The Effects of Length of Participation on Student Mental Health, Professional Identity, and Perceptions of Inclusion in Project-Based Engineering Programs

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The Effects of Time in Program on Student Mental Health, Professional Identity, and Perceptions of Inclusion in Project-Based Engineering Programs

Abstract

Background: This research paper extends previously reported results in which we demonstrated that students in project-based engineering programs report less self-reported stress and depression, stronger personal vision of an engineering career, more positive perceptions of department caring and diversity, and greater pride in their department than those the student population in Jensen and Cross's study of engineering stress culture. No statistically different differences were found for reported anxiety or engineering identity.

Purpose: We examine how these reported measures of engineering stress culture change over time as students participate in entirely project-based engineering and computer science programs. We seek to establish a baseline of measured changes in mental health (stress, anxiety, and depression), professional identity, and inclusion for students in project-based contexts as they progress through from program entry to graduation.

Design/Method: Our continued study uses the validated instrument developed by Jensen and Cross to gather data from the perspective of students pursuing engineering and computer science degrees in entirely project-based learning environments. We compare reported mental health, professional identity, and inclusion measures between students at different stages in their programs.

Results: Students who are new to project-based programs report less stress, less depression, a greater expectation of a career in engineering, and more positive reported feelings of department caring, pride, and diversity than the students studied by Jensen and Cross. After completing one project semester, however, their stress, anxiety, and depression levels become similar to the reference population even though their reported feelings of engineering career orientation and department inclusion remain significantly more positive.

Conclusions: Our results indicate the need for the important future work of determining the nature of the stress that students experience as they progress through our project-based programs, considering their much higher levels of engineering career orientation and feelings of inclusion. This may have important implications for further research into how the structure of project-based learning programs influence student learning and growth.

Background and Perspectives from the Literature

With this research we continue to examine engineering stress culture (ESC) within the context of two project-based engineering programs and one project-based computer science program, all of which are in the same college at our institution. Our main goal is to create a set of baseline measures that will allow us to compare our students' project-based experiences with students studying in more traditionally organized programs.

We continue to treat student culture across all three of our programs collectively as belonging to a shared context. For the purpose of this paper, the computer science program is considered to have an engineering culture, in line with results reported by other authors [1] [2] [3].

The stressful culture of engineering and engineering education contexts has been reported elsewhere, including documentation of student suffering and shared hardship or a bootcamp mentality [4] [5] [6]. Engineering educational programs have been described as having heavy workloads, high expectations, rigorous assignments, smart students, and fierce competition for grades [7] [8] [9]. Stress originating from perceived and experienced exclusion from participation [10] [11], especially for women [12] and people of color [13] has also been reported.

In this paper, we continue our work from our recent results [14] that were a partial replication of Jensen and Cross's [15] approach to studying the ESC of undergraduate level engineering programs. To achieve their goals, Jensen and Cross examined stress, anxiety, and depression; engineering identity; and perceptions of inclusion in undergraduate engineering programs. They collected data from student populations at three large U. S. public universities. They hypothesized that levels of stress, anxiety, and depression would vary by social identities and that levels of inclusion and engineering identity would vary by social identities and across social identities.

To gather data Jensen and Cross relied upon a validated, quantitative survey that had one open-ended item. Their findings indicated that perceptions of inclusion and engineering identity are directly related to student mental health – measures of inclusion such as "Department Caring" and "Department Pride" – were negatively correlated with stress, anxiety, and depression.

In our recent work [14] we followed Jensen and Cross's approach as a means to study the students in our programs. We deployed the same instrument they used, but in our project-based context. We found that students in the project-based programs reported less stress and depression and a stronger vision of an engineering career than the students in Jensen and Cross's population, while the project-based program students reported anxiety and professional identity comparable with the original Jensen and Cross results. Those results aligned with previous work that demonstrates some of the benefits of entirely cohort-based, project-based engineering programs: improved retention of students, more engaged learning, and improved recruitment of non-traditional students [16] [17] [18] [19] [20] [21].

