Work in Progress: Designing a Survey Instrument to Assess Graduate Student Motivation Towards Degree Completion

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Introduction

The doctoral degree process can be arduous and time-consuming; often requiring students to maintain a high level of motivation to obtain their degree [1], [2]. In King [3], attrition rates for doctoral programs were found to average 43% in the USA, between the years of 1992 and 2003, with many students only graduating after a period of 10 years. On average, the completion rates for engineering doctoral programs after 3 to 4 years were just below 20% [3]. Hasbun et al. [4] found that for many students, coursework can be an external motivator as it imposes deadlines and encourages them to interact with fellow students. Whereas, students perceive the writing phase as the most difficult. Common concerns with this last portion of the doctoral program include not having the necessary writing skills to communicate effectively, while being challenged to publicly demonstrate competence. Many students also shared concerns regarding time management, questioning their abilities (personal and academic), isolation, and the expected time frame for graduation [4].

Artiles & Matusovich [5] show that interactions, both with peers and advisors, create a sense of belonging and have a positive role in students' motivation during their time in a doctoral program. This result is supported by Tinto's [6] work that linked motivation to a sense of belonging. Also, Gilmore & Wofford [1] found that graduate faculty advisors' perceptions of student motivation were the most often mentioned category when talking about factors that support graduate students' success. However, there is a lack of validated instruments to measure motivation in an engineering graduate context, which led to the work proposed in this study. Brown & Matusovich [7] state that "few studies have developed and tested survey instruments for measuring motivation constructs within engineering education in a valid and reliable way" (p. 2). In their work, they developed and validated a survey instrument for measuring engineering student motivation at the undergraduate level, but due to the context differences it is hard to generalize the results obtained to the graduate program setting.

Knowing what motivates graduate students towards doctoral degree completion will help universities, and faculty members, better meet the needs of these students and support them in degree completion. By being aware of the different factors that impact engineering student doctoral motivation, support initiatives can be aimed at the most critical needs to reduce the burdens faced by these students. Hopefully, this relief will shorten the years towards degree completion and, eventually, will raise the percentage of students that finish their degree within 4 to 5 years [8].

Background

To better inform the support and resources provided by graduate programs at universities, it is important to understand what motivates students towards degree completion. As outlined by Hands [9], information surrounding graduate student motivation can lead to effective policies regarding advisors and supervision, academic fit and pertinence of program content, and social support. Although there is a growing body of literature that examines doctoral student motivation, there is still a need for disciplinary-specific research to identify the nuances of each program and field regarding format, methods, and educational philosophies [9]. Additionally, as mentioned in the "Graduate STEM Education Report for the 21st Century" [10], there is a call

for putting the students at the center of graduate school experiences, along with suggestions to increase data collection and research in topics such as time to degree and completion rates to support doctoral engineering student's experience.

Expectancy Value Theory and Persistence Towards Degree Completion

Expectancy Value Theory (EVT) was first proposed by Eccles & Wigfield [11] as a motivational model for studying and analyzing student choice, performance, and persistence, particularly in educational environments. The focus of the theory is related to whether an individual will be able to complete a task or activity. Although context has been noted to be an influential factor on motivation, this has only recently begun to be addressed in studies [11], [12], [13]. As outlined by Eccles & Wigfield [12], this expectancy of success is tied to value constructs that are related to subjective perception about the choice of a task and the possibility of success. The value constructs (STVs) that synthesize subject motivation are 1) intrinsic (how interesting and fun is the task), 2) attainment (importance of the task), 3) utility (usefulness of the task for an individual's goals), and 4) cost (how many resources must be invested while doing the task) [12].

Viewing doctoral attrition through the lens of EVT allows us to map graduate students' concerns with each one of the STVs. For instance, the connection between a sense of belonging and self-efficacy can be observed in the attainment STV. Additionally, doctoral students need to be willing to persist to engage in tasks and spend time and effort, two traits that map with the intrinsic and the cost STV [6]. Finally, the role of peers and faculty relationships as part of the student's daily life (i.e. socialization) during their doctoral degree process, can be linked with intrinsic, attainment, and utility [1].

