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Work-in-Progress: Psychological Safety, Belonging, and Expectancy: Early Insights from a Longitudinal Study of First-Year Engineering Students

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Background and motivation: This empirical work-in-progress paper presents preliminary data and next steps for a longitudinal mixed-methods study examining the relationship between psychological safety, sense of belonging, and expectations of success among first-year engineering students at the University of Arkansas (UA), a public R1 university in the United States. There is a critical need to educate and graduate more engineers to meet state and national workforce needs, but retaining undergraduate engineering students continues to be a challenge [1]. In Arkansas specifically, engineers, computer scientists, and data scientists have been identified as key drivers of economic growth; state and university goals to double the number of graduates from UA's College of Engineering by 2035 are estimated to create a $3.9 billion economic impact [2]. One factor that may help retain engineering students is increased psychological safety on their engineering teams. Psychological safety is the shared belief that a team is safe for interpersonal risk-taking without fear of repercussions [3], [4]. Psychological safety can improve teamwork [5], [6] and may be linked with sense of belonging and expectations of success for engineering students, two key constructs linked with retention in engineering [7], [8], [9]. While prior research has explored psychological safety on undergraduate engineering teams (see [10], [11], [12], [13], [14], [15]), its longitudinal impact on first-year students' outcomes remains underexplored. Further, research in other fields has suggested a link between psychological safety and sense of belonging [16], [17], which connects to outcomes like mental health, performance, and persistence in college [18], [19]. Similarly, expectations of success have been linked to persistence in engineering specifically [7], [8], but work on both constructs remains limited relative to psychological safety. In this work, we draw on Conservation of Resources theory to consider how psychological safety relates to academic outcomes and subsequent persistence in engineering. The underlying principle is that students aim to retain and accumulate resources and avoid the loss of resources [20]; psychological safety in a learning environment can enhance perceived resources while minimizing perceived threats, thus leading to positive academic outcomes and long-term persistence in an engineering major.

Methods: We address two research questions by conducting a longitudinal cohort study of first-year engineering students in the 2025-2026 academic year. The study uses a convergent mixed-methods design, and all data is collected through a Qualtrics survey. Data was collected four times in the fall semester and four times in the spring semester. This paper highlights initial findings from Fall 2025. The two research questions that this work-in-progress addresses are: (RQ1) How does psychological safety change throughout a 2-semester introduction to engineering course? (RQ2) How does psychological safety relate to first-year students' sense of belonging and expectations of success in engineering over time?

The survey included three validated, quantitative measures. All three quantitative measures required a participant response and will later be used in repeated-measures multilevel models.

Psychological safety was measured using Edmondson's Team Psychological Safety Scale [3]. This scale is the most commonly used measure of psychological safety [21]. It has been shown to have good reliability and validity and strong intraclass correlation [3], and it has been used in prior engineering education research (see [12], [22], [23]). This scale includes seven questions (three reverse-coded) that respondents answer on a five-point scale of strongly disagree to strongly agree. Sample items include "Working with members of this team, my unique skills and talents are valued and utilized" and "If you make a mistake on this team, it is held against you" [3]. Psychological safety was measured at the individual level at each time point for perceived psychological safety [21] and will be averaged for all team members on a given team for a team psychological safety value. To justify aggregation to a team score, within-team agreement will be assessed and the intraclass correlation will be examined the reliability of team-level means [24], [25]. We measured psychological safety on teams as opposed to other contexts because this is the most common and best validated context for the selected instrument [21]. Sense of belonging was measured using a combination of two scales: (1) the Programme for International Student Assessment (PISA) sense of belonging index [26], originally developed in 2003 and modified for use in higher education by Pedler et al. [27]; and (2) the belonging from the SUCCESS Survey [28]. Sample items include "I feel like I belong in engineering" and "I feel comfortable in engineering." All items are measured on a five-point scale from strongly disagree to strongly agree. Belonging will be used as an individual-level measure. Expectations of success were measured using the expectancy questions from the SUCCESS survey [28]. The expectancy questions from the SUCCESS survey include five items measured on a five-point scale from strongly disagree to strongly agree. Sample items include "I expect to do well in my engineering classes" and "Considering the difficulty of my engineering classes, the teacher, and my skills, I think I will do well in my engineering classes." Two additional questions from Cheryan et al. [29] were also included to capture expectations of success in the engineering major. Expectations of success will be used as an individual-level measure.

Additional optional open-ended questions were included to capture events that impacted students' feelings of psychological safety, belonging, and success beliefs. For example, participants were asked "In 3-4 sentences, describe your experience interacting with your team members during your most recent project or lab. Were the perspectives of all team members heard? Do you feel like you and your teammates could openly ask questions or share thoughts and ideas? Why or why not?" Participants were also asked to "describe any experiences from the last few weeks that impacted psychological safety for yourself personally or on your team."

Context, sampling, and recruitment: Participants were first-year engineering students at the University of Arkansas. The average retention rate at UA over the last five years remains over ten percentage points lower than the national average. Since the addition of the common first-year engineering program (FEP), first-year retention has increased by 14 percentage points, but the continuing gap between the university's retention rate and the national retention rate remains a concern. As part of the university's common first-year engineering program, all engineering

students take two semesters of a one-credit Introduction to Engineering course. For the purposes of this paper, we will focus on the data collected in Fall 2025. In the first Introduction to Engineering course (Intro I), students participate in five mini-projects throughout the semester. Each of these mini-projects lasts between one and three weeks. Students work on teams of two to three for these projects, and they work on different teams for each project. In Fall 2025, there were 695 eligible students enrolled in Intro I across 16 sections. Data collection occurred as part of the course requirements, and students who completed all four surveys in one semester earned extra credit in the course. To document early measures, the initial survey was administered in Week 4, prior to the completion of any projects but after the start of Project 1. The second survey was completed in Week 7 after Project 1. The third survey was completed in Week 11 after Project 3. The fourth and final survey was completed in the final week of the semester, Week 16, after Project 5. Data collection surrounding Projects 2 and 4 was skipped due to the short, two-day duration of the projects and to avoid survey fatigue. The study received IRB approval prior to data collection under protocol #2505608587.

