?

- Nothing.
- Make the Knowledges less time consuming.
- Aleks was a good system for learning, however the program itself is extremely time consuming.
- add a textbook to the course in conjunction with the ALEKS material
- N/A
- If they gave more explanations per topic rather than just one
- If I could change anything regarding the Aleks app I would give different ways to do a problem, considering the textbook shows you a different way to do problems that Aleks did not show. That would confuse anyone whose use to learning something a certain way. I would also make it an option where you could save your knowledge checks just like you are able to do with your practice quizzes.

Any other comments regarding the use of ALEKS in this course?

- Sometimes I got the right answer but ALKES told me I got it wrong.
- N/A

AGGREGATE OF FOUR SECTIONS *(48 responded; 90 students finished course; 97 students started course)*

	Strongly disagree	Disagree	Uncertain	Agree	Strongly agree		
25. The explanations provided by ALEKS were helpful in learning the required Math concepts.	2	4	8	12	22	0	4.00
26. Having an instructor in my ALEKS-based course substantially benefited my learning.	3	2	8	8	27	0	4.13
27. Using ALEKS enabled me to accomplish more work outside of the classroom than I would have been able to accomplish if this had been a traditional lecture-style course.	2	3	9	10	23	1	3.96
28. The increased independence in working and learning (enabled by using ALEKS) benefited my progress in the course.	2	6	8	9	23	0	3.94
29. Overall ALEKS was helpful in learning the Math concepts in this course.	3	3	8	7	27	0	4.08
30. In the future, if given the choice between an ALEKS-based Math course versus a traditional lecture-style Math course, I would choose the ALEKS-based Math course.	6	1	7	8	26	0	3.98

<u>Appendix B</u>: Individual Student Profiles per class/section, Spring 2016, First Midterm Exam

Note the following:

- one graph exists for each class, i.e., section of course
- each section's graph shows profiles for each of the students (in that section) that took the final exam
- each student profile is comprised of two bars
  - Blue bar indicates a student's percentage score on Exam 1
  - Red bar indicates percent of material learned and mastered*, relative to the total material in that part of the course
- Correlation Coefficient for each section is
  - Indicated in the graph's 'figure title'
  - Measure of correlation between Exam Score and Material Learned/Mastered
  - Calculated by Excel's CORREL() function

* Students work through a number of topic areas as determined by the adaptive-learning software. As they 'learn' a topic, they move onto the next topic(s). After certain intervals of time determined appropriate by the adaptive-learning software, students are assessed for 'mastery' of the topics that they have learned. If they do not show mastery of a topic, then the system removes that topic from the system's list of learned topics and requires the student to 're-learn' the topic and, later, re-assesses them again for mastery of that topic. At the time of the exam, for each student, the sum of their topics learned and their topics mastered was divided by the total number of topics in that part of the course (upon which the exam was based) to produce the percentage of topics learned and mastered for that student (depicted by red bar).