In this paper we deepen the analysis of mental health, professional identity, and perceptions of inclusion to look at how these reported effects change over time as students participate in our three entirely project-based programs of study. We do this by categorizing each student in our studied population by length of time in program at the time of data collection and then comparing the same results as reported in our original paper [14].

Methods

For this research we continued to Jensen and Cross's validated instrument. Students enrolled in our project-based engineering and computer science degree programs were surveyed. Looking at students at different stages of completion of their programs, we compare reported mental health, professional identity, and inclusion measures per their validated instrument results.

Methods: Research Questions

We set out to answer the following research question (RQ) and test the corresponding hypothesis (Hyp):

> **RQ:** How do mental health, engineering identity, and perceptions of inclusion vary as a function of how long students have been participating in project-based programs compared to the population studied by Jensen and Cross?
> **Hyp:** *There are no differences in the scores of self-reported stress, anxiety, and depression, engineering identity, engineering career, department caring, department pride, and/or department diversity between students who have been participating our project-based programs for different lengths of time vs. the student population studied by Jensen and Cross.*

Methods: Measures of Mental Health, Professional Identity, and Inclusion

We used Jensen and Cross's [15] survey method based on fifty-six (56) items.[1] Details can be found in their Appendix, Table A1. What follows is a high level summary of the three main sections (Mental Health, Professional Identity, and Inclusion) of Jensen and Cross's survey method.

We used a simplified form of the Lovibond and Lovibond DASS (Depression Anxiety Stress Scales) instrument [22] - the DASS-21. This instrument measures levels of stress, anxiety, and depression in survey respondents. The twenty-one (21) survey elements from the instrument were evenly distributed (seven each) across the three measurement categories. The survey element results were combined to assign severity levels for each category that range from normal to extremely severe.

We also used the Identification with Academics subscale [23], adapted to engineering, to measure students' level of engineering identity. We used a similar method to measure students' beliefs about whether their career after graduation would be related to engineering. In both cases, ratings on a Likert scale from (1) *Strongly disagree* to (7) *Strongly agree* formed the basis of analysis.

We used Engineering Department Inclusion Level Survey (EDIL) to measure student perceptions of inclusion. This set of measures included department caring, department pride, and department

[1] A typographical error that was discovered after our data was collected unfortunately invalidated the usability of one of the survey questions.

diversity. Each item was rated on a Likert scale from (1) *Strongly disagree* to (7) *Strongly agree* [24][2]

(Please see [14] for details of measurements taken for stress, professional identity, and inclusion.)

In addition, we asked participants to share age, academic major, gender, race/ethnicity, socioeconomic status, first-generation college student status, and whether they speak English as their first language. Students were also prompted respond to the question: "Is there anything else you would like to share that was not included in this survey?" [3]

Methods: Data Collection

We obtained Institutional Review Board approval to conduct the study with students in our three programs (IRBNet ID 1797019). We included only students who were currently enrolled in one of the three programs being studied, and who agreed to participate. We administered the survey asynchronously and online. No rewards, monetary or other, were offered for participation.

We collected fifty-eight (58) responses. Eleven (11) were from computer science (CS), twenty-five (25) were from one engineering program (E1), and twenty-two (22) were from the other (E2)) engineering program. All respondents were validated as being eligible to participate. The response rate was **54.2 percent** of eligible respondents.

Thirty-six (36) % of participants reported being first generation and twenty-four (24) % reported having poor or working-class backgrounds.

Results and Discussion

This table compares the **mean and standard deviation values** reported by Jensen and Cross for each of the seven constructs analyzed against our three programs combined.

[2]For these inclusion constructs, Jensen and Cross's original study used a Likert scale that spanned from 1 to 6, not 1 to 7. We rescaled our data for comparison.

[3]Neither demographic nor open response data were used in this study. This data will be retained for use in future work.

