# Creating and Assessing Classroom Interventions to Improve College-Level STEM Students' Approaches and Reactions to Challenges and Failure

Meredith A. Henry[1], Shayla Shorter[1], Louise Charkoudian[2], Jennifer M. Heemstra[1], & Lisa A. Corwin[3]

Introduction

- Navigating scientific challenges and coping with failure are hallmarks of a successful scientist.[1]
- Few studies investigate how undergraduate STEM students develop these skills or how STEM instructors can facilitate this development.
- FLAMEnet (**F**ailure as a part of **L**earning: A **M**indset **E**ducation **Net**work) creates and disseminates classroom interventions to address this gap.
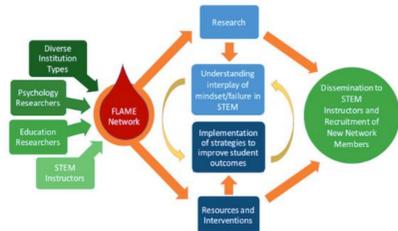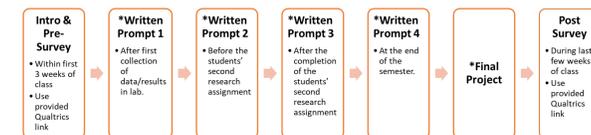

- One prime target for intervention is **fear of failure (FF)**, emotional and cognitive responses to perceived threats that decrease achievement through lack of challenge-engagement and self-handicapping. [2, 3]
- We assess FF through a modified version of the PFAI [3]
  - Self-report
  - Scale: 5 point from 1 "Never true of me" to 5 "True of me all of the time."
  - **Re-validated,** STEM undergrads, n=1309
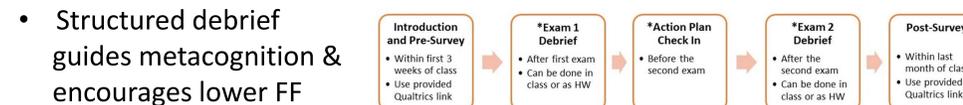 - Confirmed **4 reasons** STEM undergraduates fear failure (**Table 1**).

Table 1. Fear of Failure subscales.

Subscale	Sample Item
Fear of an Uncertain Future (FUF)	*"When I am failing…it upsets my "plan" for the future."*
Fear of Important Others Losing Interest (FIOLI)	*"When I am not succeeding…my value decreases for some people."*
Fear of Upsetting Important Others (FUIO)	*"When I am failing…important others are disappointed."*
Fear of Experiencing Shame and/or Embarrassment (FSE)	*"When I am failing…I worry about what others think about me."*

FLAMEnet Interventions


Reflections on Learning (Lab courses):
- Prompts designed to motivate metacognition around research process and lab challenges

Exam Debrief (Lecture courses):
- Structured debrief guides metacognition & encourages lower FF

Main Findings

- Multiple linear regression equations
  - **Dependent Variable:** Change Score for Fear of Failure subscales (Pre-survey score – Post survey score)
  - **Predictor Variables:**
    - *Round One:* Baseline Fear of Failure, Gender, SES, Race (Caucasian or non-Caucasian), Ethnicity (Hispanic/Latinx or non-Hispanic/Latinx, Prior College STEM experience, STEM anxiety
    - *Round Two:* Baseline Fear of Failure, Ethnicity, STEM experience, STEM anxiety, Ethnicity*Experience, Ethnicity*Anxiety
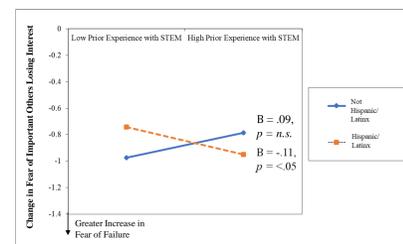
Figure 4. STEM experience interacts with ethnicity
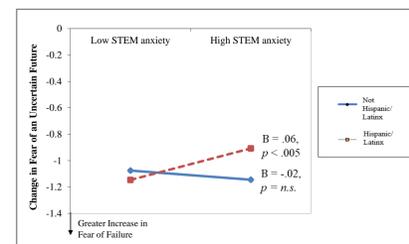

Figure 5. STEM anxiety interacts with ethnicity

- **Hispanic students** with **fewer STEM experiences** *(Figure 4)* and **more STEM anxiety** *(Figure 5)* showed **less increase** in both **FUF** and **FIOLI** in the lab course.
- Provides some support for interventions' effectiveness in at-risk students
- Average FIOLI increased pre- to- post intervention. Baseline assessments of fear of failure may not be most accurate, as students have yet to encounter STEM failure. Adding mid-semester evaluation would be beneficial

References
(1) Henry, M. A., Shorter, S., Charkoudian, L., Heemstra, J. M, & Corwin, L. A., (2019). *FAIL is not a four-letter word: A theoretical framework for exploring undergraduate students' approaches to academic challenge and responses to failure in STEM learning environments. CBE-Life Sciences Education, 18*(1), ar11.
(2) Bledsoe, T. & Baskin, J. (2014). Recognizing student fear: The elephant in the classroom. *College Teaching, 62*(1), 32-41.
(3) Elliot, A. J., & Thrash, T. M. (2004). The intergenerational transmission of fear of failure. *Personality and Social Psychology Bulletin, 30*, 957–971.
(4) Conroy, D. E. (2001). Progress in the development of a multidimensional measure of fear of failure: The performance failure appraisal inventory (pfai). *Anxiety, Stress, and Coping, 14*(4), 431-452.

Preliminary Findings

- Data analyses of two classrooms which implemented FLAMEnet interventions in Fall 2018
- Lab Course:
  - Multiple sections of Foundations of Biology lab
  - Public research university in mid-Atlantic U.S.
  - N=575; 70% female
- Lecture Course:
  - Two sections of Introductory Chemistry
  - Public research university in southeast U.S.
  - N=121; 78% female
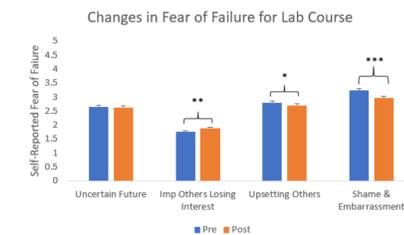
Figure 2. Average change in fear of failure pre- to post- intervention in lab course *p<.05; **p<.01, **p<.005
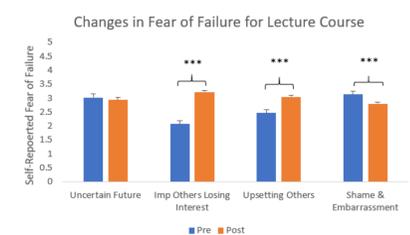
Figure 3. Average change in fear of failure pre- to post-intervention in lecture course *p<.05; **p<.01, **p<.005

- Lab *and* lecture courses showed a significant decrease in Fear of Shame & Embarrassment *(Figures 2 & 3)*.
  - Experiencing/discussing STEM failure(s) may "normalize" in any context
  - Interventions may be most effective on *internal* processes

Future Directions

- Expand detailed analyses to more classrooms
- Consider factors unique to intervention implementation (e.g., timing of intervention and assessment, paper vs. online assessment, protocol modification by instructors, etc.)
- Consider cumulative effects of interventions over time

Acknowledgements