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Confidence of Graduate Students in Engineering Masters' Programs: A Comparison of Returners and Direct-Pathway Students

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Abstract

Confidence is a critical factor in the success of graduate students; those who are not confident of their ability to succeed will have greater difficulties in persisting and graduating with the degree that they seek. Therefore, cultivating confidence is an important part of equipping graduate students for success, and the question of where confidence comes from is an important one.

In this study, 300 graduate students were surveyed, including both returners (students with a gap of at least five years between completing their undergraduate education and starting graduate study) and direct pathway students (students with a gap less than five years, if any). Several survey questions focused on the participants' confidence in their own abilities to succeed in graduate school and complete their degrees. Students' self-reported levels of confidence were compared to a variety of different metrics, including their undergraduate and graduate GPA, GRE scores, and the level of supportiveness they reported experiencing from different people in their lives. It was found that none of these metrics correlated to students' confidence.

Out of the survey population, 41 students were also interviewed, split approximately evenly between returners and direct pathway students, and the interview data was also analyzed to look at students' confidence. While none of the questions in the interview protocol specifically asked about confidence, the topic did arise naturally in the course of the interview conversations. Students reported that specific experiences in either their education or work experience led to their level of confidence. We conclude, therefore, that confidence was constructed based on internal perceptions of experiences, and not on external validation of a student's abilities or skills.

Introduction

It has been widely acknowledged that confidence is a factor in students' success at all levels, including in graduate study. Students who lack confidence may not persevere through difficulties, as they do not believe that they can overcome them. Multiple studies have shown that confidence is important in students' success, and therefore nurturing students' confidence can be expected to increase their success. This requires understanding the sources of confidence for students in a variety of educational settings, including graduate school. In this study, we focus specifically on the sources of confidence for returners in engineering graduate programs, with returners defined as those students who had a gap of at least five years between the completion of their undergraduate degree and the start of their graduate program.

Background

In understanding confidence in engineering returners, it is important to understand two different bodies of literature. The first is that on returners specifically, and what is known about this group of students. The second is the literature on confidence and its importance in student success. The literature on returners in engineering graduate programs is not yet extensive, although it has been growing in recent years. Literature on confidence, in contrast, is far more extensive and wide-ranging, with a longer history. Due to the wealth of literature in this area, only a small selection is specifically cited in this paper.

Returners

Rigorous study of returners in engineering graduate programs has only recently begun to be done, with several studies performed over the past decade. Two of the earlier papers on this group were published in 2011, with Peters & Daly [1] studying the transition of identity that took place when industry professionals returned to school for graduate degrees and Strutz et al. [2] examining the "experience capital" of industry professionals who were pursuing graduate degrees in engineering education specifically. Further work by Peters & Daly [3], [4] probed the reasons why industry professionals in STEM fields pursued graduate study and analyzed their experiences through the lens of Expectancy Value Theory (EVT) [5]. In these analyses, it was found that the returners in the study did not seriously doubt their ability to complete their degree, although they did sometimes question whether doing so was worthwhile and would serve their goals.

A subsequent large-scale national study specifically focused on returners in engineering doctoral programs, and further probed into the returners' expectancy for success and compared them to direct-pathway students, those who had either no gap or a gap of less than five years. This study characterized a larger population than that in the original study [6], and further illuminated values and cost categories that were seen in the prior study [7].

An additional large-scale national study focused on returners in engineering masters' programs, with a specific focus on knowledge construction and how their work experiences impacted their learning in graduate classes [8], [9], [10]. The work in this paper is part of that larger project effort, with a focus on several specific survey questions and relevant parts of the interviews with participants. Previous work on this project has shown that there are no significant differences in confidence between returners and direct pathway students in regard to various engineering skills [8], although the confidence of students in their academic abilities has not previously been analyzed. There is evidence that undergraduate grades are significantly different for returners and direct pathway students, with returners' undergraduate grades being lower. However, there is no significant difference in grade point averages in the two groups for graduate engineering students [10].

Confidence

There is a large body of work on the importance of confidence in students' achievement, including a great deal focused on undergraduate studies in engineering. This work includes analyses focused on the relationship between confidence and achievement, as in [11] and [12], as well as several specific aspects of achievement. Several papers focused on student attrition and the role of confidence, as in [13], or the effect of weaknesses in students' mathematical confidence, as in [14]. A substantial body of work focused on gender and confidence, e.g., [15], [16], [17], showing that female students tend to be less confident while simultaneously having a higher level of achievement [15], and that women have a lower professional role confidence than men in engineering [18]. Other work discussed the role of various active learning techniques such as paired peer learning [19] and project-based learning [20], and their impact on confidence. There are also studies focused on confidence specifically at the graduate level, e.g. [21], although this area appears to be less well explored. The intersection of returner status and confidence has not been studied at all to this point.

Methodology

In this study, a survey was designed and deployed in a web-based format to allow participants at any location to complete it. Recruitment was performed via e-mail, with a variety of universities within the United States asked to distribute information to their students. A rolling recruitment process was used, in order to ensure that a sufficient number of returners would be included in the responses. The survey population was limited to citizens and permanent residents of the United States, in order to eliminate variables due to cultural differences and variations in international undergraduate education. Ultimately, 300 valid survey responses were collected.

