

Improving First-Year Math with ALEKS, an Artificial Intelligence (AI) Learning and Assessment System

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ALEKS – Conference Themes

- **Partnership in Teaching and Learning** – we partnered with McGraw-Hill to adopt *ALEKS Math*, an online **learning environment** and artificially intelligent tutor.
- **Innovative Teaching Practice** – we integrated ALEKS Math into a first-year course, *introductory mathematics (for economics)*, a “course-within-a-course”.
- **Scholarly Teaching** – students self-reported improved learning and greater confidence; distribution of grades
- **Interdisciplinary Context** – ALEKS can be effective in disciplines where future success is highly dependant on fundamental knowledge.
- **Flexible Delivery** – ALEKS Math can integrate with traditional, flipped, or blended classrooms.

Challenges with First-Year Math

- Many of our students struggled to pass ECON1530, a first year math course.
 - The first part of the course reviewed pre-calculus (2-5 weeks).
 - The second part of the course introduced single variable calculus (7-10 weeks).
- The two most common grades were F and A;
 - The course was too easy for some while too difficult for others.

Challenges with First-Year Math

Three facts stuck out:

- Students struggled with the textbook.
- My colleagues and I were using little technology, and
- Performance in pre-calculus strongly predicted performance in calculus.

Goals:

- Technology to help the students practice at home.
- To improve student performance in pre-calculus.

I learned about ALEKS Math at a conference.

ALEKS Math

- covers a wide-array of pre-calculus topics.
- allows students to practice when and where they want.

More specifically, ALEKS Math has

- an AI that customizes a unique learning path for each student based on an initial assessment of 30 questions or less.
 - Those who know less are assigned more problems to complete.
 - Those who know more can progress quickly.

Math Technology in the literature

- Muralidharan, Karthik, Abhijeet Singh, and Alejandro J. Ganimian (2019). "Disrupting Education? Experimental Evidence on Technology-Aided Instruction in India." *American Economic Review*, 109 (4): 1426-60
- Theobald et al. (2020), "Active Learning Narrows Achievement Gaps for Underrepresented Students in Undergraduate Science, Technology, Engineering, and Math" *Proceedings of the National Academy of Sciences* Mar 2020, 117 (12) 6476-6483; DOI: 10.1073/pnas.1916903117
- Taylor, Jude (2008) "The Effects of a Computerized-Algebra Program on Mathematics Achievement of College and University Freshmen Enrolled in a Developmental Mathematics Course

Math Technology in the literature

“Taken together, the findings from these studies suggest that [Computer Assisted Learning] ... show[s] enormous promise in improving learning outcomes.. the majority of studies finding positive effects (15 of 20) were focused on improving math outcomes”

“Education Technology: An Evidence-Based Review” Maya Escueta, Vincent Quan, Andre Joshua Nickow & Philip Oreopoulos (2017) NBER 23744

How to use ALEKS Math in ECON1530

“Good remote technologies that can teach math exist, but somebody has to get the kids to do it.”

–Steven Levitt, Professor of Economics at the UChicago, author of Freakonomics

- “To get our students to do it” – we integrated ALEKS into our Fall 2020 courses.

How We Used ALEKS Math in Weeks 1-4

'Blended' classroom:

- Created video lectures to support student activities on ALEKS outside class time.
- Re-arranged delivery of course topics to match ALEKS.
- Class time was spent on problems of my choosing.
- Assigned weekly quizzes and a term test on ALEKS.
- Offered a weekly bonus mark for time worked on ALEKS.