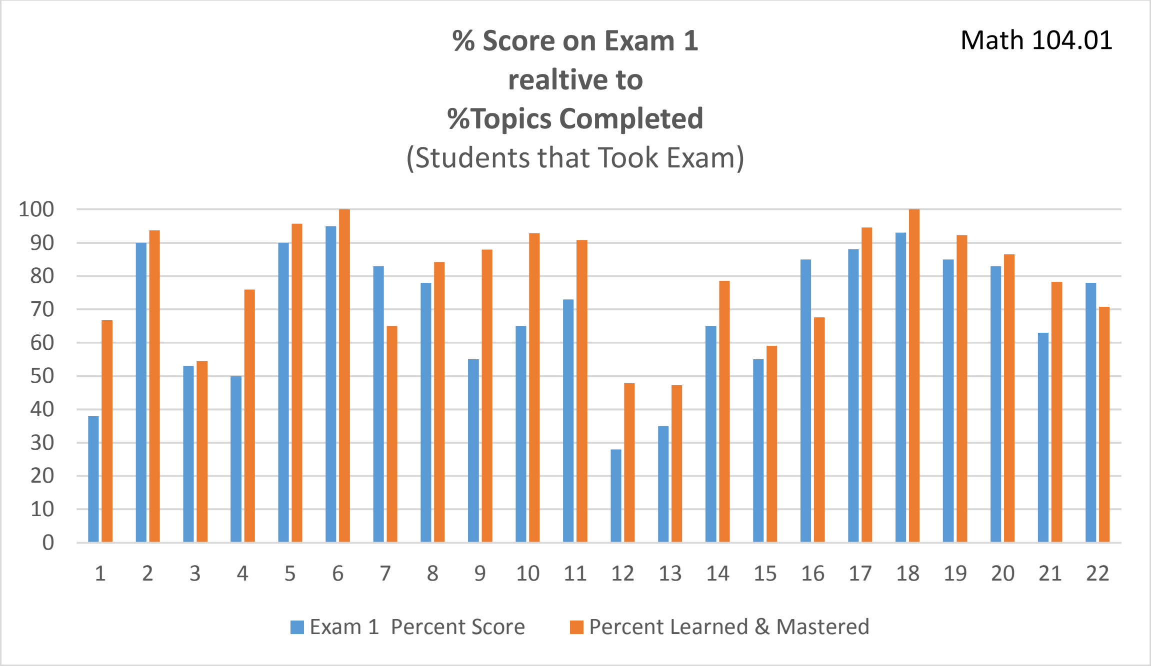


Figure B1. Math 104, Section 01 (Correlation Coefficient≅ 0. 8)

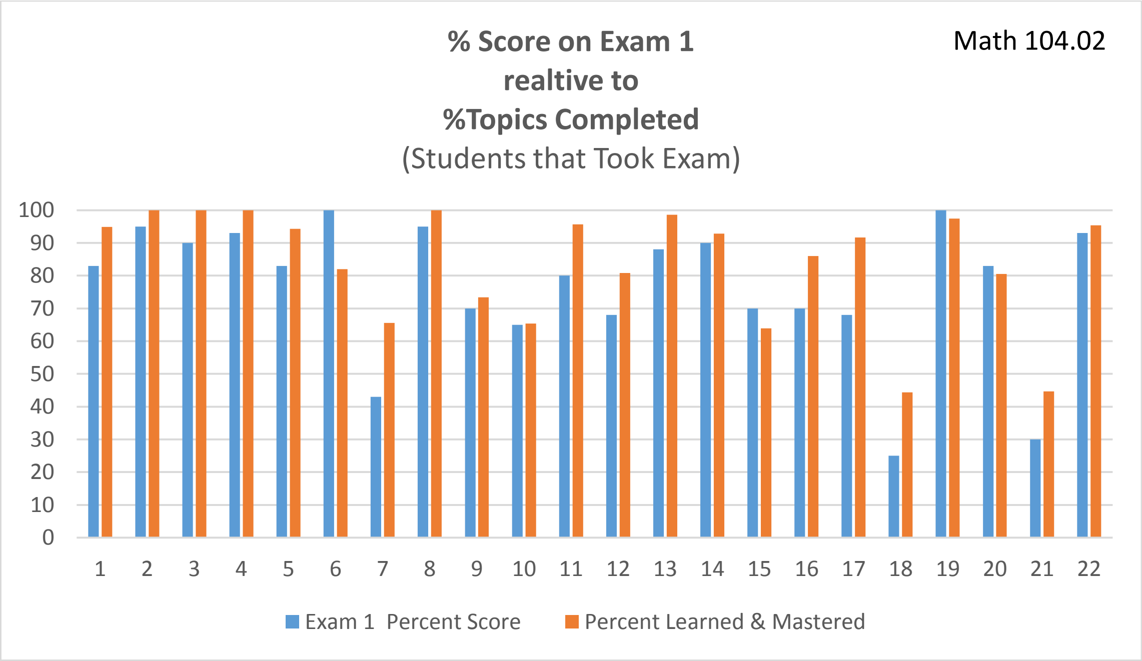


Figure B2. Math 104, Section 02 (Correlation Coefficient≅ 0. 9)