While the survey included a wide variety of questions about past experiences, motivation, learning in the classroom, decision process, and future plans, this particular study focused exclusively on questions of confidence related to academic performance. These questions were:

- How confident did you feel prior to taking the GRE? (Very confident, Somewhat confident, Neither confident nor unconfident, Somewhat unconfident, Very unconfident)
- How confident are you that you will complete your Master's degree? (Very confident, Somewhat confident, Neither confident nor unconfident, Somewhat unconfident, Very unconfident)
- How confident are you that you will complete your Master's degree by the date you indicated? (Very confident, Somewhat confident, Neither confident nor unconfident, Somewhat unconfident, Very unconfident)
- How did your confidence change since you began your degree?

As part of the survey, participants were asked if they would be willing to participate in an interview. Out of those who were willing to do so, 41 participants were selected and interviewed

by one member of the research team, with 21 of those participants from the group of returners and 20 from the direct pathway students.

Survey data analysis was carried out using standard statistical methods, with T-tests used to determine whether differences in the populations were significant. Interview data analysis was carried out using multiple coding methods for different parts of the project; in this particular analysis, open coding was used.

Findings

Analyses of the survey data showed that there were no differences in confidence between the two groups, returners and direct pathway students, despite their differing backgrounds and experiences. Responses to the specific questions are shown in Tables 1 through 4.

When asked about their confidence prior to taking the GRE, the average rating for returners, on a five-point scale (5 - Very Confident to 1 - Very Unconfident) was 3.65 with a standard deviation of 0.95, and the average for direct pathway students was 3.81 with a standard deviation of 0.82. This difference was not found to be statistically significant. It can be noted that not all participants answered this question, as many of them did not take the GRE. The number of participants who did not take the GRE was proportionally higher for returners than for direct pathway students.

Table 1: Confidence Prior to Taking the GRE

	Returner		Direct Pathway	
	Number of Responses	Percent of Total	Number of Responses	Percent of Total
5 - Very Confident	7	7.9%	26	12.3%
4 - Somewhat Confident	30	33.7%	88	41.7%
3 - Neither Confident nor Unconfident	13	14.6%	30	14.2%
2 - Somewhat Unconfident	2	2.2%	11	5.2%
1 - Very Unconfident	3	3.4%	1	0.5%
No response or did not take GRE	34	38.2%	55	26.1%

When asked about their confidence that they would finish their master's degree, participants expressed a high degree of confidence that they would do so. Using the same five-point scale, returners had an average confidence of 4.84 with a standard deviation of 0.42, and direct pathway students had an average of 4.86 with a standard deviation of 0.41. Statistically, the two groups had identical levels of confidence. The numbers of responses at each level are given for both groups in Table 2.

Table 2: Confidence in Degree Completion

	Returner		Direct Pathway	
	Number of Responses	Percent of Total	Number of Responses	Percent of Total
5 - Very Confident	77	86.5%	185	87.7%
4 - Somewhat Confident	10	11.2%	23	10.9%
3 - Neither Confident nor Unconfident	2	2.2%	2	0.9%
2 - Somewhat Unconfident	0	0.0%	1	0.5%
1 - Very Unconfident	0	0.0%	0	0.0%

Participants were also asked about their confidence that they would complete their degree by the date they had identified as an expected completion date. Participants were not quite as confident in their expected date of completion as in the completion itself, but their confidence was still high. Returners' average confidence was 4.69 with a 0.56 standard deviation, and direct pathway students had an average confidence of 4.62 with a 0.59 standard deviation; again, this was not statistically significant. Results are shown in Table 3.

Table 3: Confidence in Degree Completion by Target Date

	Returner		Direct Pathway	
	Number of Responses	Percent of Total	Number of Responses	Percent of Total
5 - Very Confident	64	71.9%	141	66.8%
4 - Somewhat Confident	23	25.8%	62	29.4%
3 - Neither Confident nor Unconfident	1	1.1%	6	2.8%
2 - Somewhat Unconfident	1	1.1%	2	0.9%
1 - Very Unconfident	0	0.0%	0	0.0%

Participants were also asked about increases in their confidence since beginning their program, with a five-point Likert scale used; choices were Much more now, Somewhat more now, Neither less nor more now, Somewhat less now, or Much less now. Results are shown in Table 4; for returners, the mean score was 4.18 with a standard deviation of 0.72, and for direct pathway students the mean was 3.89 with a standard deviation of 0.86. While the score was higher for returners, the difference was not statistically significant.

