SIISP: Self-Efficacy Intervention to Improve STEM Performance

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OBJECTIVES:
• Develop, test, document, and disseminate a practical, scalable intervention to increase self-efficacy in university STEM students.
• Develop and validate an efficient instrument for measuring university STEM self-efficacy, growth mindset, and perceived academic control in university STEM students.
• Improve our understanding of the dynamics of self-efficacy – the factors that lead to growth, especially for traditionally under-represented, at-risk demographic groups.

THE INSTRUMENT:
• 34 Likert scale items gauging three psychosocial traits, plus demographic questions:
  → 20 items targeting self-efficacy (in 3 sub-groups);
  → 7 items targeting perceived academic control; and
  → 7 items targeting growth mindset.
• Iteratively improved through three revisions.
• Validated via exploratory factor analysis, Rasch analysis, and multi-trait multi-method comparison to coded interviews (in progress).
• Rasch modeling produces a reliable estimate for each student’s trait scores, with uncertainties (±).
• Efficient and portable: can be administered online or via scannable paper form; requires ~10 minutes to complete.

THE PROTOCOL:
• Week 1: Solicit informed consent, collect demographics, & pre-test with survey (“the instrument”) for baseline.
• Week 4 (or shortly after first course exam): Main intervention in lab meetings; collect workbooks w/written responses (qualitative data) and subset of questionnaire.
• Week 7: Follow-up intervention in class or online; worksheet provides more qualitative data.
• Subsequent academic term: Delayed post-test with same survey (third time) for longevity of impact.
• Timeline is adaptable to each course schedule.
• Students are quasi-randomly assigned by lab section to either treatment or control groups.
• The control group receives an alternate intervention about “cultural competency,” designed to be relevant and engaging but unlikely to influence instrument responses.

WHAT’S NEXT?
• Replicate the Spring 2018 results in Fall 2018, including a third site and much larger population.
• Validate the survey instrument against interview data.
• Polish and package for distribution the intervention and survey instrument.
• Seek partners for implementation and scaling-up research.

Why?
• Self-efficacy (beliefs about one’s ability to perform tasks successfully) is a psycho-social construct that strongly correlates with academic success. It is a stronger predictor of student performance than purely cognitive traits.
• Social/psychological interventions are particularly effective for women and underrepresented minorities because they mitigate stereotype threats.
• No practical, replicable interventions exist to increase university-level STEM students’ self-efficacy. Extant interventions are resource-intensive, hard to replicate, and domain-specific.
• Growth mindset is a key ingredient for maintaining and strengthening self-efficacy in the face of challenges.

THE INTERVENTION:
• One 30-minute main session in a lecture, recitation, or lab section, led by a project team member.
• One 10-minute follow-up ~3 weeks later, in-class or online.
• Main session involves interspersed presentation (oral PowerPoint), narrated video, open discussion, and written reactions in a workbook.
• Focuses on the science of growth mindset, its link to academic success, and its application to taking a hard STEM course.
• Suggests concrete strategies and actions students can try to manifest growth mindset in their behavior (thus encouraging a sense of academic control).
• Followup session worksheet asks students to recall key ideas and reflect on whether/how they’ve adjusted their behaviors.
• Intervention design elements are based on successful extant interventions for success/failure attributional retraining and growth/fixed intelligence mindset.

RESULTS & FINDINGS SO FAR:
• Data drawn from calculus- and algebra-based physics at three North Carolina public universities with different demographics.
• Linear modeling was used to test the impact of treatment vs. control on pre-test to post-test score changes for self-efficacy (SE), growth mindset (GM), and perceived academic control (PAC) – including interactions with institution, course, and demographics.
• Spring 2017: No statistically significant effects of treatment vs. control, prompting revisions of instrument & intervention.
• Fall 2017: Greater increase in GM for treatment than control (p=0.02). Effect depends on institution (p=0.1).
• Spring 2018: Due to treatment, significant increase in GM (p<0.001), marginally significant increase in SE (p=0.062), significant increase in PAC for calculus-based courses (p<0.01).
• We’ve also learned much about the details of delivering an effective self-efficacy intervention, including mechanisms for increasing engagement, and contextual characteristics of the course and university that mediate success.