Implementation and Continuation Issues for Supporting Underprepared Introductory Statistics Students Using an Assessment and Peer Tutoring Intervention Program

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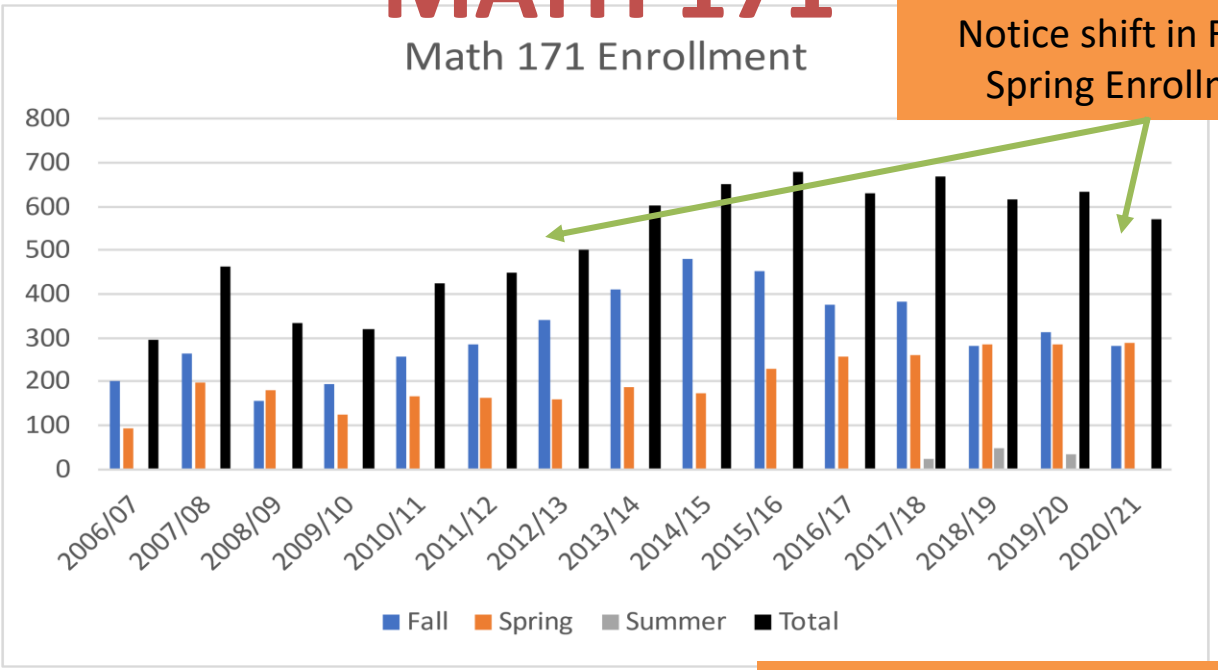
Overview

- Introductory Statistics (MATH 171): A Gateway Course at LU
- Scholarship of Teaching and Learning (SoTL): Using Assessment with a Purpose!
- Lessons Learned
  - Results from Studies
  - Implementations (Peer-Tutoring Intervention)
- Future Work

Introductory Statistics (MATH 171) at Longwood University

- *No prerequisites*. Non-calculus based, included in Civitae Core Curriculum at LU.
- *Follow best practices* as recommended by the statistics education community.
  - **Emphasis on *concepts*** instead of computations.
  - Use real data.
  - Course is ***algebraically light***.
  - Course is ***computationally light*** (i.e. make *extensive use of technology*)
- *Service course* to other disciplines: *Required* by Psychology, Mathematics, Business, Biology, Communication Studies
- *Prerequisite* for Applied Statistics (MATH 301) which is required by Environmental Science majors, Business majors, and counts towards the Mathematics major and minor.

Increasing Enrollment in MATH 171



Notice shift in Fall and Spring Enrollments

- **Mostly freshmen.**
- **More professors teaching course.**
- **Issues:**
  - **Success rate of students, implications for retention in face of declining enrollments.**
  - **Weaker students.**
  - **Consistency, quality, and fairness.**

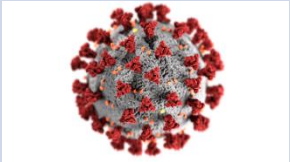
NOTE: Overall Declining Enrollments but Larger Percent of Students Enrolled in Math 171.