Expectancy Value Theory and Engineering Education

In a review of the application of EVT within engineering, we found that use of the engineering specific EVT instrument developed by Brown & Matusovich [7] has been limited to studies just focused upon undergraduate engineering students. As for motivation studies in a graduate level context, Peters & Daly [14] did a qualitative study of the motivation of professionals that returned to pursue a graduate degree in engineering. Out of the interviews performed, utility value was identified as the factor that drove most of the participants to pursue and complete a graduate school program. Additionally, four types of cost were identified. These were: intellectual, balance, cultural and environmental, and financial; Intellectual cost is related to learning content during the graduate program, balance refers to time and responsibilities management, cultural and environmental relates with the change in culture and getting to know new people, and financial ties up with the money expenditure (direct and indirect costs). Mosyjowski et al. [15], [16] expanded on this work and developed a survey instrument for comparing the differences in motivations of what they describe as students on a direct pathway to a PhD vs returning students. The final survey included questions to gather demographic information, academic background, and professional activities. The motivation section of the instrument had likert scale questions for the STVs and also included some open-ended responses for gathering data when neither of the options in the scales apply (i.e., Other (Please specify)). Utility, intrinsic, and attainment values were grouped and only cost STV was presented as an independent entry in the survey. The results of the study focused on the cost STV and suggested strategies to reduce it. Factor analysis of the responses supports Eccles' EVT as a consistent framework for studying and analyzing motivation in a graduate context.

Methods

This study consisted of a think-aloud protocol that was conducted with 6 engineering doctoral students at a research intensive university in the mid-Atlantic region. The aim is not to transfer the findings at this early stage of the project, but to get a better understanding of the interpretations of the survey prompts by exploring participants' reasons behind their answers. As such, the small sample size is reasonable for the scope of this study, given the rich detail that is present in most qualitative research [17]. All registered and active graduate students of the university enrolled in the College of Engineering were contacted via email with an invitation to participate in the study. Out of the students that responded with interest in study participation, six students were selected based on their representation of different disciplines found within the college (1 Engineering Education, 2 Mechanical Engineering, 2 Chemical Engineering, and 1 Electrical and Computer Engineering). Five out of six of the participants were male with one female student. Proper human subjects' approval was obtained prior to conduct of the study.

Survey Development

The engineering graduate EVT instrument was developed based upon the engineering specific EVT instrument from Brown & Matusovich [7]. Brown & Matusovich instrument's validity was confirmed by consulting three experts for content validity and through factor analysis for construct validity. Cronbach's alpha was used as a measure of reliability for internal consistency [7]. In the first step of the survey development process, all original survey prompts were reviewed and rewritten to reflect a graduate program setting. Some examples are found in Table 1 where the added words are presented in *italics*. The wording changes made were simple and accounted for clarification of the graduate context. There were no additional questions added and hence no literature was reviewed as part of the modifications made.

Table 1. Survey prompts rewording to reflect graduate focused setting.

Original Prompt	Rewording
Getting an engineering degree is essential to being the person that I want to become.	Getting *a doctoral* degree *in engineering* is essential to being the person that I want to become.
Obtaining an engineering degree will make my life better.	Obtaining *a Ph.D. in* engineering will make my life better.
Getting an engineering degree takes me away from things I enjoy.	Getting *a Ph.D. in* engineering takes me away from things I enjoy.

Think-aloud Sessions

After the rewording to the original engineering EVT survey was complete, it was presented to graduate students in a think-aloud cognitive interview. The process was selected as it allows for the revisiting of the instrument to identify the need for additional changes based upon participants' comments about vocabulary, sentence structure, and meaning among others [18]. It also allows for the identification of any survey prompts that may be confusing to our intended audience and that may need revising altogether. Even though cognitive interviews do not provide quantitative data, they help improve the understanding of sources of error in the measuring instrument [18].

During the participant think-aloud sessions, the participants were provided with a link to the current version of the engineering graduate student EVT survey. They were then asked to share their screen, read aloud each of the prompts of the survey, and explain their decision for their selected response. Participants were encouraged to ask questions and/or clarifications regarding the wording and meaning of the survey prompts. As appropriate, the research team would ask participants to expand on their reasons when there was the possibility of ambiguity surrounding an answer given or the possibility that the participant had misconceptions about the intended goal of a survey prompt.

