Abstract and Overview

The Penn State University Toys’n Mathematical Options for Retention in Engineering (Toys’n MORE) project has completed seven semesters of data collection. This paper presents preliminary data analysis for the first six semesters. This project is based upon work supported by the National Science Foundation under Grant No. 1248586. The goal of Toys’n MORE is to increase the retention of Science, Technology, Engineering, and Mathematics (STEM) students enrolled at 14 geographically dispersed regional campuses in the Penn State system. These campuses, along with thestein project, also include the four campuses within the Regional Penn State Coalition (RPC) composed of 15 campuses throughout the Penn State system. The RPC goal is to enhance retention by engaging students in a fun, non-threatening, team-based environment.

Project Goal

Increase the number of students in STEM majors by 20% at 16 regional campuses of the Pennsylvania State University.

Figure 1: One Project, 14 Regional Penn State Campuses

Math Tutoring Outcomes for 1-Credit Math Tutorial Class

Math Course Grades

Hypothesis: Students enrolled in the Toys’n MORE sponsored 1-credit math tutoring class would earn higher math course grades than students not enrolled in the 1-credit math tutoring class.

Results:

- No differences in course grades in Algebra I, Trigonometry, or Calculus I between students who enrolled in the accompanying math tutoring class or not.
- Students with higher SAT Math scores (regardless of enrollment in the math tutoring class) earned significantly higher math course grades.
- Students enrolled in the math tutoring class had significantly lower SAT Math scores compared to math students who did not enroll in the math tutoring class.

Cumulative GPA

Hypothesis: Students enrolled in the Toys’n MORE sponsored 1-credit math tutoring class would have a higher cumulative GPA than students not enrolled in the 1-credit math tutoring class.

Results:

- Algebra I and Calculus I students enrolled in the math tutoring class had significantly higher cumulative GPAs compared to students not enrolled in the math tutoring class (Fall 2010 to Spring 2012).
- The increase in GPA may have resulted from the 1-credit grade earned in the math tutoring class and not from the grade in the math course.

Outcomes for the 2010 Summer Bridge Programs at Regional Campuses

Goals:

- Academic preparation for first-year STEM curriculum
- Build on-campus and community relationships in support of first-year engineering projects
- Retention in STEM, particularly engineering

Results:

- Mean SAT scores of summer bridge participants (946) are comparable to other students who attend the three Penn State regional campuses (947) that sponsored new summer bridge programs.
- Retention at Penn State - 42% of the participants are enrolled in Penn State as a junior, which is on track to exceed the Regional Penn State Coalition’s 35% retention rate.
- Retention in STEM - 52% of the participants are retained as STEM majors, which is on track to exceed the 35% retention rate at the Regional Penn State Coalition.
- Retention in Engineering - 56% of the participants are retained as STEM majors, which is on track to exceed the 35% retention rate at the Regional Penn State Coalition.
- Retention in Enrichment - 56% of the participants were retained in STEM majors and 78% are on track to exceed the 50% retention rate at the Regional Penn State Coalition.
- Junior-year fall semester cumulative GPA of participants (2.4) is slightly higher than other regional campus students (2.4).

Table 2: Background Characteristics and Preliminary Outcome Data for the 2010 Bridge Students

<table>
<thead>
<tr>
<th>College Name</th>
<th>Enrollment</th>
<th>Fall GPA</th>
<th>Spring GPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
<td>25%</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td>Science</td>
<td>30%</td>
<td>23</td>
<td>24</td>
</tr>
<tr>
<td>Engineering</td>
<td>40%</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>total</td>
<td>100%</td>
<td>23</td>
<td>24</td>
</tr>
</tbody>
</table>

Second Year Fall Semester GPA for Students in the 2010 Bridge Programs

<table>
<thead>
<tr>
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<th>Spring GPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
<td>25%</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>Science</td>
<td>30%</td>
<td>25</td>
<td>26</td>
</tr>
<tr>
<td>Engineering</td>
<td>40%</td>
<td>26</td>
<td>27</td>
</tr>
<tr>
<td>total</td>
<td>100%</td>
<td>25</td>
<td>26</td>
</tr>
</tbody>
</table>

Table 3: Retention in STEM Majors Among 2010 Summer Bridge Students

<table>
<thead>
<tr>
<th>College Name</th>
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<th>Fall GPA</th>
<th>Spring GPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
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<td>26</td>
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</tr>
<tr>
<td>Science</td>
<td>30%</td>
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</tr>
<tr>
<td>Engineering</td>
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<td>28</td>
<td>29</td>
</tr>
<tr>
<td>total</td>
<td>100%</td>
<td>27</td>
<td>28</td>
</tr>
</tbody>
</table>

Challenges and Solutions

- Each campus was given the freedom to design their own programming for the foundational math courses that suited their needs.
- The diversity of tutoring programs is challenging from an assessment perspective when evaluating the programs implemented by each campus and the quality of implementation.
- Based on math exams results from the first half of the study, the campuses were encouraged to adopt either or both of the top-performing tutoring programs to increase the homogeneity of the math tutoring. Four campuses adopted the tutoring strategies that were more successful based on the first half of the study.

Overall impact of the project:

- The project involved 14 campuses and coordination of numerous individuals from different disciplines.
- In the early planning stage, achieving “buy-in” from a diverse audience, i.e. faculty (ranging from part-time to full-time), students, and administration, to implement the intervention strategies was a challenge.
- A major challenge is maintaining communication.
- The need for “buy-in” and maintaining communication is to develop personal relationships through the use of telephone, e-mail, and in person conversations with the faculty and staff who implement the interventions at the geographic hopscotch campuses. Although we maintain regular communication via e-mail and drive to be clear and positive with our communication, communication is an ongoing effort.
- A close group of faculty and staff has emerged who provide reliable support in conducting the Toys’n MORE interventions and assessment.

Summary and Take-Home Message

- Toys’n MORE interventions focused on freshmen and sophomore STEM majors have been implemented for seven semesters at 14 regional campuses of the Penn State System. At this time, we are reporting data for the first six semesters.
- We present data on official enrollment in STEM majors as well as students’ preferences for majoring in a STEM major.
- No graduation data is available yet.
- The three interventions are embedded math tutoring in foundational math courses, toy-based curricular in freshman engineering design courses, and math-intensive summer bridge programs at three regional campuses.
- 1-Credit Math Tutorial Course
- Excellence in a 1-credit math tutorial course appears to provide a small but statistically significant increase in cumulative GPA for Algebra I and Calculus I students.
- There is no evidence that the 1-credit math tutorial course benefits the grade in the accompanying math course.
- To be examined is how long the GPA benefit lasts and whether the tutorial course benefits retention in the next math course in the sequence.
- Improving foundational math course grades is an ongoing challenge.
- Toy Design Curriculum in freshman engineering design course
- Examination of three cohorts of students who enrolled in a freshmen design class with the Toys’n MORE toy-based design curriculum shows a net increase in retention among students who take the freshmen engineering design class with the Toys’n MORE curriculum compared to those taking the class based on the standard curriculum.
- Math-intensive Summer Bridge Programs at Three Regional Campuses—2010 cohort
- When we examine students from the first cohort of summer bridge students in their junior year, they are as track to surpass rates of retention at Penn State, retention in STEM majors, and retention in Engineering compared to all students, STEM students, and engineering students from those three regional campuses.
- Each of these three interventions are conducted with minimal budget. The positive message appears to be that a modest investment of money and effort yields significant increases in the retention of STEM majors. We will continue to track the students who participated in interventions sponsored by the Toys’n MORE project.