In the Beginning: Understanding Our Students

- Low success rate in Introductory Statistics (MATH 171)
  - **Only 54% of students completing course with grade of C- or better.**
- Starting in 2006, we used a Basic Skills Mathematics Quiz* (BSMQ) to measure incoming fundamental math skills.
  - Administered first day of class.
  - Most questions are problems involving simple algebra, percents, ratios, and proportions.

**Journal of Statistics Education (JSE):* "Basic Math Skills and Performance in an Introductory Statistics Course" by Marianne Johnson and Eric Kuennen, 2006

Studies to Date

Study	Start Date	Finish Date	General Results
1	Fall 2006	Spring 2008	• BSMQ Predictor of Success • Professor Effect • Results Published in JSE in 2011 [2]
2	Fall 2011	Spring 2014	• BSMQ Predictor of Success • Professor Effect • **Early Intervention using Peer-Tutoring Seemed to Work** • Results Published in JSE in 2018 [3]
2 ¾	Spring 2020	Stopped via COVID-19 	• BSMQ Predictor of Success • Professor Effect • **Early Intervention using Peer-Tutoring Seemed to NOT Work**
3	Fall 2021		

Students With Low Basic Math Skills Less Likely to Be Successful

Study	Overall Success Rate	Above 50% on BSMQ Success Rate	50% or lower on BSMQ Success Rate
Study 1	53.8% (269/500)	58.7% (222/378)	38.5% (47/122)
Study 2	67.5% (1018/1508)	69.6% (830/1193)	59.7% (188/315)
Study 2 ¾	72.6% (143/197)	78.6% (103/131)	60.6% (40/66)

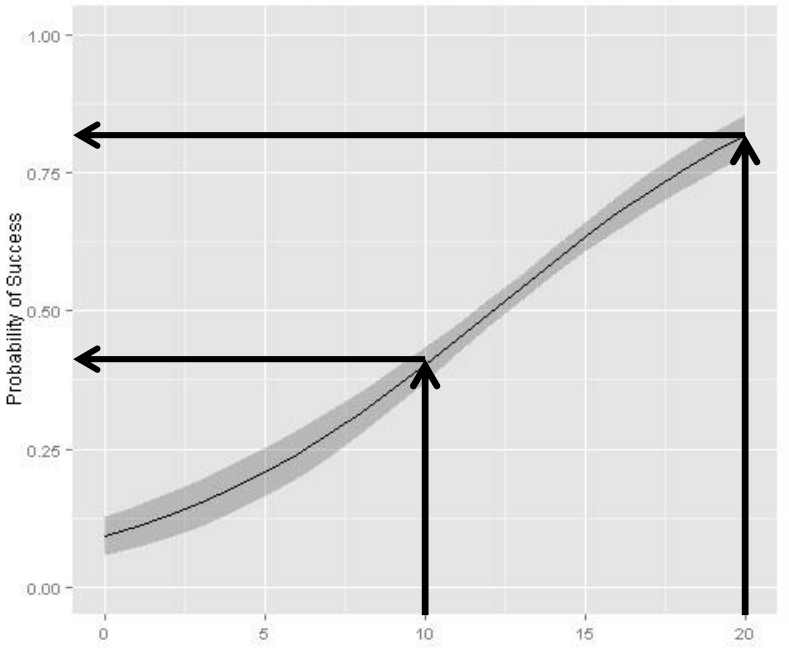
NOTE:

- Increasing overall success rate (success is a class grade of C- or higher).
- Increasing success rate for both groups of students.
- Students who scored 50% or lower on Basic Skill Math Quiz less likely to be successful than those who scored above.
- Small sample size for Study 2 ¾ compared to first two studies.

Basic Skills Quiz a Fair Predictor of Student Success

- Students with low basic mathematics skills were less likely to be successful (C- or higher) in MATH 171.
- A typical student who scored 10 on the 20-question basic skills test had an approximate 40% chance of success in the course and one who scored 20 had an 80% chance. Band is ± 1 SE.
- Students scoring 50% or less deemed “at risk” for success.