Preliminary findings and anticipated results: In Fall 2025, we received 1,624 total responses, including 597 unique participants. 416 participants responded to exactly one survey, 203 responded to exactly two surveys, 122 responded to exactly three surveys, and 109 responded to all four surveys. Participants were asked to complete demographic data if it was their first time completing the survey; demographic data is summarized in Table 3 in the Appendix. We have calculated average individual psychological safety (PS), belonging (Bel.), and expectancy (Exp.), and expectations of success in the engineering major (Succ., from [29]) at each of the four time points throughout the semester, along with standard deviation, which is summarized in Table 1. One corresponds to “strongly disagree” and five corresponds to “strongly agree”, so values closer to five indicate a more positive experience. Initial trends show increases in psychological safety, belonging, and expectations of success in the engineering major and decreases in expectancy throughout the semester.

Table 1 Summary of psychological safety, belonging, expectancy, and success expectations across four time points in Fall 2025

Time point	**Mean PS**	**SD PS**	**Mean Bel.**	**SD Bel.**	**Mean Exp.**	**SD Exp.**	**Mean Succ.**	**SD Succ.**
1: 9/14/25	3.54 (*n*=408)	0.66	3.78 (*n*=403)	0.74	NA*	NA*	3.79 (*n*=403)	0.73
2: 10/5/25	3.84 (*n*=332)	0.73	3.86 (*n*=330)	0.74	4.38 (*n*=26)	0.78	3.83 (*n*=329)	0.82
3: 11/2/25	4.14 (*n*=398)	0.73	4.00 (*n*=392)	0.69	4.23 (*n*=394)	0.73	3.90 (*n*=396)	0.83
4: 12/4/25	4.16 (*n*=349)	0.75	4.06 (*n*=348)	0.72	4.18 (*n*=347)	0.80	3.91 (*n*=347)	0.76

*The expectancy measures from the SUCCESS survey were added late and were missed in early responses.

We also conducted initial Pearson correlations using individual responses to identify any statistically significant correlation between psychological safety, belonging, expectancy, and

expectations of success. Each individual relationship was statistically significant and positively correlated; these are summarized in Table 2.

Table 2 Descriptive statistics and correlation matrix between study variables based on all individual Fall 2025 responses

Variable	*n*	*M*	*SD*	1	2	3	4
1. Psychological safety	1233	3.92	0.77	-			
2. Belonging	1226	3.93	0.73	0.48**	-		
3. Expectancy	621	4.23	0.74	0.44**	0.59**	-	
4. Success beliefs	1223	3.86	0.77	0.21**	0.44**	0.58**	-

*p<.05. **p<.01.

While there is a large amount of qualitative data, one exemplary quote regarding team interactions comes from a participant early in the semester, sharing *"Every time one of us has an issue we work through the problem and share insights never with any judgement or undermining. I make sure to include everyone through talking and asking questions."* Alternatively, participants had team experiences that negatively impacted their psychological safety and teamwork. One participant, for example, wrote: *"Working on this project was generally mediocre…my team became fixated on their idea and were reluctant to listen to other ideas. Additionally, when I tried to give input it became a matter of justifying, reasoning, defending…I did not feel like I could be open with my team…"*

Next steps: We have continued to collect data Spring 2026 during the second Introduction to Engineering course. We will incorporate the complete 2025-2026 data once data collection is done. Quantitative data will be analyzed using repeated-measures multilevel modeling, which accommodates the nested data structure and allows us to capture changes in the study variables over time, to evaluate the relationships between the variables, and to evaluate whether there are differential effects of team psychological safety on belonging and expectancy. A subset of the qualitative data will be analyzed using thematic analysis [30] to explore potential reasons for changes in psychological safety over time and examine why psychological safety, belonging, and expectations of success may be related. We will also investigate whether there are differential effects of psychological safety on sense of belonging and expectations of success on different groups of students, such as students of color, women, and first-generation students. Findings from this study may inform the timing and design of targeted interventions to foster improved team and classroom environments, ultimately supporting broader efforts to improve retention in engineering education. Qualitative responses may also suggest potential directions for the development and evaluation of interventions or educational practices. Positive practices can then be adapted and evaluated in different settings while negative practices can be modified or removed in future offerings in the first-year program.

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Appendix

Table 3 Summary of participant characteristics

Characteristic	Response	Count	Percent
Age (*n*=561)	Years, mean	18.4	NA
Sex (*n*=561)	Female	131	23.4%
	Male	411	73.3%
	Non-binary	4	0.7%
	Other	0	0%
	Prefer not to say	12	2.1%
	Prefer to self-describe	3	0.5%
Race/ethnicity (*n*=561)	American Indian or Alaska Native	6	1.1%
	Asian	45	8.0%
	Black or African American	20	3.6%
	Hispanic or Latinx	50	8.9%
	Middle Eastern or North African	2	0.36%
	Native Hawaiian or other Pacific Islander	1	0.18%
	Other	1	0.18%
	Prefer not to say	14	2.5%
	Two or more races	60	10.7%
	White	362	64.5%
First-generation status (*n*=561)	First-generation college student	146	26.0%
	Not first-generation college student	353	62.9%
	Unknown	62	11.1%