

MathXL

School Name University of Delaware, Newark, DE

Course Name Introduction to Statistical Methods I

Course Format Lecture

Key Results Data for this course indicate a strong positive correlation between MathXL homework grades and final course grades. Additionally, students who performed below average on their initial exam but earned higher than average MathXL grades throughout the course experienced increasingly higher exam averages for Exam 2 through the Final Exam.

Submitted by
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Course materials
MathXL and *Statistics for Business and Economics*, McClave, Benson, Sincich

Setting

The University of Delaware is a four-year university that boasts four satellite campuses in addition to its flagship campus in suburban Newark. The largest university in Delaware, it is a state-assisted but privately governed institution that serves more than 17,000 students.

Approximately 49 percent of students receive some need-based financial aid, 25 percent report ethnicity other than Caucasian, and 68 percent of students graduate within four years.

Statistics for Business and Economics is a one-semester, three-credit course that is part of a two-semester sequence taught out of the Mathematics Department and required of all students in the School of Business (approximately 1,200 students per year). The course is also available to students in other majors who are required to take just one semester of statistics.

Upon successful completion of this course, students should be able to:

- Recognize the importance of random sampling and random assignment in collecting data.
- Appropriately summarize data numerically and graphically.
- Identify the relevant population characteristics in a problem.
- Use statistical software to perform data analysis.
- Interpret the results of a data analysis.
- Recognize applications of statistical methods in fields such as marketing, accounting, operations, finance as well as non-business fields.

Challenges and Goals

While students have always been assigned homework, they did not necessarily complete it, and their resulting exam grades were poor. In addition, students routinely came to professor office hours seeking help with problem solving, but it was clear that they were not completing assignments and were falling behind. Believing that structured practice results in success when learning statistics, in 2012, Professor Crissinger and his colleagues identified the need for a digital program that would assign and grade homework, putting students in a better position to both practice and keep up with the course content. Because the department was already using a Pearson text, and other colleagues in the Math Department had been using a similar Pearson digital program with success, they decided to pilot MathXL in fall 2013. At that time, MathXL was required only for students who were not performing well on exams. By fall 2014, all sections began to require MathXL with all students assigned the same homework.

Implementation

Students attend large course sections that meet twice a week for lecture and smaller lab sections that meet once a week with a teaching assistant. Crissinger requires all students to use MathXL for homework. Because the program is primarily used outside of class for homework, MathXL usage is self-paced, and students usually use their personal computer to complete their work.

With lecture sections capped at 120 students, presentation of content and working through example problems are the core responsibilities of the lecturer. The weekly lab section provides a small-group setting to teach students how to use software to analyze data, to encourage students to ask questions and practice working through problems, and to reinforce topics from lecture. Lab activities are consistent across sections with all students using the same data set.

“The Help Me Solve This feature provided assistance on problems when I had trouble getting started.” —Student

Crissinger gives 26 MathXL homework assignments overall, approximately one assignment per section. An assignment generally consists of 10 multiple-choice, fill-in-the-blank, and numeric fill-in type questions; students have three attempts at completion with the highest score recorded in the gradebook. Additionally, numeric problem-solving questions are optional, allowing students unlimited attempts at similar exercises. All learning aids are turned on, and students have strict weekly due dates. Crissinger has found the Ask The Instructor learning aid to be very helpful when students have questions on specific homework problems, as the exact problem is populated into the student's email, allowing Crissinger to respond to their specific area of challenge. His students find the Help Me Solve This learning aid to be a source of guidance while doing homework, as one student commented: “The Help Me Solve This feature provided assistance on problems when I had trouble getting started.”

Two mid-term exams and a comprehensive final exam form the summative assessments for Crissinger's course; all are pencil and paper, face-to-face, and common across all sections. Students have two hours to complete each exam. The mid-terms have approximately 22–25 multiple-choice questions each and the second mid-term also includes five free-response questions. The final exam has 21 multiple-choice questions and three free-response questions. Questions are created by the course instructors or pulled from other textbooks and available standard tests like the AP Statistics exam. The final exam is cumulative, but the emphasis is on material from the final one-third of the course. With instructor approval, students may schedule a make-up exam before the original exam date and time.

Crissinger uses SAS to write data generating and scoring programs that students complete as their data analysis assignments. These exercises round out student coursework and require them to use Minitab and Excel to analyze differing sets of real-world data in an assignment setting. Equivalent to a take-home quiz, students complete these assignments independently, and the lowest score is dropped when calculating the final course grade.