Probability of Success Graph from First Study



Number Correct (out of 20) on Basic Skills Test

Administration of Basic Skills Math Quiz: Lessons Learned

- Students given BSMQ on first day of class:
  - Professors felt this set the wrong tone.
- Done via Scantron:
  - Issues getting results back to students and professors in a timely manner.
- Had considered using SAT scores but administration no longer requiring those.
- For new study starting this Fall will administer BSMQ via Canvas using HonorLock:
  - Can be completed outside of class.
  - Results can be compiled quickly.

Our Second Study
Assessment *with a Purpose*

Use basic skills quiz to identify students who are not likely to be successful ("at-risk") and require early intervention.

Early Intervention: Students who score 50% or below on Basic Skills Math Quiz ***required*** to attend at least 6 hours of peer-tutoring in Center for Academic Success (CAS) before midterm.

Peer-Tutoring: Implementation and Issues

- **Administered via LU's CAS:**
  - No departmental control though professors did recommend tutors.
- **High performing student peers tutoring students in groups:**
  - Minimal peer-tutor training.
- **Walk in tutoring model:**
  - No procedure to require students to sign up for tutoring hours.
- **Many students waited until last minute to complete tutoring hours:**
  - Led to excessively large tutoring sections in the last 2-week period before the deadline for completion.
  - Frustrating experience for students and tutors.
- **Consistency of topics and order of topics covered:**
  - While all professors were using the TI-84 calculator, they did not follow the same order of course topics nor cover the topics at the same rate.
  - Made tutoring groups of students more difficult for peer-tutors.

A Closer Look at Early Intervention

Students Who Scored 50% or Lower (Required Intervention in Second Study)

	Success	Failure	Total
First Study	47 (38.5%)	75	122
Second Study	188 (59.7%)	127	315

There was a 21.2 point increase in percent successful in this group.

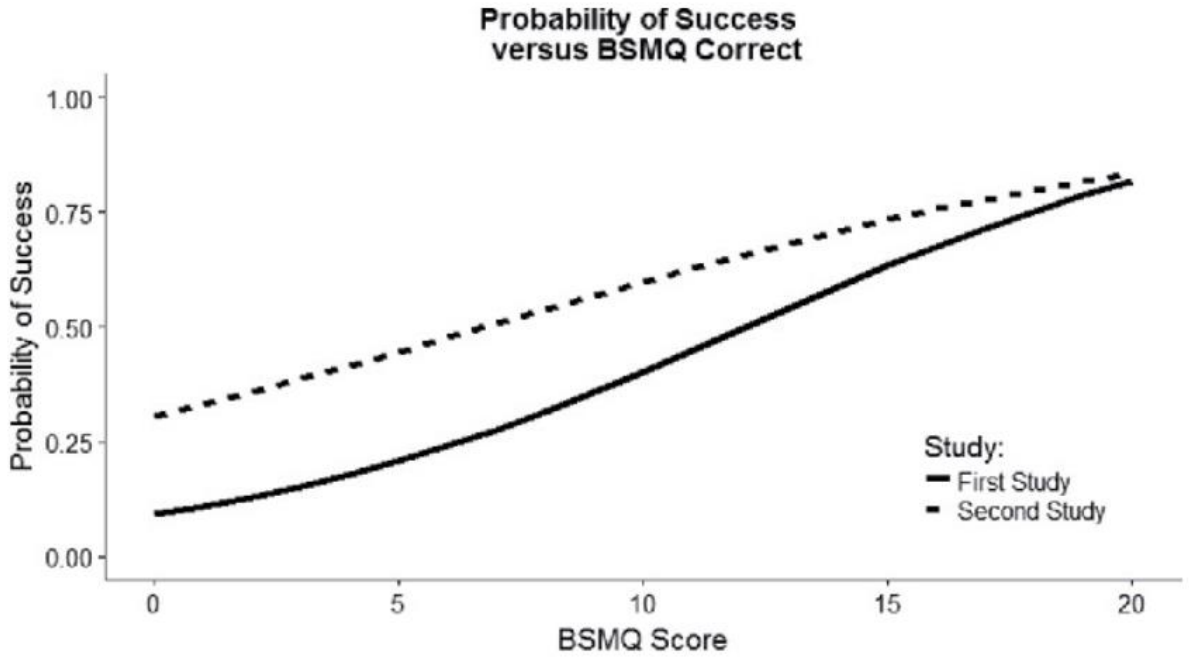
Students Who Scored Above 50% (No Required Intervention in Either Study)

	Success	Failure	Total
First Study	222 (58.7%)	156	378
Second Study	830 (69.6%)	363	1193

There was a 10.8 point increase in percent successful in this group.

