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Board 349: Predicting Persistence in Engineering via Framing Agency

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Predicting Persistence in Engineering via Framing Agency

Introduction & research purpose

This paper reports results from an NSF CAREER award.

With perennial interest in broadening participation in engineering, much focus has been given to predicting persistence. Persistence intentions related to degree completion and pursuance of engineering career are commonly connected to developing a strong sense of identity in the discipline and feelings of confidence (or self-efficacy) about disciplinary practices [1, 2]. While psychosocial factors like identity and self-efficacy are often studied in engineering, they are less often linked to specific learning experiences, such as design education. Even studies investigating the contributions that design education makes have yet to disambiguate the impact of design education from persistence behaviors. For instance, a survey study linked participating in capstone design to stronger engineering identity, but without accounting for the differences that might be due to comparing seniors to students earlier in their educational careers [3].

To address this gap, we extend typical models of persistence intentions to examine the effects of engagement in a core engineering practice—design problem framing—across first-year and senior students. We conjectured that framing agency—the capacity to make decisions consequential to design problem framing [4]—relates to engineering identity and engineering design self-efficacy, which in turn predicts persistence intentions. We sought to answer a research question:

- To what extent do framing agency constructs predict first-year and senior students' design self-efficacy, engineering identity, and persistence intentions?

Background

Research in engineering education and other STEM fields has long linked self-efficacy and identity to persistence [1, 2]. Self-efficacy, which can be considered synonymous with confidence, refers to the degree to which one feels they can accomplish some task [5]. As such, self-efficacy is situated to specific endeavors, like mathematics, engineering design, etc.

In the current study, we build on recent development and testing of the framing agency survey [6, 7], which identified subconstructs:

- Individual consequentiality describes how responsible students feel for making decisions;
- Shared consequentiality describes how important teammates' decisions are;
- Learning as consequentiality is the notion that students learn as a result of these decisions;
- Constrainedness indicates that design problems occur under constraint, but with degrees of freedom; and
- Tentativeness, the notion that design problems and solutions are tentative, rather than well-structured.

We explore how these relate to engineering identity, self-efficacy, and persistence intentions.

Methodology

The current study uses structural equation modeling of survey responses to investigate the relationships between students' perceptions of their agency, identity, self-efficacy, and persistence (Table 1). We used the framing agency survey [6, 7], which incorporates research-based measures of design self-efficacy [8, 9] and engineering identity [1, 10].

Table 1. Survey questions and constructs measured

Construct	*Items (7-point scale, with ends named in question)*
Individual consequentiality The extent to which an individual reports that the problem changed, or their understanding changed as a result of decisions made individually meaning that the decisions were consequential.	How responsible or not responsible have you felt: • for making decisions personally? • for coming up with your own ways to make progress on the design project? • for the outcomes of the design project? Considering the decision you described, how important or unimportant was: • the decision? • the impact of that decision on your design process?
Shared consequentiality The extent to which an individual reports that the problem changed, or their understanding changed as a result of decisions made by the team, meaning that the decisions were consequential.	Considering the [teammate's] decision you described, how important or unimportant was: • the decision? • the impact of that decision on your design process?
Learning as consequentiality The extent to which an individual reports that their understanding changed because of decisions made individually or by the team, meaning that the decisions were consequential.	How much or little have you learned as a result of • decisions about the design problem you personally made? • decisions about the design problem a teammate made?
Constrainedness The extent to which an individual reports having opportunity to make decisions about the problem despite having design requirements or constraints.	Considering these constraints, how free or restricted: • have you felt when making decisions yourself? • have your teammates seemed when making decisions? How free or limiting does the design problem seem to be?
Shared tentativeness The extent to which an individual reports certainty about the design problem and solution.	How certain or uncertain do you feel that: • your design project has a single right solution? *(reversed)* • you have to solve the problem as given to you? *(reversed)* • you have to just develop what was asked of you? *(reversed)*

Construct	*Items (7-point scale, with ends named in question)*
Design self-efficacy Confidence that one can complete practices/tasks associated with designing.	How certain or uncertain are you that you can: • identify a design need • develop design solutions • evaluate and test a design • recognize changes needed for a design solution to work
Engineering identity Degree to which one positions self and is positioned by others as belonging in engineering.	Please rate your agreement with the statements below: (Strongly agree / Strongly disagree) • My parents, relatives, and friends see me as an engineering person • My instructors see me as an engineering person • I feel like I belong in engineering
Persistence in degree	I intend to complete my current degree in engineering (Strongly agree / Strongly disagree)
Persistence post degree	I intend to stay in engineering for at least 3 years after I graduate—as a professional engineer, a graduate student, and/or researcher. (Strongly agree / Strongly disagree)

Following IRB approval, we collected a national sample (N = 991): 59% (583) were first-years and 31% (305) seniors; a majority (69%, 685) were men and from racial and ethnic groups that are privileged in engineering (82%, 809). Overwhelmingly, students reported working in teams (96%). We calculated descriptive statistics and conducted structural equation modeling [11, 12]. We found a comparative fit index (CFI) of .93; greater than 0.9 is acceptable [13]. We found a standardized root mean square residual (SRMR) of .06; less than 0.8 suggests a good fit [14]. These indicate that our model, despite being complex, is overall a good fit.