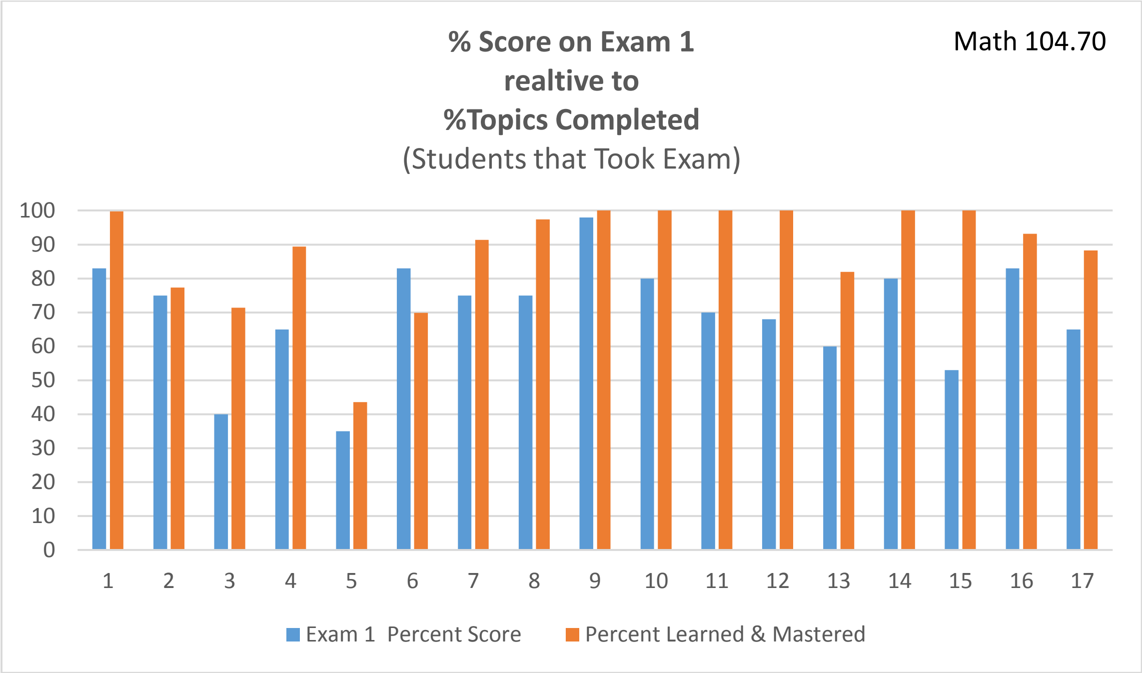


Figure B3. Math 104, Section 70 (Correlation Coefficient≅ 0. 6)

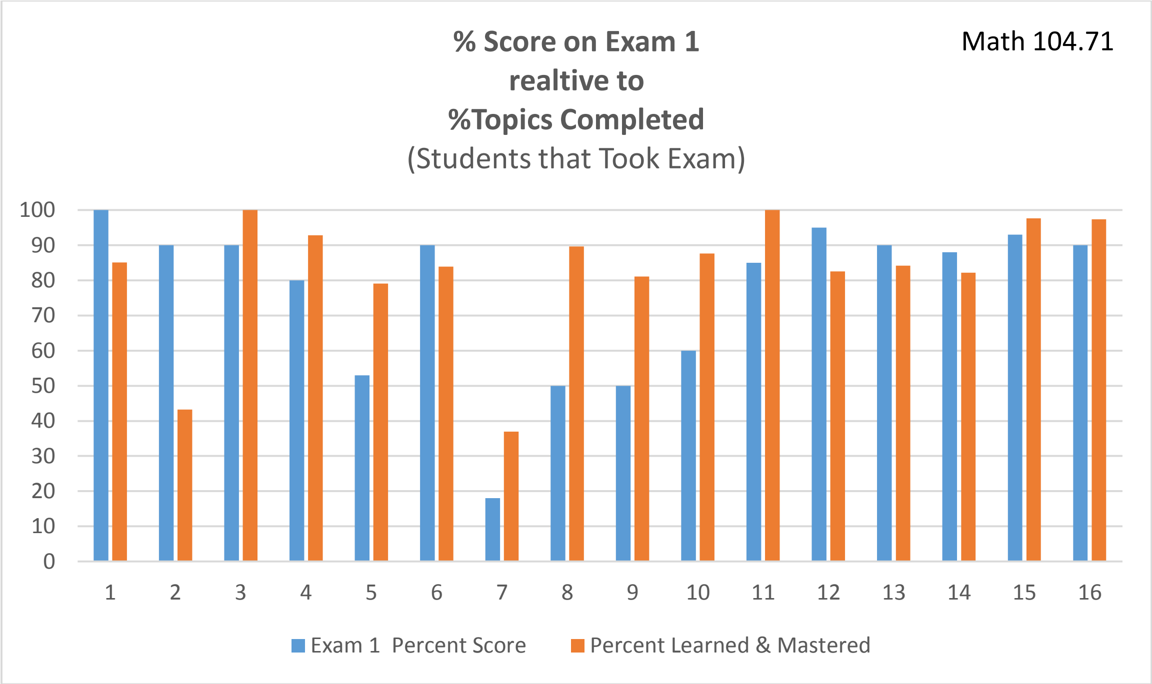


Figure B4. Math 104, Section 71 (Correlation Coefficient≅ 0. 5)