While there was a significant increase in success for both groups, the increase in success for students who scored 50% or lower was significantly* higher in the second study (i.e. with required intervention).
***Cochran-Mantel-Haenszel Test, $p < 0.001$.**

Basic Math Skills *Still* a Fairly Good Predictor of Success

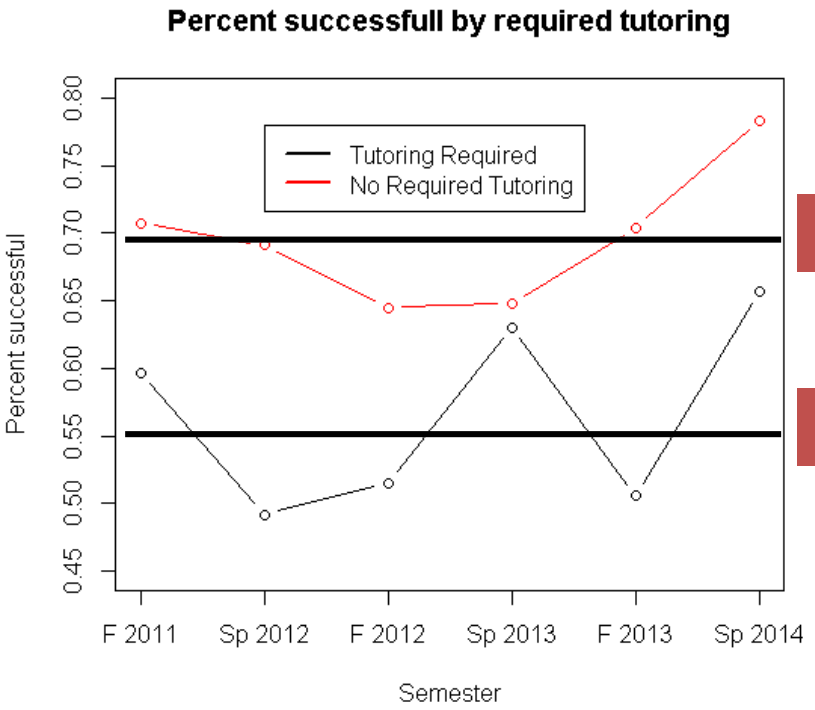


Number Correct (out of 20) on Basic Skills Quiz

Notice the shift up, especially in the lower portion of the second study success curve (dashed line).

Lesson Learned: Variation in Success by Semester

- General trend is increasing.
- Success rate for at-risk students is lower *and* more variable.
- Success for rate at-risk students generally lower in Fall semesters.
- Delay Math 171 until Spring semester for students with low test scores and/or in majors that do not require Math 301.



69.6%

55.1%

The Professor Effect in the First Study

For a given basic skills quiz score, a student may be more likely to succeed with one professor than another.

Notice the gaps

Number Correct (out of 20) on Basic Skills Test

There is still a positive relationship between student basic math skills and student success, however the extent of the relationship varies between professors.

Study 2 ¾ Design Overview

- Started in Spring 2020.
- BSMQ test given to determine "at risk" students on first day of class.
- Intervention: Required 6 hours of peer-tutoring for "at risk" students in LU's new Quantitative Reasoning (QR) Center.
- Three professors in study:
  - Two junior tenure track mathematics faculty.
  - One full-time adjunct faculty.
  - None of professors in previous studies.
- Common final exam component to be graded via AP model.
- **Study interrupted via COVID-19!**

New!

- Each professor taught at least two sections: a control section and a treatment section. Both groups given BSMQ.
  - Treatment Sections: "At risk" students required to complete intervention.
  - Control Sections: "At risk" students not required to complete intervention.
- Required tutoring to be completed gradually (at least one hour per week).

"Results" from Study 2 ¾

- BSMQ *still* a fairly good predictor of success.
  - At-risk students less likely to be successful.
  - Percent of students who scored 50% or lower on the Basic Skills Test was percent was 34% (66/197) compared to 24% in 1st and 23% in 2nd Studies.
  - There was *still* a significant professor effect.
- There was no difference in success rate for "at risk" students in control and treatment groups.
  - Small sample size.
- Having both a control and a treatment section a burden for instructors.