Results and discussion

Overall, we found that students expressed a strong intention to persist to degree (M = 6.46; SD = 1.67, all constructs on scale 1-7), not surprising given the percent of seniors in the sample. They also expressed generally positive intentions to persist in engineering careers following graduation (M = 5.80; SD = 1.23). Students reported high design self-efficacy, (M = 5.64; SD = 1.00) and engineering identity (M = 5.55; SD = 1.17). In terms of the framing agency constructs, students reported very high shared consequentiality (M = 6.22; SD = 0.96); high individual consequentiality (M = 5.98; SD = 0.72); high learning consequentiality (M = 5.67; SD = 0.98); and moderately high constrainedness (M = 5.02; SD = 1.23); the scale on tentativeness, which probes students' certainty that their role is to solve the problem as if it were well-structured rather than an ill-structured design problem, is reversed (such that a high score is aligned with design practice), and students expressed neither certainty nor uncertainty about this (M = 4.09; SD = 1.29).

In terms of our overall model, engineering identity, but not design self-efficacy positively predicted persistence intentions. This outcome is interesting because self-efficacy measures often predict persistence intentions [1, 2, 15] and are sometimes even treated as a fundamental component of identity within engineering education research [15]. One explanation for this finding is that we measured *design* self-efficacy, and students may or may not perceive design as central to engineering. Indeed, research suggests that engineering students' perceptions about the discipline are shaped by their course experiences, and when, as is common, course experiences do not align with professional work, students sometimes view problems as solvable through linear, logical methods [16, 17].

Few framing agency constructs directly predicted persistence intentions. However, several framing agency constructs explained variance in engineering identity and engineering design self-efficacy. In particular, individual consequentiality—the sense that one is responsible for making decisions about the design problem—predicted engineering identity and design self-efficacy (Figure 1). In contrast, shared consequentiality tended to negatively predict engineering identity and design self-efficacy.

These results underscore the importance of design education experiences that provide students with opportunities to direct problem framing.

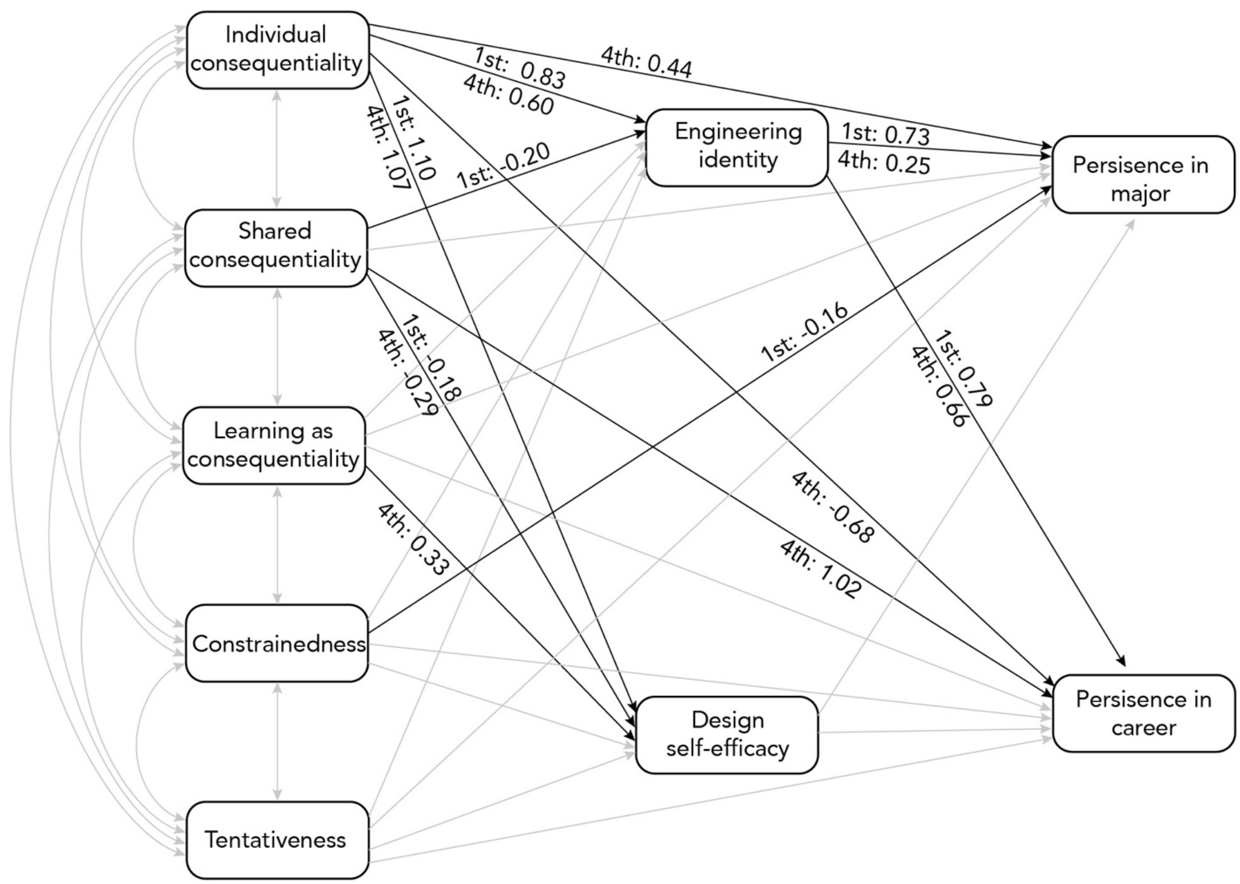

Figure 1. Structural equation model of persistence intentions. Significant relationships are noted with black arrows, comparing first year and senior (respectively, on figure: 1st; 4th) students.

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