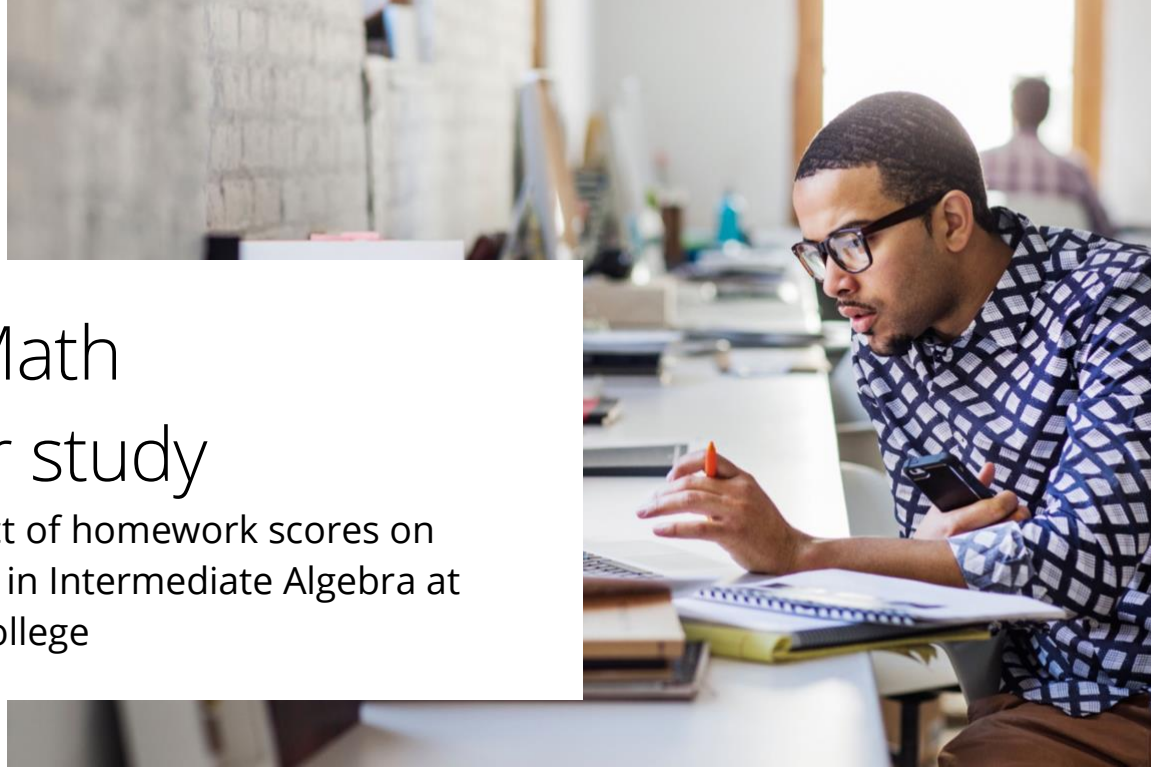

MyLab Math educator study

Examines impact of homework scores on student success in Intermediate Algebra at Riverside City College

Key findings:

- Students earning higher MyLab™ homework scores had better exam and course scores.
- Students scoring at least 80% on MyLab homework earned an average of 11 percentage points higher on exams, final exams, and course scores.
- The final course pass rate for students earning at least 80% on MyLab homework was 27 percentage points higher than for students earning less than 80% on homework.

Setting

Riverside City College (RCC) in Riverside, CA, is one of three colleges in the R iverside Community College District. Serving more than 28,000 students, RCC provides students with a wide range of choices including associate's degree programs, transfer to a four-year college or university, and career certificates that prepare them to enter the workforce. In the 2016–2017 academic year, approximately 57% of the student population were female, 79% were minorities, and 19% were first-time, degree-seeking freshmen.