Each of the think-aloud sessions was held virtually and recorded. Transcripts of the sessions were automatically generated by the video conferencing software after which they were reviewed for consistency and accuracy with the session recording. Transcripts were then reviewed and notes were taken on specific elements of the survey that yielded confusion or involved mis-interpretation on the part of the participants. A summary of these results are presented in the section that follows.

Results and Discussion

The think-aloud sessions provided an opportunity to identify areas of the engineering graduate EVT instrument that were in need of further clarification to avoid mis-interpretation as well as additional survey prompts that may be necessary to fully capture the graduate student experience.

Survey Prompt Wording Clarifications

Regarding differences in interpretation, the most common words in need of clarification were "skills" and "cost". Skills were often perceived differently by participants with some understanding that it related only to disciplinary skills (e.g., circuit simulations, reactor design), while others thought of it as only professional skills (e.g., critical thinking, time management, writing). It is important to note that both of them are perceived as relevant inside and outside academia, and while professional skills are welcome, one can not disregard the importance of disciplinary research and education breadth [8]. One participant commented *"when we talk about necessary skills (...) are they essentially limited to the specialization that we are working with? Or do they refer to the general skills that a PhD. student needs to have"*. Another participant addressed the inclusion of both skills not being clear by commenting *"I feel like there is something else you're asking for. But if it is the mental skill, and technical skill, and the rest of the other is the communications skill, then I say I'll agree with that part."* Moving forward, "skills" will be clarified in the survey to reflect both disciplinary and professional skills as highlighted in the modified prompts here: " I believe I can learn the necessary *professional* skills to obtain a Ph.D. in engineering." and "I believe I can learn the necessary *technical* skills to obtain a Ph.D. in engineering."

The interpretation of the word "cost" was mostly seen as the financial cost of pursuing a Ph.D as shown in this student's quote *"cost wise, in my case I'll say somewhat disagree because my program is funded"*. However, the intention of this word is to capture other elements of cost including time, stress, anxiety, and other resources in general. After all, cost is a multidimensional construct that can have a positive or negative impact on the remaining three STVs. This is a reflection of the complexity of the construct and serves to exemplify why it has been less studied until recently [11]. For this reason, rephrasing was done to make explicit the other aspects of cost important to this prompt, as highlighted in the modified prompt here: "Ph.D in engineering is a tough path, *both mentally and physically.*".

Survey Prompt Additions

The think-aloud sessions identified some common concerns about the wording and scope of the survey prompts. One of the identified issues was the lack of survey prompts specifically focused upon the research process. Many of the engineering EVT survey items focused upon coursework [7], which was reasonable given its intended use for an undergraduate context. However, as the research component of a doctoral program is just as critical to the degree as the coursework [4], it was identified that these prompts would need to be repeated to provide opportunities for responses related to both components of a students' doctoral program. Two participants stated that *"I know coursework is the thing a lot of people stress over the most. But for me it was like, this is my break from the experiments that aren't working."* and *"So if that question is coursework for me, everything was easy. But if (...) you rephrase the coursework with my research and everything, then I have to look through this again."* Examples of the suggested modifications to the prompts based on this identified area for improvement are found in Table 2.

Table 2. Additional prompts to account for the graduate context differences.

Original Prompt	Additional prompt
I find graduate engineering coursework interesting.	I find graduate engineering *research* interesting.
Through my graduate engineering coursework, I learn things that are useful to me in my everyday life.	Through my graduate engineering *research process*, I learn things that are useful to me in my everyday life.
I have little time to do anything but my graduate engineering coursework.	I have little time to do anything but my graduate engineering *research*.

Conclusions

Although EVT survey elements exist to study motivation in an engineering context, there is no general instrument to assess motivation in the graduate engineering population. As stated previously in the article, prior works have either focused on undergraduate population or expanded on a particular STV like cost [14], [15], and [16], while grouping the remaining three STV values. With a motivation instrument for undergraduate engineering population as a baseline [7], it has been possible to develop a survey to assess graduate student motivation including additional elements that make it suitable for a graduate context. One of the main barriers of using the original baseline instrument is the shift from a heavy focus on coursework and disciplinary skills of the undergraduate program to a focus on both coursework and the research process, as well as the development of professional skills as part of the graduate program. The think-aloud process allowed us to identify these necessary modifications to ensure the alignment of the EVT instrument with its intended context.

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