Construct	Jensen&Cross Mean	Jensen&Cross SD	Project-based Mean	Project-based SD
Stress	13.93	9.264	11.4	6.647
Anxiety	8.3	8.505	8.67	6.261
Depression	11.41	10.023	9.25	6.264
Engr Identity	5.83	1.212	5.64	0.947
Engr Career	5.84	1.628	6.43	1.078
Dept Caring	4.31	0.904	5.24	0.568
Dept Pride	4.88	0.974	5.26	0.702
Dept Diversity	4.68	0.976	5.38	0.59

Table 1: Mean (M) and standard deviation (SD) construct values, Jensen and Cross vs. our three programs combined

At a 95% confidence level the students enrolled in our three project-based programs showed less self-reported stress and depression but not anxiety than those assessed by Jensen and Cross. Project-based students were not statistically different with respect to engineering identity but did more strongly envision an engineering career. Also, the project-based students perceived their departments as more caring and diverse than those in the Jensen and Cross study. They also took more pride in their departments.

The next table compares the **mean and standard deviation values** reported by Jensen and Cross for each of the seven constructs analyzed against students in our project-based programs broken out by whether or not they have yet completed the first of their four project-based learning semesters.

Construct	Jensen& Cross Mean	Jensen& Cross SD	PB prior to first project Mean	PB prior to first project SD	PB one+ projects complete Mean	PB one+ projects complete SD
Stress	13.93	9.264	9.8	6.086	13.45	6.953
Anxiety	8.3	8.505	8.29	6.158	8.92	6.473
Depression	11.41	10.023	8.26	5.522	10.46	7.15
Engr Identity	5.83	1.212	5.57	0.959	5.73	0.943
Engr Career	5.84	1.628	6.3	1.262	6.6	0.764
Dept Caring	4.31	0.904	5.27	0.517	5.19	0.636
Dept Pride	4.88	0.974	5.26	0.711	5.25	0.704
Dept Diversity	4.68	0.976	5.39	0.604	5.37	0.582

Table 2: Mean (M) and standard deviation (SD) construct values, Jensen and Cross vs. students in project-based programs who have and haven't yet completed at least one project-based learning semester (out of four)

At a 95% confidence level, students enrolled in our project-based programs who have yet to complete their first semester-long project showed no differences in anxiety and engineering

identity when compared with the students studied by Jensen and Cross. On all other dimensions there were clear differences - less stress, less depression, a greater expectation of a career in engineering, and more positive reported feelings of department caring, pride, and diversity.

The situation is different, however, for students in our project-based programs who have completed one or more projects. While these students continue to report higher expectations of a career in engineering and more positive feelings of department caring, pride, and diversity, their reported stress and depression levels are no longer different than those of the students studied by Jensen and Cross.

Further Reflection and Future Work

The programs in this study are still growing and evolving. Consequently, limitations of this work include the current small sample size. One of the consequences of our currently low N is that we are not yet able to break down results by ethnicity, gender identity, or other important identity and background variables. However, while it's true that our N is small (both overall and in comparison with Jensen and Cross), our results do show the strong potential impact of project-based engineering programs. As our programs grow and our N increases in future studies, we may observe further differentiation in outcomes with the population studied by Jensen and Cross.

The results of this research stimulates us to prepare for future work in which we plan to evaluate the nature of the stress that students experience as they progress through our project-based programs. Why is it that after their first semester-long project our students' experience changes such that they end up reporting similar stress and depression levels as the students studied by Jensen and Cross?

Future work will thus examine performance changes as a function of time and population size, investigation of the nature of the stresses students are facing in project-based programs, and triangulating and supporting quantitative results with qualitative data.

Another limitation of this study that could be addressed in future research is non-respondent selection bias. Finally, additional work is needed to explore the similarities and differences between the stress cultures in project-based engineering programs and project-based computer science programs, which we are currently treating monolithically.

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