Work in Progress: Motivational Differences Between Civil and Environmental Engineering Doctoral Students in the Pre-writing and Writing Phases

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Introduction & Background

There is a common perception among students about the difficulties associated with the dissertation writing process. Anticipation of isolation, time management issues, and not having the technical skills to write in a structured manner are some of the challenges that students fear[1], [2], [3]. These fears can be attributed to the autonomous nature of the dissertation writing process as a result of the shift from instructor-led coursework to a self-directed and unstructured process of writing the dissertation [1], [2], [3], [4]. In their study, Kelley & Salisbury-Glennon [2], distributed a survey to doctoral students from engineering, nursing, hard sciences, and social sciences, to determine the level of intrinsic task value and self-regulation associated with the dissertation process. They commented that upon coursework and comprehensive examination completion, doctoral students tended to be left alone to complete their dissertation. Their results emphasized the importance of self-regulation strategies to improve degree completion, in which intrinsic value was found to be a mediating factor and predictor of this behavior. Specifically within the field of engineering, Hasbun et al. 's [3] study on motivating doctoral students supports that the end of coursework marks a critical point in students' motivation towards degree completion.

Recent studies have explored engineering graduate students' motivation through different theories and frameworks, including Identity Based Motivation (IBM), Future Time Perspective (FTP), Expectancy-Value Theory (EVT), Graduate Engineering Identity (GEI), and Graduate attrition decision (GrAD) [5], [6], [7], ,[8]. Findings from these studies have shown that graduate engineering identity is a key contributor to graduate student motivation and persistence. Identifying as a research scientist allows graduate students to better integrate within their communities of practice. For instance, Bahnson et al., [8], observed that research interest and scientist performance/competence sub-constructs were particularly important for integrating students into the research community. They also commented on the importance of students' involvement in the research community because of the training and guidance that is provided. Similarly, Cass et al., [5] noted that increased levels of socialization with graduate students within communities of practice were important for successful graduate students' experiences.

Additional findings by Perkins et al., [6] and Sallai et al., [7] point to identity challenges as a factor that affects students' motivation. Because of the struggle of the programs to present students with multiple options after degree completion and making connections between graduate tasks and their future career plans, Perkins et al., [6] commented that students' motivation decreases as the program fails to meet their needs. Lastly, Sallai et al. [7] identified identity-informed opportunity as a perceived cost of students pursuing their graduate degree (i.e., loss of hypothetical opportunities if the individual were not pursuing their graduate degree). An interesting finding from their study was that the main reason for participants to keep persisting was the time and resources already invested. This is known as the "sunk cost" effect or fallacy, and it is basically a push to make the struggle count for something, in this case, their graduate degree. This result may imply that there are no intrinsic (interest or enjoyment) or extrinsic (perceived usefulness or reward expectation) motivators acting on their decision to persist. At this point, students ignore the high cost of persisting and misalignment of their programs to their personal and career goals and justify their continuation for the need to have something to show at the end of their time investment.

For this reason, we sought to better understand the motivation of Civil and Environmental Engineering (CEE) doctoral students. By comparing two groups, as characterized by the stage of the doctoral process (pre-writing and writing) we would like to answer the question, what differences exist in graduate student motivation between these two doctoral program phases (pre-writing and writing)?

Methods

The graduate student motivation survey was distributed during the second week of the Fall 2023 semester to 20 doctoral Civil and Environmental Engineering (CEE) students. Students were recruited in-person during a program gathering . All subjects consented to take part in the study and appropriate IRB approval was obtained before the start of the study.

Out of the 20 participants, 16 identified as male and 4 as female. The sample included participants that identified as Asian (7), Middle Eastern or North African (5), and White (4). Two participants preferred to self-describe, as Bangladeshi and Southeast Asian respectively, and two preferred not to share their information. Participants were evenly distributed in terms of their year in the program, with 6 in their first year, 5 in their second, 5 in their third, and 4 in their fourth or more. Regarding the phase, 16 participants indicated that they were registered for coursework, 3 have already finished coursework, and 1 did not answer. Lastly, participants' age range includes 3 between 18 to 24, 16 between 25 to 34, and 1 between 35 to 44.