School name: Riverside City College, Riverside, CA

Course name: Intermediate Algebra

Course format: Face to face

Course materials: MyLab Math for *Intermediate Algebra* by Martin-Gay; *The New Science of Learning* by Doyle and Zakrajsek; *Intermediate Algebra (A Concept Map Approach)* by Nabours and Dawson

Timeframe: Fall 2016–Spring 2017

Educator: Kathy Nabours, Associate Professor

Results reported by: Julie Labbiento, Pearson Customer Outcomes Analytics Manager

About the course

Intermediate Algebra is a five-credit course, designed to prepare students for the study of higher level mathematics. Coverage begins with a deeper exploration of concepts introduced in the Elementary Algebra course, including real numbers and variables in polynomials, fractions, linear and quadratic equations, systems of equations, inequalities, exponential and radical expressions, absolute value, factoring, graphing and word problem applications. Additional new topics include: logarithms, exponential equations, systems of linear and nonlinear equations, Cramer's Rule, the Binomial Theorem, the complex number system, and sequences and series.

In addition to the MyLab Math access code, the book *The New Science of Learning* by Terry Doyle and Todd Zakrajsek (Stylus Publishing ©2013) must be purchased. A basic calculator is allowed for the course.

Challenges and Goals

In response to the traditionally low success rates in mathematics at the community college level nationwide, Professor Kathy Nabours says that RCC faculty decided to pilot their New Science of Learning Project, inspired by practices shared in The New Science of Learning by Doyle and Zakrajsek, which discusses how neuroscience research can inform practice in education. In addition to restructuring their course objectives and utilizing MyLab Math, they decided to incorporate the book directly into their Intermediate Algebra course with hopes that they could improve learning and student outcomes in the course by teaching the students to recognize how their brains learn and, in particular, the value of doing homework.

Implementation

The project contains two main components: (1) the restructuring of the course objectives and (2) the incorporation of practices centering on how the brain accepts new information, synthesizes it, and recalls it when needed. Nabours says that the instructors involved in the project aim to motivate and inspire their students to learn the mathematics while breaking down the barriers to learning that so many students believe exist.

All sections of the course in the project use a common syllabus, materials, exams, major worksheets, and final exam, as well as common rubrics for grading exam problems. Common homework assignments are created in MyLab using a coordinator course. All instructors utilize *The New Science of Learning* as required student reading, and discussions take place in each course to reinforce how the contents apply to learning mathematics. Nabours says, "We make the assumption that any student can learn math and that any student can get 100% on the assignments if they try."

Course structure

Nabours says that the first step in the project was to rearrange the structure of the topics in the course to wrap the course around two large concepts: Solving Equations & Inequalities and Functions & Graphing. Chunking the curriculum in this manner makes it easier for students to learn, she believes. Nabours and colleague, Shelly Dawson, created *Intermediate Algebra (A Concept Map Approach)*, a PDF workbook for the course that maps the concepts required for mastery directly to daily lessons within the workbook.

While the prerequisite for Intermediate Algebra is successful completion of Elementary Algebra or a qualifying score on the placement exam, faculty recognize that review at the beginning of the semester is necessary. Nabours shares in her course syllabus that she expects to devote the first three weeks of the semester and the first exam primarily to review, but that she does not have time to cover the prerequisite material in detail. In order to be successful, students are encouraged to do extra work in these prerequisite skill areas before moving forward.

The course is taught in a traditional format, with lots of time for discussion and activities that support learning. Students have an abundance of resources for the course. In addition to the concept map workbook, instruction and activities in the course are derived heavily from the book *The New Science of Learning*, which students are required to purchase and bring to class daily. Students also purchase access to MyLab Math and Nabours notes that the students' MyLab Math account gives them access to a textbook, *Intermediate Algebra*, 6th edition, by Martin-Gay. She shares in her syllabus that the MyLab account allows students to access homework assignments, the Study Plan, lecture videos, and other resources for the course. Inside a Course Resources link in the MyLab shell, students are provided with *Intermediate Algebra (A Concept Map Approach)* containing typed lesson notes for each section, as well as video lectures. Students are expected to read the lesson notes prior to class and watch the video lectures if they need more clarification. Finally, several worksheets are provided in class to help students master the material.