Scholarly Teaching: Qualitative and Quantitative Results

How helpful was ALEKS in
helping with your overall
learning for this course

Frequency

Percentage

Not helpful at all

5

1.42

Not helpful

2

0.57

Neutral

32

9.07

Somewhat helpful

114

32.29

Very helpful

197

55.81

I feel much more prepared for
taking future courses at York
University after using ALEKS

Frequency Percentage

Strongly disagree	8	2.27
Somewhat disagree	10	2.84
Neither agree nor disagree	50	14.2
Somewhat agree	153	43.47
Strongly agree	130	36.93

Using the ALEKS software has
increased my likelihood of staying
in a math-based program

Frequency

Percentage

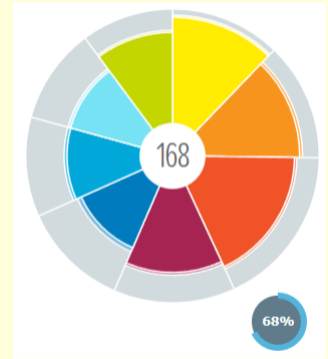
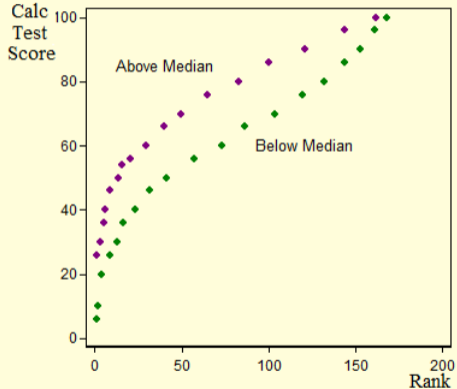
Strongly disagree	7	1.99
Somewhat disagree	8	2.27
Neither agree nor disagree	68	19.32
Somewhat agree	139	39.49
Strongly agree	127	36.08

Would you recommend other
instructors use ALEKS in their
first-year math classes?

Frequency Percentage

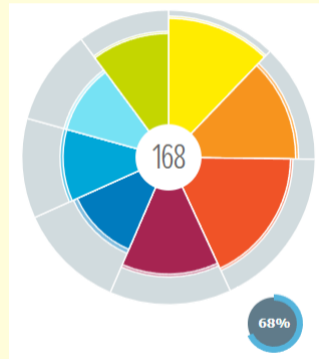
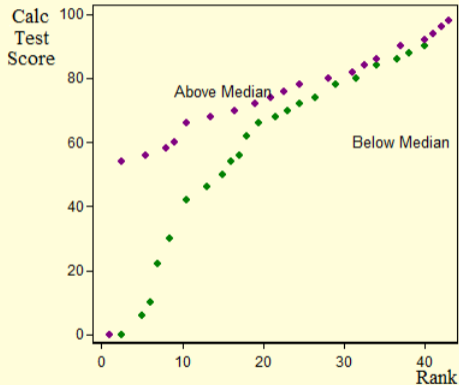
Yes	305	88.66
No	39	11.34

Fall 2021 – 337 Students – Prof. Robert McKeown



Students are divided into two groups by their median **topic completion rate** on ALEKS.

Fall 2020 – 85 Students – Prof Karen Bernhardt-Walther



Students are divided into two groups by their median **topic completion rate** on ALEKS.

“How did ” ALEKS” encourage or not encourage your overall learning? Was it boring? Frustrating? How were the learning modules helpful, or not helpful? Are there any other materials you would have found to be more useful?”

- *“... [ALEKS] encourage[s] my overall learning, it is not boring and I had lots of fun learning through this software. It is very helpful for me.”*

“How did ” ALEKS” encourage or not encourage your overall learning? Was it boring? Frustrating? How were the learning modules helpful, or not helpful? Are there any other materials you would have found to be more useful?”

- *“ALEKS software is awesome in helping my overall learning. It was interesting, and maybe one of the best platforms for teaching and learning online or remotely.”*

“How did ” ALEKS” encourage or not encourage your overall learning? Was it boring? Frustrating? How were the learning modules helpful, or not helpful? Are there any other materials you would have found to be more useful?”

- *“I literally don't know a better way I could have been taught. Its organization was encouraging.”*

Closing Thoughts on Components of Success

- Our partnership with McGraw-Hill was vital to our success because of their
 - expertise with the technology,
 - front-end support for students,
 - back-end support for instructors.
- Integrating ALEKS Math into our course was vital
 - Students recognize material they learned on ALEKS in the classroom and on assessments.
 - ALEKS is a major component rather than an add-on.

It was my great pleasure to speak with you today.

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