It was observed that one participant identified as white and Middle Eastern or North African, and another as Middle Eastern or North African and self-described as Sudanese. These participants were categorized in the first ethnicity category they selected as part of our data representation.

Graduate Student Motivation Survey
The graduate motivation survey was developed based upon an undergraduate Expectancy Value Theory (EVT) instrument developed and validated by Brown & Matusovich [9]. It is composed of the five main constructs of the EVT: 1) interest/intrinsic (how fun and interesting is a task), 2) attainment (personal/identity importance of a task), 3) utility (usefulness for present or future goals), 4) cost (resources to be invested in a task), and 5) self-efficacy (an individual's beliefs about how well their performance will be on an upcoming task). The original prompts from Brown & Matusovich [9] were modified to account for the graduate context and think aloud cognitive interviews with graduate students that were performed to check for clarity and comprehension of the revised instrument [10]. Each of the prompts was evaluated based on a scale from 1 to 7, where 1 represented strongly disagree and 7 represented strongly agree.

Through this instrument testing process, we found that the perception of coursework and research activities were seen as distinct by graduate students [10] leading to the inclusion of separate motivation prompts for each of these phases of the dissertation process. A complete copy of the final motivation survey instrument can be found in the Appendix. The graduate motivation survey also included demographic questions related to the student's year in the program and if the student is currently registered for coursework to enable identification of students in each phase of the dissertation process.

Cronbach's alpha for each EVT construct was determined from the data collected to ensure reliability of the survey instrument with this student population. It was found that the Cronbach's alpha values ranged from 0.62 (attainment value) to 0.91 (cost value), with all values meeting the minimum threshold for acceptable reliability (>0.70) except for the attainment value, which is still characterized as moderate reliability [11].

Data Analysis
After corroborating normality of the data (skewness and kurtosis in the +/- 3.0 range), descriptive statistics, including the median for each EVT prompt and mean for each of the EVT constructs were calculated. Paired T-tests were used to determine if there were any statistical significance of the differences (p value equal or less than 0.05) between the motivation constructs (i.e., interest, attainment,

utility, self-efficacy, and cost) of students in the pre-writing and writing phase. Lastly, Cohen's d was determined to measure the effect size of the possible differences.

Limitations

The greatest limitation in this study is the low number of participants due to the limited number of students enrolled in the CEE program under study. The sampling distribution of the participants is not representative of the national CEE graduate student population, but only of those associated with the program under study. Due to the low sample size, the findings of this study are not generalizable, and the confidence intervals indicate that any replication studies could find lower effect sizes.

Results and Discussion

To answer the question, what differences exist in graduate student motivation between the two doctoral program phases (pre-writing and writing) the mean values of each of the EVT constructs were obtained for each doctoral program phase and compared (Table 1).

Table 1: EVT construct mean values per pre-writing and writing phase (Scale of 1 to 7)[1] and Paired T-test results per EVT construct.

	Pre-writing phase (Standard Deviation) (n=16)	Writing phase (Standard Deviation) (n=3)	*p* value	Cohen's d	Confidence Interval (95%)
Interest Value	6.2 (0.7)	5.7 (0.2)	0.210	0.82	[-0.45, 2.07]
Attainment Value	6.3 (0.6)	5.5 (0.7)	0.048*	1.34	[0.01, 2.63]
Utility Value	5.7 (0.8)	4.2 (0.2)	0.005*	2.00	[0.58, 3.39]
Self-efficacy Value	6.3 (0.6)	5.9 (0.1)	0.280	0.84	[-0.67, 2.32]
Cost Value	4.6 (1.2)	5.3 (0.3)	0.328	-0.63	[-1.88, 0.63]

[1]Where 1 represented strongly disagree and 7 represented strongly agree.

When comparing the two groups, the mean values for each construct are lower for students in the writing phase, except for the perception of cost. Statistical analysis of the data between pre-writing and writing phase found statistical and practical significance for the attainment and utility constructs between the two groups. Attainment and utility value constructs presented statistical significance (indicated by *) but as indicated by the confidence interval for the effect size, any replication studies could find results with lower effect.