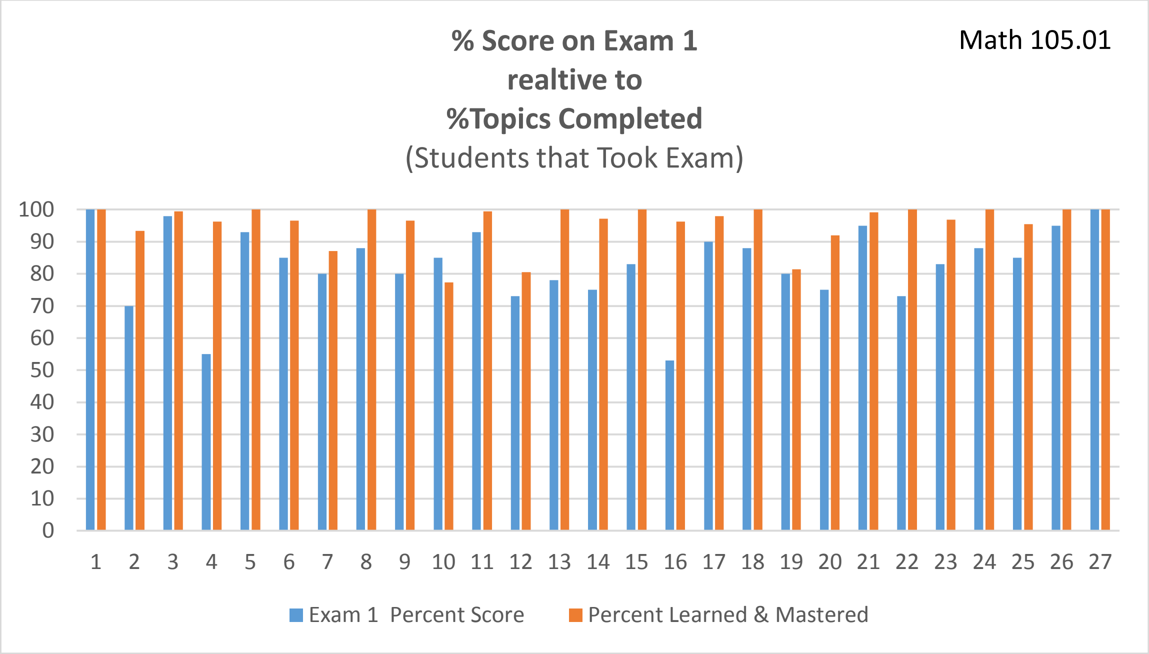


Figure B5. Math 105, Section 01 (Correlation Coefficient≅ 0. 3)