> "The more practice you have, the stronger your neural pathways will become, and the better you will learn and remember the material for your next course!"
>
> — Kathy Nabours, Riverside City College

Neurological connection

In the second component of RCC's New Science of Learning Project, students are exposed to knowledge about how their brains learn and, ultimately, the habits that will make learning mathematics easier for them.

Students read *The New Science of Learning* and discuss it in class alongside the mathematics. Says Nabours on her syllabus, "The more practice you have, the stronger your neural pathways will become, and the better you will learn and remember the material for your next course!"

In early semesters of the project, Nabours tracked such things as the number of contact periods per week and whether the course was offered online. She discovered that four-day courses, with homework assigned more often, had the highest success rate, followed by online courses, three-day courses, and two-day courses, respectively. She postulated that student homework should be distributed as close to daily as possible to yield the largest learning advantage for the student. Latter semesters saw efforts made to schedule homework for all courses in a more frequent way, rather than having homework due only once or twice per week.

Homework assignments consist of 25–30 problems per lesson, with the first five questions typically being conceptual or definition problems and the last five being just-in-time distributed practice problems from prior assignments. The instructors also spend class time discussing *The New Science of Learning* with their students, providing them with information about how the brain learns in order to increase performance. Healthy habits and their impact on learning are explored, including distributed practice over cramming, sleep, nutrition, hydration, exercise, stress reduction, and limiting multitasking. Practicing recall is also key, so instructors stop after some key examples and let students try on their own several times during lecture. In an RCC survey, students commented on the habits they learned about, saying, "Reducing stress has helped me to be more careful on my assignments," and "The distributive learning freshens my memory. Instead of just studying the night before, I study days before and wake up early before the test to review what I've studied."

Homework

Nabours faced two primary issues: the retention of material by students and student homework habits, which impacted the first issue. Students were unaware of much of the information about how the brain actually learns and hence did not see the personal need for doing homework and avoiding cramming for exams. Restructuring the curriculum to create 50 homework assignments that map directly to course lessons gave students a clear link between content and their work.

Homework assignments are due daily in MyLab in order to help students distribute their practice and put the material into long term memory. One student shared, "With distributive practice, I feel that when I schedule my time for homework, I learn more because I'm not rushing." Students may work each of the problems as many times as needed to in order to get 100% before the due date and Nabours says that students are reminded to utilize the Similar Exercise option on the problems to get the best score. All learning aids are available on the homework assignments to maximize the students' attempts to review and learn the material. If a student's assignment score is an A (90% or above) at the end of the semester, the lowest exam score is replaced by the final exam score, if it benefits the student's grade. There are no extensions on the assignments. Once the due date passes, there is a 10% penalty per day, but only on the problems submitted late.

Exams and final exam

Six exams are given throughout the semester, in addition to a comprehensive final exam at the end of the term. Each exam accounts for 10% of a student's final grade, with the final exam contributing 25%. The six exams are each in a free-response format and students must show all work for full credit. The final exam is cumulative. No make-up exams are given. Only basic scientific calculators (no graphing calculators) are allowed on the exams.

Assessments

- 60% Exams
- 25% Final Exam
- 10% MyLab homework
- 5% Classroom participation

Grades are assigned using the following scale:
A 90–100% | **B** 80–89% | **C** 70–79% | **D** 60–69% | **F** 0–59%

Any student with two consecutive unexcused absences or a total of three unexcused absences may be dropped from the course. Arriving late or leaving early may count as an absence. Any student with an unexcused absence in the first two weeks of the course is subject to being dropped from the course. Students must also be signed up for MyLab Math within the first two weeks of the course with a permanent account or they may be dropped from the course.

Results and Data

Nabours hoped that the distributed homework assignments, with support from discussion on healthy habits to aid learning, would translate to positive outcomes for students in the course. Students agree, sharing, "Distributed workloads over many days greatly assisted by overall success in this class," and, "Rather than procrastinating, I really tried to do a little at a time every day. It really helped me with my stress levels to product a better end result."

