Targeting Students-at-Risk Using a Standard Math Skills Assessment

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Measuring Math Skills

• Math skills are critical for success in economics courses.

• Introductory courses require students to have a good grasp of basic arithmetic and algebra, as well as to be able to work with graphs.

• Intermediate courses add calculus to that mix.

• As instructors, we often do not have an accurate picture of what the students’ math skills look like coming into our classes.
Measuring Math Skills: MESA

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• Irene Foster has been using an in-house math assessment to direct students at GWU into a course aimed at developing their math to a level where they can succeed in introductory economics.

• Doug McKee and I developed a mathematics assessment for use in Cornell’s intermediate microeconomics course in 2018.
Measuring Math Skills: MESA

• In 2019, we joined forces and developed two new multiple-choice assessments:
  • MESA-Foundations (Arithmetic, Graphs, and Algebra)
  • MESA-Intermediate (Algebra, Graphs, and Calculus).

• These assessments were developed following the rigorous procedures described in Adams and Wieman (2011, Int. J. of Sci. Edu.), including faculty feedback and conducting think-aloud interviews with students.
Measuring Math Skills: MESA

28 multiple-choice questions:
• 7 on foundational arithmetic (unit conversions, percentages, translate word problems into math)
• 9 on reading and using graphs
• 12 on algebra: solving equations and systems of equations, and working with functions

Intermediate version:
• Removes arithmetic questions.
• Adds 11 questions on calculus: derivatives and basic integration

This serves as “training data” - we use this data to determine best methods for identifying students at-risk.
Identifying Students-at-Risk

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• Administering assessments at the start of the semester provides instructors with two opportunities:
  ▪ Identify students with a higher likelihood of failing, dropping out, or underperforming due to lacking math skills and conduct an intervention.
  ▪ Identify and address class-wide misconceptions as a part of start-of-term math review or TA sections.
Identifying Students-at-Risk: Data

• Data come from four classes at Cornell: two sections of Introductory Microeconomics (Fall 2019) and two terms of Intermediate Microeconomics (Spring 2019 and Fall 2019).

• We observe MESA scores, gender, underrepresented minority status, year in college, course letter grades, and first-generation student status and self-reported GPA (for Intermediate Microeconomics).

• We are currently piloting MESA-Foundations and MESA-Intermediate at external sites. (If you are interested in using either of them and/or participating in the pilot, contact us at econ-assessments@cornell.edu)
Identifying Students-at-Risk: Data

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- “Low Grade”: Letter grade in the lowest quartile (in these courses at Cornell, a “B-” and lower).
- **TPR (True Positive Rate):** fraction of the students who receive a low grade and score below this threshold.
- **FPR (False Positive Rate):** fraction of the students who do not receive a low grade but score below this threshold.
Simple Thresholds: Grade in Lowest Quartile

At MESA score of 72, we will have a TPR of 0.537 and an FPR of 0.221

At MESA score of 69, we will have a TPR of 0.524 and an FPR of 0.126
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At probit threshold of 0.41, we will have a TPR of 0.492 and an FPR of 0.186

The probit models contain: a spline of MESA score, gender, minority status, year in college indicators, first-generation status, and GPA (these two only for Intermediate Micro).
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We have also obtained a prediction based on a statistical learning model, with similar results. (In the interests of time these results have been relegated to the Appendix).
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- Develop a supplemental course that teaches both foundational mathematics for economics and study skills. Advise students at-risk to enroll in the course (optional enrollment). [Cornell route]
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- Develop a *principles of mathematics for economics* course that identified students at-risk are strongly recommended take before they can enroll in introductory economics. [GWU route]
THANK YOU FOR YOUR ATTENTION!

If you have any questions or are interested in using and/or piloting our assessments, you can reach us at:

econ-assessments@cornell.edu

You can learn more about the suite of assessments we are developing (including MESA) at

https://cdcr.as.cornell.edu/economics
APPENDIX: \(k\)-fold CV LASSO Logit

At logit threshold of 0.38, we will have a TPR of 0.510 and an FPR of 0.193.

At logit threshold of 0.53, we will have a TPR of 0.508 and an FPR of 0.169.

We run a 10-fold cross-validated LASSO logit model on individual questions in MESA, gender, minority status, year in college, first-generation status, and GPA. The estimated model is selected to have a \(\lambda\) that minimizes the mean-squared prediction error.