# Belongingness, Student Anxiety, and Student Performance

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**Research Question: Can a lay theory intervention improve the performance of students in introductory physics and math courses, and does the intervention have any impact on student anxiety in these courses?**

## Introduction

Belongingness is defined as a sense of connectedness to ones peers. A sense of not belonging can have a negative impact on intellectual achievement[1]. Marginalized groups such as minorities, first generation college students[2], and students from disadvantaged socio-economic backgrounds are susceptible to feeling isolated in higher education settings. Research has shown that a simple intervention on social-belongingness can raise the GPA of first year college students from among these socially marginalized groups[1].

The interventions involve providing students with a lay theory that tries to change how students view the obstacles they face. A lay theory intervention introduces the idea that concerned students have about the challenges they face, including their sense of belonging and their fears of not succeeding are (1) shared by many other students, (2) something that can be improved, (3) and do not limit their future sense of belonging or success. Providing students with a lay theory may provide them a framework to understand their concerns and to take steps to overcome these problems. Previous research has shown that a single lay theory intervention for incoming freshmen increases the retention rate of disadvantaged students and also results in closing the GPA performance gap between advantaged and disadvantaged students[3]. The intervention increased student use of support services and resulted in the development of friendship networks and mentor relationships.

Two areas that impact student performance in physics[4] and mathematics[5] classes are self-efficacy and anxiety towards the course. This research looks at whether a lay theory intervention has an impact on student performance in math and physics courses, as well as whether it has an impact on self-efficacy and anxiety towards the course.

Self-efficacy is a measure of an individual's belief in their ability to complete a task or goal. In our case we were interested in the students belief in their ability to succeed at physics or mathematics.

Anxiety towards the course includes anxiety towards the topic in general, test anxiety, and willingness to make use of additional resources such as tutors or instructor office hours.

## Methodology

The research was performed at a small public university in the Midwest with a large fraction of first generation college students (42% in our data set). The research was conducted in an introductory math course (*Fundamentals of Algebra* (**MATH-010**)) and an introductory physics course for engineers (*Statics* (**PHYS-291**)). Data from a second math course was too sparse to analyze.

A survey is administered at the beginning and end of the semester to measure student anxiety, self-efficacy, whether they seek support or not, and conscientiousness. The questions were taken from the Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ)[5]. For physics courses, the word 'math' was replaced with the word 'physics' throughout the questionnaire. Two questions measuring conscientiousness were included. The survey consisted of 34 questions.

Students were enrolled in either the intervention or control group based on which class section they were in. The lay theory intervention, given a week into the semester, consists of students reading three paragraph-long stories from previous students explaining how they didn't feel like they belonged in the class but eventually overcame that feeling and succeeded in the class.

An example story read by the math students would look like the following:
*"I have never done well in math in high school and have some serious anxiety about the subject. When I started this class I was unsure of how I would do. I heard from the tutors that if I work hard and practice that then I would be ok, but I didn't really believe them in the beginning. I remember being so stressed out on the first test, and I ended up working the practice test 8 times (which is crazy), but it paid off and I got a B! Who knew! I'm not sure if I'll ever feel completely confident with math, but I'm happy with the grade I got at the end of the course and feel that I'm well prepared for the next class."*

After reading the three stories, students are given two writing prompts:
1) Write a brief paragraph about why it is common for students to feel initially unsure about taking part in a physics course. Use examples from your own past experiences in math (physics) classes.
2) Write a brief paragraph about how and why these initial worries about belonging are likely to diminish over time as students become more comfortable in the class and with the material.

## Results

An example of a student response to the first question on the intervention is:

*"It can be scary to put your ideas and questions out there for others. We never want to feel stupid, so the "best" way to avoid it is to not participate. Back when I took AP physics in high school, I started out rarely ever talking. I didn't want to sound stupid. After I eventually got over that, I started doing better in the class overall."*

An example of a student response to the second question on the intervention is:

*"The initial worries diminish because after that first day you get a feeling of how the class works. There is also help from the teaching because the professor then starts to slow down and focus more on the main topics. It allows the student to ask questions and get answers from the professor. Also as the class goes on people become more comfortable with classmates and can asks questions outside of class and get strong explanations from others."*

Using paired t-tests, there was no statistically significant difference between the course grades of the control group and intervention group in PHYS-291.

| PHYS-291 | Intervention | Control | P-value |
|---|---|---|---|
| Grade (4.0 scale) | 2.52 | 2.34 | 0.440 |
| N | 46 | 148 | - |

The only difference between the two groups in terms of survey questions was 'I believe I can get an A when I am in a physics course' (p-value=0.0241). The students in the intervention group felt slightly less likely that they could earn an A than the control group.