Data from the Fall 2016 and Spring 2017 cohorts were analyzed, paying particular attention to homework scores and the impact they had on other course scores and pass rates. First, students were divided into ten groups based on their average homework score. Average exam, final exam, and final course scores were then computed for each group. The results demonstrate the rise in assessment and overall course scores as homework scores increase.

Exploring the homework impact more deeply, students were grouped into two categories: those earning at least 80% on homework and those earning less than an 80% average. When average exam, final exam, and final course scores were analyzed for the two groups, the data show that students who earned at least 80% on homework scored 12 percentage points higher on exams, 11 percentage points higher on the final exam, and 11 percentage points higher overall for the course. These results were statistically significant for each course assessment, as well as for the final course score.

[1] Exam scores: $t(727)=6.89$, $p > 0.05$
[2] Final exam scores: $t(695)=4.71$, $p > 0.05$
[3] Final course scores: $t(727)=6.18$, $p > 0.05$

Finally, pass rates for students earning at least 80% on homework and those earning less than 80% were considered. Students must earn a C or better in Intermediate Algebra in order to advance to college-level courses. Results show a 27 percentage point difference in pass rates between students in the two groups.

The Student Experience

In conjunction with *The New Science of Learning*, faculty and students discussed healthy habits that affect learning in the course. Students were asked to reflect on study habits used in the past and their outcomes in those courses, then encouraged to explore the options discussed in class and apply them to the current course. In a Spring 2017 end-of-semester survey given by RCC for the project, 532 students reported on their incorporation of the habits into their study. Overall, 38% of students reported making changes in their behavior or routine over the course of the semester.

- 29% of students applied the distributed practice technique instead of cramming
- 31% of students focused on improving their sleeping habits
- 25% of students paid attention to healthy eating
- 38% of students made sure they were drinking enough water
- 27% of students incorporated exercise
- into their strategies
- 19% of students reduced their stress levels
- 31% of students learned the value of paying attention, rather than multitasking during class

Students were asked to comment on the habit they felt was most useful during the semester. Selected responses from open-ended questions on the survey illustrate students' recognition of the link between these habits and their performance in class.

> "Believing in myself, acknowledging that although math is not easy for me, my brain is capable of learning it."

> "Distributed practice helped me to not stress about learning the material."

> "Sleeping enough (8 hrs). It helped because when I was here I saw that I could learn better and I was more focused."

> "Remaining calm. I found even during the final once I got calm the problems were not terribly hard."
>
> "Cutting the need for multi-tasking, focusing on lectures more."

Conclusion

Kathy Nabours and the faculty at RCC felt that student outcomes would be positively affected if they restructured their course objectives into chunks, created daily distributed homework assignments, and helped students more clearly understand how their brains processed information while learning. Data show that students who earn at least 80% on homework assignments earned higher scores on other assessments and had better final course scores. Nabours continues to evaluate the results of the project and incorporate strategies to lead students towards success in their math courses.

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[1] Exam score *t*-test results: Students with average MyLab homework scores of 80% or higher (M=77%, SD=14%, N=142) had significantly higher exam scores than students with MyLab homework scores less than 80% (M=65%, SD=19%, N=587), $t(727) = 6.89$, $p<0.05$.

[2] Final exam score *t*-test Results: Students with average MyLab homework scores of 80% or higher (M=69%, SD=19%, N=139) had significantly higher final exam scores than students with MyLab homework scores less than 80% (M=58%, SD=26%, N=558), $t(695) = 4.71$, $p<0.05$.

[3] Final course score *t*-test results: Students with average MyLab homework scores of 80% or higher (M=77%, SD=13%, N=142) had significantly higher final course scores than students with MyLab homework scores less than 80% (M=67%, SD=19%, N=587), $t(727) = 6.18$, $p<0.05$.