Improving STEM Motivation and Retention with Postsecondary Classroom Interventions: A Meta-Analysis

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Year 1: Protocol creation, literature search, screening → **Year 2:** Screening, coding → **Year 3:** Analysis, dissemination

Need for Improving STEM Retention and Motivation

- Fewer students graduating with STEM degrees can hinder efforts to meet growing demand for workers with STEM skills and experience[1]. ***Identifying interventions that influence postsecondary STEM retention decisions*** is a key effort in addressing this issue.
- Our meta-analysis sought to identify interventions to improve undergraduates' STEM motivation and retention. ***Motivational factors predict undergraduate retention,*** even after controlling for prior performance and academic ability.[2]
- Prior meta-analyses have either examined instructional innovations while focusing on achievement outcomes only[3] or examined motivational interventions while excluding instructional innovations.[4]

Meta-Analytic Research Questions

1. What are the average effects of classroom-based motivational and instructional interventions on undergraduate retention and motivational outcomes in STEM?
2. What factors explain or contribute to heterogeneity of effects of these interventions?
3. What intervention types show differential effects for certain groups and are especially effective at narrowing STEM outcome gaps?

Example Eligible Classroom-Based Interventions

- **Motivational interventions**
  - Task-value interventions (e.g., utility value)
  - Framing interventions (e.g., self-efficacy)
  - Personal values interventions (e.g., values affirmations)
- **Instructional interventions**
  - Peer-led instruction
  - Cooperative/collaborative learning
  - Flipped classrooms

Eligible studies must also (a) use an experimental or quasi-experimental design, (b) measure a quantitative STEM retention or motivation outcome, and (c) include a sample of undergraduates.

Year 1 Project Activities

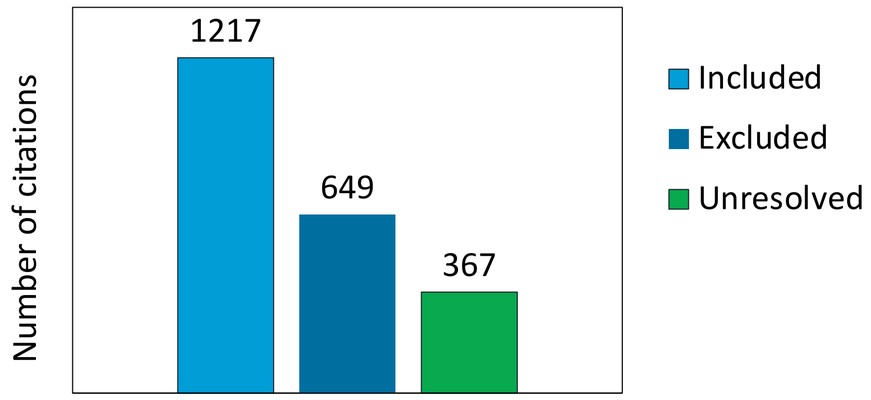
Literature Search

Used litsearchr, a state-of-the-art automated search process in R (Grames, 2019), to systematically identify relevant keywords for searching literature databases (e.g., ERIC, PsycInfo, Web of Science), yielding more than 18,000 unique citations abstracts to screen for relevancy.

Abstract and Full Text Screening

- Using a systematic screening protocol, we found **an abstract inclusion rate of 26%** for a random subsample of abstracts that would require closer review for eligibility based on the article full text, indicating a large body of potentially relevant literature.
- We are using Abstrackr, a machine learning tool, to prioritize and dual screen the most relevant abstracts, yielding high inclusion rates for the non-random set of abstracts screened so far (Figure 1).

Figure 1. Current Number of Screened Abstracts (Out of 18,479)



Challenges and Next Steps

Interesting challenges encountered so far include:

- Defining the boundary of a classroom when identifying "classroom interventions" (e.g., summer bridge programs)
- The treatment of samples of pre-professional students and STEM courses for non-majors (e.g., Chemistry for nursing majors), and
- Determining the eligibility of attitudinal outcomes (e.g., enjoyment of the course).

Immediate next steps will be to finish abstract screening and then conduct full-text screening to determine the set of included studies.

Footnotes

1. U.S. Bureau of Labor Statistics. (2020). Employment in STEM Occupations. https://www.bls.gov/emp/tables/stem-employment.htm
2. Robbins, S. B., Le, H., Davis, D., Lauver, K., Langley, R., & Carlstrom, A. (2004). Do psychosocial and study skill factors predict college outcomes? A meta-analysis. *Psychological Bulletin, 130*(2), 261– 288. https://doi.org/10.1037/0033-2909.130.2.261
3. Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences of the United States of America, 111*(23), 8410– 8415. https://doi.org/10.1073/pnas.1319030111
4. Lazowski, R. A., & Hulleman, C. S. (2016). Motivation interventions in education: A meta-analytic review. *Review of Educational Research, 86*(2), 602–640. https://doi.org/10.3102/0034654315617832