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

- 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.

Notice shift in Fall and Spring Enrollments

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.

# Studies to Date

<table>
<thead>
<tr>
<th>Study</th>
<th>Start Date</th>
<th>Finish Date</th>
<th>General Results</th>
</tr>
</thead>
</table>
| 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

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

**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.
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)

<table>
<thead>
<tr>
<th></th>
<th>Success</th>
<th>Failure</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Study</strong></td>
<td>47 (38.5%)</td>
<td>75</td>
<td>122</td>
</tr>
<tr>
<td><strong>Second Study</strong></td>
<td>188 (59.7%)</td>
<td>127</td>
<td>315</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>Success</th>
<th>Failure</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Study</strong></td>
<td>222 (58.7%)</td>
<td>156</td>
<td>378</td>
</tr>
<tr>
<td><strong>Second Study</strong></td>
<td>830 (69.6%)</td>
<td>363</td>
<td>1193</td>
</tr>
</tbody>
</table>

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

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

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.
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.

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 Usage (19-20)

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

- Fully in-person tutoring, no appointment required
## QR Center Usage (19-20)

<table>
<thead>
<tr>
<th>SEMESTER</th>
<th># TUTORS</th>
<th>TOTAL VISITS</th>
<th>TOTAL # STUDENTS</th>
<th>VISITS PER COURSE(# SECTIONS)/#(% OF TOTAL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring 2020 (Pre-COVID)</td>
<td>14</td>
<td>392</td>
<td>124</td>
<td>ALL CMSC(4) 49 (13%)</td>
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<td>MATH 135 (4) 37 (9%)</td>
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<td>MATH 164(1) 1 (&lt;1%)**</td>
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<td>MATH 171(12) 209 (53%)</td>
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<td>MATH 175(1) 9 (2%)</td>
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<td>MATH 261(1) 31 (8%)</td>
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<td>MATH 262(1) 9 (2%)</td>
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<td>MATH 301(5) 34 (9%)</td>
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<td>MATH 309/310/313(9) 9 (2%)</td>
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<td>PRAXIS CORE 4 (1%)</td>
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<tr>
<td>Spring 2020 (Post-COVID)</td>
<td>12</td>
<td>42</td>
<td>18</td>
<td>ALL CMSC 14 (33%)</td>
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<td>MATH 135 1 (2%)</td>
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<td>MATH 164 0 (0%)</td>
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<td>MATH 171 15 (36%)</td>
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<td>MATH 175 6 (14%)</td>
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<td>MATH 261 0 (0%)</td>
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<td>MATH 262 0 (0%)</td>
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<td>MATH 301 1 (2%)</td>
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<td>MATH 309/310/313 5 (12%)</td>
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<td></td>
<td>PRAXIS CORE 0 (0%)</td>
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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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Leah N. Shilling-Stouffer  shillingln@longwood.edu

References:
   www.amstat.org/publications/jse/v14n2/johnson.html
   https://www.tandfonline.com/doi/full/10.1080/10691898.2018.1483785