New QR Center!

- Created in Fall 2018 as part of new Civitae Core Curriculum.
- Up and running by Fall 2019.
- Top priority: Offer peer tutoring in a wide variety of courses.
- Support faculty engaging in SoTL.

QR CENTER
Quantitative Reasoning

QR Center Usage (19-20)

SEMESTER	# TUTORS	TOTAL VISITS	TOTAL # STUDENTS	VISITS PER COURSE(# SECTIONS)/ # (% OF TOTAL)	
Fall 2019	10	395	103	ALL CMSC(5)	13 (3%)
				MATH 135 (5)	81(20%)
				MATH 164 (1)	33 (8%)
				MATH 171(14)	123 (31%)
				MATH 175(1)	5 (1%)
				MATH 261(1)	3 (<1%)
				MATH 262(1)	2 (<1%)
				MATH 30 (5)	47 (12%)
				MATH 309/310/313(13)	41 (10%)
				PRAXIS CORE	47 (12%)

- Fully in-person tutoring, no appointment required

QR Center Usage (19-20)

SEMESTER	# TUTORS	TOTAL VISITS	TOTAL # STUDENTS	VISITS PER COURSE(# SECTIONS)/ # (% OF TOTAL)	
Spring 2020 (Pre-COVID)	14	392	124	ALL CMSC(4)	49 (13%)
				MATH 135 (4)	37 (9%)
				MATH 164(1)	1 (<1%)**
				MATH 171(12)	209 (53%)
				MATH 175(1)	9 (2%)
				MATH 261(1)	31 (8%)
				MATH 262(1)	9 (2%)
				MATH 301(5)	34 (9%)
				MATH 309/310/313(9)	9 (2%)
				PRAXIS CORE	4 (1%)
Spring 2020 (Post-COVID)	12	42	18	ALL CMSC	14 (33%)
				MATH 135	1 (2%)
				MATH 164	0 (0%)
				MATH 171	15 (36%)
				MATH 175	6 (14%)
				MATH 261	0 (0%)
				MATH 262	0 (0%)
				MATH 301	1 (2%)
				MATH 309/310/313	5 (12%)
				PRAXIS CORE	0 (0%)

Moving Forward

- Lessons learned
  - In-person vs. online
  - 1-1 tutoring vs. group tutoring
  - Data collection
- Institutional support
  - Improving data collection
  - Improving tutor preparation
- Lack of standardization in Math 171 sections.

Future Work: New Study!

- Fall 2021 Baseline Study
  - Identify at-risk students using BSMQ given online via Canvas using HonorLock.
    - Is the 50% cutoff still reasonable for determining “at-risk” students?
  - No required tutoring for students.
  - Encourage peer tutoring by QRC and assess student voluntary usage.
- Spring 2022 require Peer-Tutoring for “at risk” students.
  - Use BSMQ to identify “at-risk” students.
  - Require peer-tutoring for “at-risk” students to be completed gradually.
    - Students can earn at most one hour per week for required tutoring.
  - QRC will manage tutors
  - End of semester survey will be administered to obtain student feedback and perception of peer tutoring intervention.

Summary of Strategies for Improving Our Student Success in MATH 171

- Identify at-risk students with easily obtainable data:
  - BSMQ administered via Canvas using HonorLock.
- Delay MATH 171 for at-risk students:
  - More students take course in spring semester.
- Improve and expand tutoring services:
  - QRC created in 2018.
  - Students can earn at most one hour per week towards tutoring requirement.
- Course standardization:
  - Working to standardize course topics and order.
  - Common component on final exam.
  - Develop strategies for dealing with resistance by some senior faculty.
- Professional development for faculty teaching the course:
  - Monthly meetings for Math 171 instructors started in 2019/20 academic year, fizzled last academic year, but will do again this year.
  - Encourage enrollment in MAA minicourses about teaching statistics, etc.
- New statistics professor hired in 2020/21 academic year!

Thank you!
Questions?

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3. Lunsford, M. L., Poplin, P. L., Pederson, J. G, (2018) "From Research to Practice: Using Assessment and Early Intervention to Improve Student Success in Introductory Statistics," *Journal of Statistics Education*, V 26(2). https://www.tandfonline.com/doi/full/10.1080/10691898.2018.1483785