The MATH-010 students who underwent the intervention did receive better grades than those in the control group

| Math-010 | Intervention | Control | P-value |
|---|---|---|---|
| Grade (4.0 scale) | 3.64 | 2.59 | 0.0272 |
| N | 18 | 13 | - |

There was also a statistically significant shift from the presurvey to postsurvey between the control and intervention group. The following questions related to anxiety and self-efficacy were different between the two groups. The questions were answered on a 5-point Likert scale (Usually = 2.0,..., Never = -2.0)

### Anxiety Questions
Q16: I worry I will not be able to understand the mathematics.
Q18: I get tense when I prepare for a mathematics test.
Q21: I worry that I will not be able to do well on mathematics tests.
Q27: I get nervous when I have to use mathematics outside of school.
Q33: I get nervous when going to my instructor's office hours

| Math-010 | Intervention | Control | P-value |
|---|---|---|---|
| Q16 | -0.33 | 0.23 | 0.02894 |
| Q18 | -0.89 | -0.15 | 0.02178 |
| Q21 | -0.56 | 0.23 | 0.0201 |
| Q27 | -0.28 | 0.31 | 0.01294 |
| Q33 | -1.11 | 0.077 | 0.00708 |
| N | 18 | 13 | - |

### Self-Efficacy Questions
Q19: I believe I can do the mathematics in a mathematics course.
Q20: I believe I am the kind of person who is good at mathematics.
Q25: I believe I can learn well in a mathematics course.
Q26: I believe I can complete all of the assignments in a mathematics course.
Q29: I believe I can do well on a mathematics test.

| Math-010 | Intervention | Control | P-value |
|---|---|---|---|
| Q19 | 0.61 | -0.077 | 0.02101 |
| Q20 | 0.50 | -0.077 | 0.04725 |
| Q25 | 0.78 | 0.00 | 0.03132 |
| Q26 | 0.00 | 0.077 | 0.00856 |
| Q29 | 0.67 | 0.077 | 0.04353 |
| N | 18 | 13 | - |

The physics data showed no such difference between the control and intervention group. One possible explanation for the difference between the outcomes for physics students and math students may be a result of differences in their self-efficacy and anxiety towards the course. The presurvey results show higher anxiety and less self-efficacy for the MATH-010 students than the PHYS-291 students for 13 of the 32 questions. For 2 of the questions the MATH-010 students had higher self-efficacy or lower anxiety than the PHYS-291 students.

| Anxiety | Physics Mean | Math Mean | P-Value |
|---|---|---|---|
| Q5 | 0.74 | -0.49 | 4.59E-09 |
| Q7 | 0.46 | -0.09 | 6.15E-03 |
| Q27 | -0.68 | -0.23 | 1.29E-02 |
| N | 194 | 31 | - |

| Self-Efficacy | Physics Mean | Math Mean | P-Value |
|---|---|---|---|
| Q3 | 0.85 | 0.36 | 2.95E-03 |
| Q4 | 0.78 | 0.07 | 1.24E-04 |
| Q6 | 0.49 | -0.22 | 1.12E-04 |
| Q19 | 1.00 | 0.35 | 5.06E-06 |
| Q20 | 0.27 | -0.71 | 4.53E-07 |
| Q23 | 0.16 | -0.24 | 4.15E-02 |
| Q25 | 0.54 | 0.20 | 2.68E-02 |
| Q26 | 0.79 | 1.23 | 1.11E-03 |
| Q28 | 0.76 | 0.29 | 1.40E-03 |
| Q29 | 0.46 | -0.13 | 3.40E-04 |
| N | 194 | 31 | - |

### Anxiety
Q5:I have enjoyed mathematics/physics.
Q7:I have been happy in my mathematics/physics courses.
Q27:I get nervous when I have to use mathematics/physics outside of school.

### Self-Efficacy
Q3:I have been able to understand mathematics/physics.
Q4:I have done well in my mathematics/physics courses.
Q6:I am the type of person who is able to learn mathematics/physics well.
Q19:I believe I can do the mathematics in a mathematics/physics course.
Q20:I believe I am the kind of person who is good at mathematics/physics.
Q23:I believe I can get an A when I am in a mathematics/physics course.
Q25:I believe I can learn well in a mathematics/physics course.
Q26:I believe I can complete all of the assignments in a mathematics/physics course.
Q28:I believe I can understand the content in a mathematics/physics course.
Q29:I believe I can do well on a mathematics/physics test.

The MATH-010 showed lower anxiety and higher self-efficacy on questions 27 and 28.

## Conclusion

The lay theory intervention provided benefits to students in MATH-010, resulting in higher course grades than for students in the control group. Students in PHYS-291 did not see any benefits from the intervention.

The MATH-010 students showed greater decreases in anxiety towards math and increased self-efficacy than the control group on 10 out of 32 survey questions. Changes in the other 22 questions were not statistically different between the two groups.

The students in MATH-010 started with greater anxiety related to certain aspects of math than students in the PHYS-291 course and they experienced a greater change in their anxiety levels, which may explain why the lay theory provided benefits to the MATH-010 students.

## Future Directions

The difference between the PHYS-291 and MATH-010 results are interesting and worth further study. We will look at how the initial anxiety levels and self-efficacy correspond to benefiting from the intervention. We plan to look at gender and ethnicity. We will also look at whether affective factors (anxiety/self-efficacy) or minority status (gender/first generation/ethnicity) are better predictors of benefiting from the intervention.

The small sample size of MATH-010 is a limiting factor. More sections of this class are offered during fall semesters so this will yield more data. We will continue to take data in PHYS-291, although we do not expect the results to change as a result of gathering more data. We will also consider looking at students in an algebra-based physics course. These students are more likely to have significant math and science anxiety and lower self-efficacy and would be more likely to benefit from our intervention.

## References

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