At this point in time, students in both phases enjoy their program and are confident in their abilities to succeed (i.e., interest and self-efficacy). The difference in attainment value implies a reduction in the importance of aspects of students' central selves [12], which is in line with the identity-informed opportunity cost found by Sallai et al. [7]. For instance, pre-writing phase students' median values for the prompts *"Getting a graduate degree in engineering is essential to being the person that I want to become"* (median writing phase = 5.0 and median pre-writing phase = 6.5) and *"I am becoming a*

graduate engineering professional by working towards my degree" (median writing phase = 6.0 and median pre-writing phase = 7.0) were 1.5 and 1 points higher than those in the writing phase, respectively.

Differences in the utility construct could be explained, as commented by Perkins et al. [6], by the failure to connect the work done in graduate school with a variety of possible careers, or struggles with mental health. An interesting observation was that students in the dissertation writing phase of their program no longer associated a graduate engineering degree as providing an opportunity to make a lot of money after graduation (median writing phase = 2 and median pre-writing phase = 5), neither as a way to get good working opportunities (median writing phase = 4 and median pre-writing phase = 7). The change that occurs could be due to the failure of the program to meet students' needs, both personal and career wise [6], [7]. Additionally, we found that students in the dissertation writing process found that they were not learning things that were useful to them in their everyday lives from either coursework and research activities (median writing phase = 3 & 5 and median pre-writing phase = 5 & 7, respectively). It could be that since the doctoral students have now transitioned to the writing process and are not doing as much hands-on research and coursework, they do not see the relevance the writing process will have for their future careers. A similar observation was identified by Sallai et al. [7] where they found that although students no longer saw value in their degree, they had invested too much time not to complete it.

Students in the writing phase were observed to have a higher mean value of cost, although the results from this study did not show statistically significant differences between the two doctoral student populations. Specifically, doctoral students in the dissertation writing phase noted that their graduate degree takes them away from things they enjoy (median value of 6) and that they had very little time to do anything but their graduate engineering research (median value of 6), which could be leading to lower motivation towards degree completion, consistent with previous findings across the literature [1], [2], [3].

Overall, differences in attainment and utility value suggest that students lose focus on the implications of their work in their future careers and personal goals, and identify a high opportunity cost, informed by their identities as they progress through their doctoral programs [6], [7]. Additionally, although doctoral students are encouraged to take a class that focuses upon effectively writing articles and proposals for winning grants, the writing process of their dissertations still seems to pose a major roadblock. This may occur due to the lack of connection between the writing process highlighted in this course and the dissertation writing process itself. Although doctoral students in this program are encouraged to write conference papers each year, or journal articles as appropriate, the translation of these research activities into the dissertation writing process may also not be evident.

Conclusion

In the doctoral process, two main phases have been identified: pre-writing and writing. These phases have been found to be critical in doctoral students' motivation towards degree completion because they represent opposing feelings. During the pre-writing phase, students tend to be guided in a structured way, while transitioning to the writing phase marks the start of a self-directed and unstructured process. Using a graduate motivation survey we found statistical and practical differences between students in these two phases, in line with what the literature suggests. Pre-writing phase students presented a higher average value in the EVT constructs of utility and attainment, and while not statistically significant, students at the writing phase presented a higher value in the cost construct. These preliminary motivation results serve as support for the importance of explicitly stating to the students the utility of the knowledge they are acquiring all throughout their doctoral degree progress, as well as the different career options they have after degree completion to ensure that students maintain motivation towards degree completion. Regarding the writing process, further research should be conducted to try to understand how writing research activities and writing courses may be linked to students' self-efficacy and how the course content

could be better aligned with the dissertation writing process (i.e., stating the utility of the knowledge and experience gained through the course).

