Student Beliefs on Math Ability and Sense of Belonging to a Math Community

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Background

This work is based on the findings of Dweck and Legett [1] regarding implicit theories of intelligence and how these theories affect math motivation and achievement. Dweck and Legett identified two different beliefs (or implicit theories) about intelligence.

- Students with implicit entity (or fixed) beliefs are more likely to assume that their knowledge and abilities are not malleable or open to change from experience.
- Students with implicit incremental (or malleable) beliefs assume that their abilities can be changed over time through effort and learning.

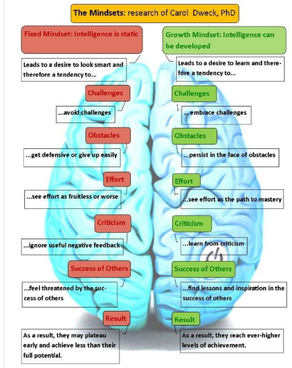

Figure 1: Fixed vs. growth mindset

Questions Considered

- Do women and men students in lower-level mathematics courses differ in their implicit theories of math ability and are there changes in these implicit theories ?
- Are there changes in students' sense of belongingness and self-concept over the course of the semester?
- Do women and men students differ in their sense of belongingness to a math community and does belongingness correlate with implicit theories of math ability?

The Sample

We surveyed four 100-level math courses at Denison University with a total of 182 students (69 men, 113 women).

- Intro to statistics (N=44, 14 men, 30 women)
- Essentials of calculus (N=41, 17 men, 24 women)
- Single variable calculus (N=57, 21 men, 36 women)
- Multi-variable calculus (N=40, 17 men, 23 women)

References

[1] Dweck, C., Legett, E. (1988). A social cognitive approach to motivation and personality. Psychological Review, **95**, 256–273.

[2] Good, C., Rattan, A., Dweck, C. (2012). Why do women opt out? Sense of belonging and women's representation in mathematics. Journal of Personality and Social Psychology, **102**, 700–717.

[3] Rattan, A., Good, C., Dweck, C. (2012). "It's ok- not everyone can be good at math": Instructors with an entity theory comfort (and demotivate) students. Journal of Experimental Social Psychology, **48**, 731–737.

The Measurement Tool

A 21 question survey based on the works of Good et al. [2] and Rattan et al. [3] was used. The identical survey was administered during the first and last week of classes. The study had IRB approval, was voluntary, and students signed an informed consent. The survey measured each student's implicit theory of math ability, sense of belongingness to a math community, and three other items that measured self-concept associated with success in math. Items were randomly ordered and a 6-point response scale was used (1= Strongly Disagree, 6= Strongly Agree).

FIXED ENTITY (Implicit theory)(higher scores = fixed entity; lower scores = incremental)

- My math intelligence is something about me that I personally can't change very much.
- I can learn new things, but I don't really have the ability to change my basic math intelligence.
- To be honest, I don't think I can really change my math intelligence.
- I don't think I personally can do much to increase my math intelligence.

ACCEPTANCE (Belongingness)(higher scores = a stronger belief of acceptance)

- When I am in a math setting, I feel accepted.
- When I am in a math setting, I feel valued.
- When I am in a math setting, I feel excluded. (reverse-scored)
- When I am in a math setting, I feel neglected. (reverse-scored)

MEMBERSHIP (Belongingness)(higher scores = a stronger belief of membership)

- I feel that I belong to the math community.
- I consider myself a member of the math world.

TRUST (Belongingness)(higher scores = a stronger belief of trust)

- When I am in a math setting, I have trust that I do not have to constantly prove myself.
- When I am in a math setting, I trust my instructors to be committed to helping me learn.

POSITIVE AFFECT (Belongingness)(higher scores = a stronger belief of positive affect)

- When I am in a math setting, I feel anxious. (reverse-scored)
- When I am in a math setting, I feel comfortable.
- When I am in a math setting, I feel inadequate. (reverse-scored)
- When I am in a math setting, I feel at ease.

DESIRE TO FADE (Belongingness)(higher scores = a stronger belief of negative affect)

- When I am in a math setting, I try to say as little as possible.
- When I am in a math setting, I wish I were invisible.

OTHER (self-concept)

- Overall, being good at math has little to do with how I feel about myself.
- In general, I enjoy math.
- How likely are you to take math classes in the future?

Outcomes

Question 1

- The average pre/post-test response for women and men were both 2.4/2.5 which is closer to the incremental (or growth mindset) where a response of 3.5 is neutral (see Figure 2).
- There was no significant change in time for this belief and gender did not reveal any significant differences in implicit theory of math ability at either the beginning or end of the semester.

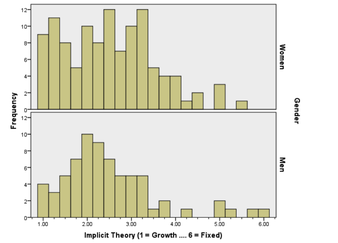

Figure 2: Frequencies by gender of average responses pre-/post-test implicit theory questions

Question 2 (see Figure 3)

- Of the five measures of belongingness, there were statistically significant decreases in three: membership, acceptance, and positive affect.
- Of the three measures of self-concept, there were statistically significant decreases in two: enjoyment and Interest in future course.

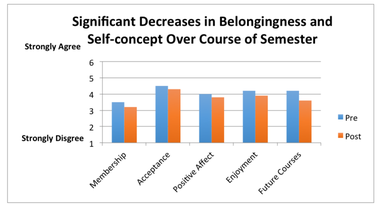

Figure 3: Changes in Belongingness and Self-Concept

Question 3

- Figure 4 shows that there were three significant gender differences in three of the belongingness measures averaged over time: Men reported higher feelings of membership and acceptance; women reported higher feelings of motivation to fade (negative affect).
- For women, statistically significant negative correlations were found between implicit theory ratings and several other measures. For example, women who held a stronger growth theory also reported higher levels of belongingness for membership, acceptance, positive affect, and trust; and higher levels of math identification, enjoyment, and motivation to take future math courses. measure.

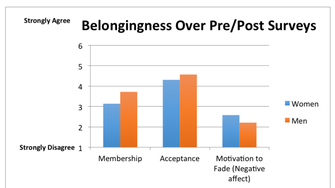

Figure 4: Significant Gender Differences in Three Belongingness Measures Averaged Over Pre/Post Surveys

- For men, their implicit theory ratings did not correlate with any belongingness or self-concept
- There were no significant differences in course grade (women = 2.81, men = 2.63).

Future Questions to Consider

- How might gender differences in belongingness affect students' decisions or motivation to take upper-level math courses?
- Will these patterns of implicit beliefs and belongingness to a math community be replicated in students who undertake upper-level math courses?