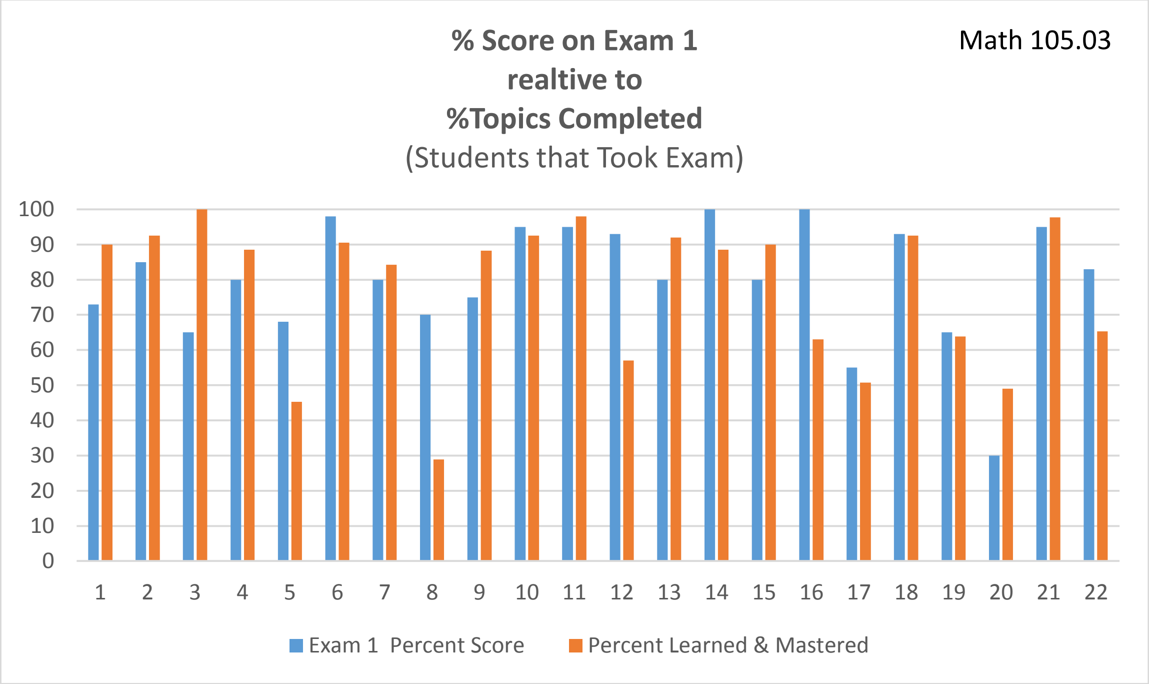


Figure B6. Math 105, Section 03 (Correlation Coefficient≅ 0. 5)

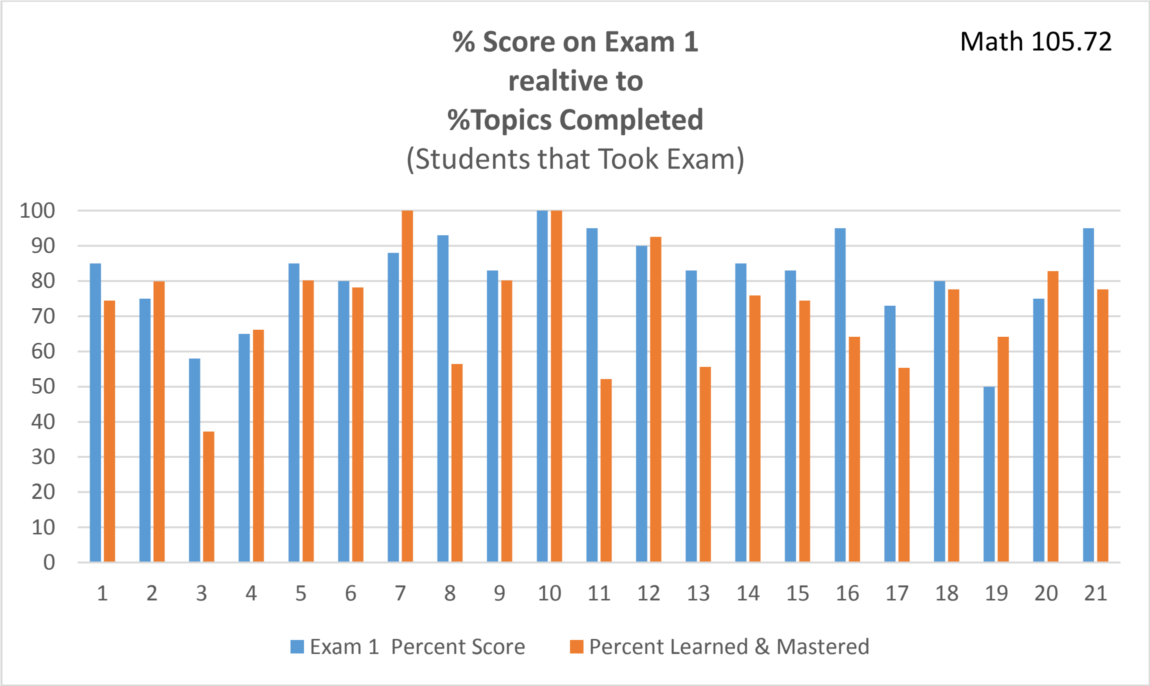


Figure B7. Math 105, Section 72 (Correlation Coefficient$\cong$ 0.4)