Assessment

| | |
|------------|---------------------------|
| 50 percent | Midterm exams (2) |
| 30 percent | Final exam |
| 10 percent | Data analysis assignments |
| 5 percent | MathXL homework |
| 5 percent | Lab activities |

Results and Data

Individual scores on Exam 1 were evaluated to measure the relationship between MathXL homework grades and individual performance on exams. Students were divided into two groups: the Low Performing Group (Low Exam) scored at or below the average (73 percent) for Exam 1, the High Performing Group (High Exam) scored above the average. Using the Exam 1 analysis as a baseline, an evaluation of exam trajectories over the course of the semester was done based on the average MathXL Homework (HW) grade of 84 percent, dividing each group (Low and High Exam) into a Low HW or High HW group. The following key findings were observed for the low performing student group (Figure 1):

- **Low Exam/High HW and Low Exam/Low HW Groups.** By Exam 2, and continuing through the Final Exam, the Low Exam/High HW Group experienced a higher, and increasing, exam average, ultimately averaging seven percentage points higher on the Final Exam, even though both groups started with the same exam average on Exam 1 (62 percent).

In this implementation, the findings identify a trend toward higher exam averages for students who earn higher MathXL homework scores, despite their initial performance on Exam 1.

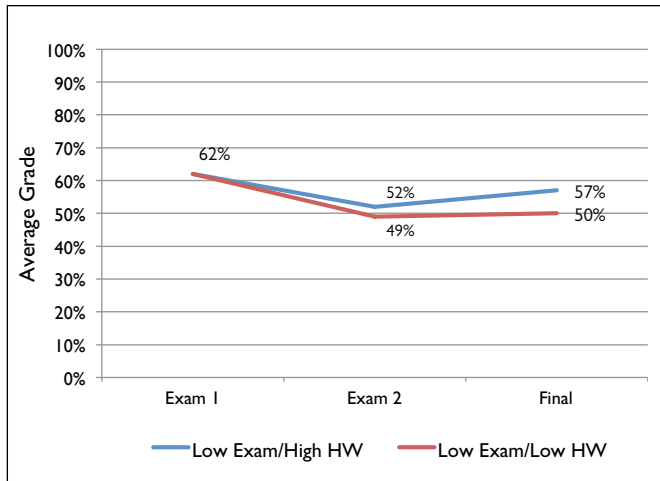


Figure 1. Exam Performance Based on Exam 1 Scores as the Baseline and Average Grade on MathXL Homework Assignments, Fall 2014 ($N = 83$, $n = 33$ LE/HHW, $n = 50$ LE/LHW)

Figure 2 is a correlation graph; correlations do not imply causation but instead measure the strength of a relationship between two variables. The corresponding p -value measures the statistical significance and strength of this evidence, where a p -value $< .01$ confirms the existence of a positive correlation between these two variables.

- Data show a strong positive correlation between the average MathXL homework grade and the final course grade, where $r = .52$ and p -value $< .01$. (Note: MathXL is five percent of the final grade, influencing this correlation.)

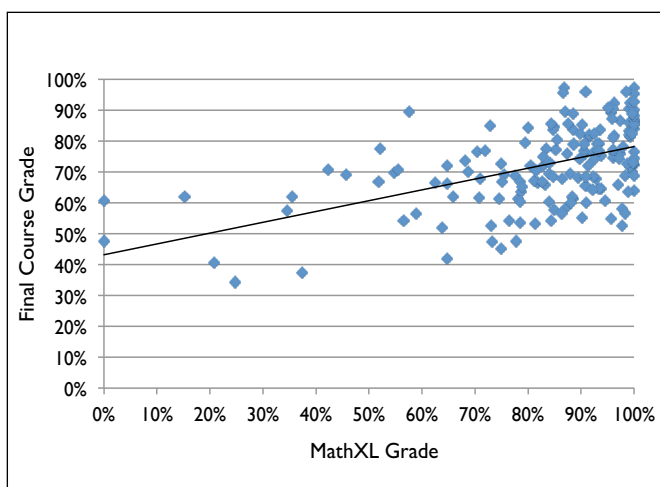


Figure 2. Correlation of Average MathXL Homework Grade and Final Course Grade, Fall 2014 ($n = 176$)

- Regression analysis identified that every three-point increase in MathXL scores is, on average, correlated to a one-point increase in a student's final course grade; the MathXL coefficient is .37 which equates to a 1.11 actual final course grade increase.
- Data show a moderate correlation between MathXL homework and average exam grades, where $r = .37$ and p -value $< .01$. This was not unexpected as the average MathXL homework grade was 84 percent while the average exam grade was 68 percent. It is likely that the unlimited attempts available on homework exercises allowed some degree of homework grade inflation that students could not replicate on exams.

As a best practice, MathXL is intended to help Crissinger identify students early on who are struggling and might be at risk of poor overall course performance.