Implications for practice based on these findings suggest that it may be useful for advisors to be explicit in their discussions of the connections between coursework and research activities with their students. By relating the importance of the knowledge gained through coursework, students could be more aware of the utility of the skills and information that they develop while attending their classes and how to apply them in their research activities. Faculty that teach graduate research courses could also consider including references related to the dissertation writing process (e.g., institutional templates, writing center information, online resources) to better prepare students for the transition to the writing phase of their doctoral program. Finally, gatherings could be offered for those students in the writing phase (e.g.,, writing retreat or writing day) to provide a space for them to share with their peers and make meaningful progress on their dissertation.

Future work will focus upon completing interviews with doctoral students of the program during the Spring 2024 semester to better understand the results obtained about their experiences and perceptions of coursework and research activities (i.e., pre-writing and writing phases) as identified from the motivation survey. Additionally, we are planning on doing a longitudinal assessment of doctoral student motivation to see how student motivation changes as the doctoral students progress through their doctoral degree program.

Acknowledgements

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Appendix
Graduate student motivation survey under the EVT framework.

<u>7 point Likert Scale:</u>
1. Strongly disagree
2. disagree
3. Somewhat disagree
4. Neither agree nor disagree
5. Somewhat agree
6. Agree
7. Strongly agree

<u>Interest Value</u>
1. I find graduate engineering coursework interesting.
2. I find graduate engineering research interesting.
3. I like engineering.
4. Solving challenging advanced engineering problems is rewarding.
5. I like design projects.
6. Graduate engineering program is exciting.
7. Graduate engineering is an intellectually rewarding field of study.
<u>Attainment Value</u>
8. The amount of effort it will take to get my graduate degree in engineering is worthwhile to me.
9. Being good at solving advanced engineering-related problems is important to me.
10. Getting a doctoral degree in engineering is essential to being the person that I want to become.
11. I am becoming a graduate engineering professional by working towards my degree.
12. I want to become a graduate engineering professional
13. I am a graduate engineering professional.
<u>Utility Value</u>
14. A graduate degree in engineering is useful to my career plans after graduation.
15. Individuals with graduate degrees in engineering make a lot of money.
16. A graduate degree in engineering leads to good working opportunities.
17. Obtaining a graduate degree in engineering will make my life better.
18. Having a graduate degree in engineering gives a person higher status in society than other graduate degrees.
19. A person that holds a graduate degree in engineering has more opportunities to succeed.
20. Through my graduate engineering coursework, I learn things that are useful to me in my everyday life.
21. Through my graduate engineering research, I learn things that are useful to me in my everyday life.
<u>Self-Efficacy/Expectation of Success</u>
22. I am confident in my ability to complete required math and science courses for a graduate degree in engineering.
23. I am confident in my ability to excel in basic math and science requirements.
24. I am confident in my ability to excel in my current graduate engineering coursework.
25. I am confident in my ability to excel in my current graduate engineering research.
26. I am confident in my ability to excel in future graduate engineering coursework.
27. I am confident in my ability to excel in future graduate engineering research
28. Compared to other students, I expect to do better than average in my graduate engineering coursework.
29. Compared to other students, I expect to do better than average in my graduate engineering research.
30. I believe I can learn the necessary professional skills to obtain a graduate degree in engineering.
31. I believe I can learn the necessary technical skills to obtain a graduate degree in engineering.

32. I have the necessary professional skills to obtain a graduate degree in engineering.
33. I have the necessary technical skills to obtain a graduate degree in engineering.

Cost

34. Ph.D in engineering programs are difficult.
35. Ph.D in engineering is a tough path, both mentally and physically.
36. Earning a graduate degree in engineering takes a lot of effort.
37. Getting a graduate degree in engineering takes me away from things I enjoy.
38. I am often stressed out by graduate engineering coursework.
39. I am often stressed out by graduate engineering research.
40. My graduate engineering coursework prevents me from being physically healthy.
41. My graduate engineering research prevents me from being physically healthy.
42. My graduate engineering coursework prevents me from being mentally healthy.
43. My graduate engineering research prevents me from being mentally healthy.
44. I am often exhausted after completing my graduate engineering coursework.
45. I am often exhausted after completing my graduate engineering research.
46. I have little time to do anything but my graduate engineering coursework.
47. I have little time to do anything but my graduate engineering research.