Figure 3 looks at the average MathXL homework grade for students showing mastery of course material by earning an A, B, or C as their average exam grade compared to students who earned a D or F as their average exam grade, demonstrating that a relationship exists between successful homework completion and summative exam success. Additionally, data showed that:

- Students earning an A or B as their average exam grade scored an average of 94 percent on the MathXL homework ($n = 54$).
- Students earning an F as their average exam grade scored an average of 69 percent on the MathXL homework ($n = 33$).

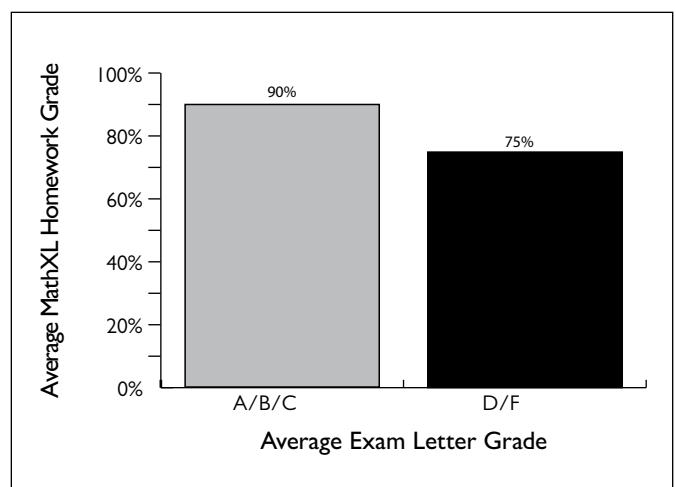


Figure 3. Comparison of Average Exam Grades Showing Content Mastery (A/B/C) and Non-Mastery (D/F), Fall 2014 ($N = 176$, $n = 101$ earned A/B/C, $n = 75$ earned D/F)

As a best practice, MathXL is intended to help Professor Crissinger identify students early on who are struggling and might be at risk of poor overall course performance.

Data review of the average exam grade and final course grade distribution, before using MathXL (fall 2012, $n = 342$) and after implementing MathXL (fall 2014, $n = 176$), shows a decrease in student exam grades in fall 2014 and an overall course average decline of one percentage point (Table 1). It is, however, worth noting that the exam format changed during this time period from all multiple choice in fall 2012 to a combination of multiple choice and free response problems in fall 2014. While significant effort is made to create exam questions that are similar in scope and difficulty to homework problems, several questions are usually added to the exam that ask students to synthesize concepts and go beyond what they practice in homework. The addition of MathXL as homework support and/or the change in exam format might have contributed to lower exam averages in fall 2014. Expanded analysis of MathXL use can be done to reevaluate these results in the future.

The Student Experience

A voluntary survey of students, conducted at the end of the semester in fall 2014, revealed what students liked best about MathXL:

I found the Help Me Solve This option the most helpful. I thought that by walking through a problem step-by-step, it really helped me understand the process and helped me recall the steps better when it came time to sit for the exam.

Instant feedback!

You could take quizzes on each section to help review the material or to study.

The Help Me Solve This feature provided assistance on problems when I had trouble getting started.

| Exam Average | Fall 2012 | Fall 2014 |
|----------------------|-----------|-----------|
| Exam 1 Average | 80% | 73% |
| Exam 2 Average | 66% | 64% |
| Final Exam Average | 73% | 68% |
| Total Average Exam | 73% | 68% |
| Final Course Average | 74% | 73% |

Table 1. Comparison of Average Exam Grades and Final Course Grades Before Implementation of MathXL, Fall 2012 ($n = 342$) and After MathXL Implementation, Fall 2014 ($n = 176$)

Conclusion

Crissinger's implementation of MathXL in his Business Statistics course follows many of the Pearson best practices for new users, including:

- Create a coordinator course that all instructors use, giving all students the same assignments, due dates, and overall digital experience.
- Start with the basics: Don't use everything MathXL has to offer at once, rather, add functionality as time progresses.
- Make the digital program required for a specific percentage of the student grade.
- Assign specific due dates and adhere to them.
- Keep the learning aids turned on so students can get "just in time" assistance and support, enabling them to learn at their own pace and as dictated by their learning style.

What began as a pilot to help struggling students get additional practice, adapted and became a required course component one year later. Implementation continues to evolve as Crissinger and his colleagues identify the most effective use of the digital program for their students.

Implementation and results case studies share actual implementation practices and evaluate possible relationships between program implementation and student performance. The findings are not meant to imply causality or generalizability within or beyond these instances. Rather, they can begin to provide informed considerations for implementation and adaptation decisions in other user contexts. For this case study, mixed-methods designs were applied, and the data collected included qualitative data from interviews, quantitative program usage analytics, and performance data. Open-ended interviews were used to guide data collection.