Table 4: Changes in Confidence since Beginning the Program

	Returner		Direct Pathway	
	Number of Responses	Percent of Total	Number of Responses	Percent of Total
5 -Much more now	29	32.6%	54	25.6%
4 - Somewhat more now	48	53.9%	89	42.2%
3 - Neither less nor more now	10	11.2%	52	24.6%
2 - Somewhat less now	0	0.0%	12	5.7%
1 - Much less now	1	1.1%	0	0.0%

A number of correlations were studied, to determine the source of confidence, particularly for returners, as they were the group that the study focused on. There were no statistically significant correlations found to exist based on GRE scores, grades in undergraduate education, or graduate school grades. Furthermore, the number of years that a returner had been working was not correlated to their confidence, nor was the degree of supportiveness that was reported for a variety of different people in their lives.

Analysis of the interview data was then carried out. While no questions in the interview protocol specifically referenced confidence, it did appear in some participants' responses to various questions. Out of the 41 interviews, 10 of them referenced confidence, or approximately 25%. Seven direct pathway students and three returners discussed confidence, two of whom were female (both direct pathway students) and eight were male. Their responses were primarily in response to questions about how their work experience or undergraduate education impacted their approach to coursework in the master's program. These references included both sources of confidence, and things that decreased confidence. There were two basic sources of confidence discussed by participants; one was the experiences they had during their education, and the other was experiences in the workplace. Those experiences also interacted, with the workplace reinforcing what was learned during undergraduate education. Interestingly, all of the direct pathway students who discussed confidence had at least some work experience, whether it was in the form of co-ops, internships, or some amount of post-baccalaureate employment.

Confidence from Undergraduate Experiences

A total of three participants, two direct pathway students and one returner, reported that their undergraduate experiences were a source of confidence for them. The way in which this manifested itself was somewhat different; for one participant, a direct pathway student, this was based on course content, although this content was reinforced by his work experience. He stated that

> ... what I think engineering school prepared me for was how to figure out the answer… That's the best thing engineering school has taught me, and my job too. It's not that… It's this confidence that even though I don't know anything about this problem, or anything about this subject, or topic I am equipped with the knowledge base to figure out how to answer it.

Two of those who referenced confidence from their undergraduate education had attended military academies, and this experience seemed to greatly influence their level of confidence. As one returner stated,

> Having the confidence to know I can do well in some academic rigor is probably… I don't think there was a technical aspect about my undergrad degree that made me prepare for any other class I took. Like I said there's only probably a big confidence like if I did

> well then I could probably do well now I had confidence in myself that I could survive the academic program…

Another participant, who was a direct pathway student, referenced his military academy as providing him with good preparation and giving him confidence. In this case, he said that

> I felt pretty confident and they said that I did a good job… so that was something I felt prepared for and then in technical skills I think it prepared me well.

Confidence from Graduate Education

One participant, a returner, talked about confidence from the graduate program itself. This was unique, as no other participant discussed any aspect of the graduate program itself as a source of confidence. In his case, he felt that the experience of his professors was a source of confidence in terms of the utility of what he was learning.

> It's research I didn't know. It seems ... I had seen it or observed it. You had the weight of the experience learning a class from other experts who've used in the field, made me more confident… Now I'm able to get that data set, analyze it and bring that valuable information much faster.

This participant highly valued the work experience of his professors, indicating that work experience in general was valued and could enhance graduate education, even if it was not his own work experience.

Confidence from Work Experiences

A total of four participants, one returner and three direct pathway students, indicated that their work experiences were a source of confidence for them. One of them, a direct pathway student, indicated that his internships had been a source of confidence. He stated that

> I think it's made me a lot better at approaching my coursework in that the projects I've had in my work experience have been much more difficult than the projects I've had in my coursework. So it makes the projects in my classes seem a lot easier and it, like, eliminated a lot of, I don't want to call it fear, but when I was just starting my undergrad I was like, wow. This programming, this is really intimidating. But I liked it so I stayed with it. But after a couple internships I said, you know, whatever they throw at me I'll figure it out. Because that's exactly what I had to do at work.

Another direct pathway student indicated that her internships taught her a lot, and that this was a source of confidence.

> One of the things that I found that was nice with going into my internships was that they really do teach you anything that you don't know. It's really great. I felt like I was able to learn everything that they taught me.

One of the returners referred to his experiences making him more confident, and extrapolated that beyond his coursework and into his future possible career trajectory, stating that

> I actually feel confident that if I got sent to China and someone would translate the code for me I could make sense of it, you know, or Europe, so I like the fact that those courses marry the theory, which I appreciate, with the practical knowledge, which makes you a better engineer, a more intellectual, intelligent engineer. It makes you more versatile. It makes you understand where everything comes from, that's the whole point.

Decreases in Confidence

While the majority of those who mentioned confidence reported that theirs had been increased by experiences, there were two participants who had experienced a decrease in confidence, or who saw that in others. The decreases in confidence were only reported by direct pathway students.

One direct pathway student reported that an internship had impacted "the level of confidence with which I proclaim results," but in a way that reflected less confidence instead of more. He reported having given specific numerical results as "a figure of speech", and after being challenged on that in the workplace, changed his approach. As he stated,

> I throw a lot of disclaimers before I give specific numbers now because unless you have data to back it up, people will latch onto the numbers and then when it comes back and it's only a 40% improvement, they'll be, "Hey, I thought you said it was 80 before."

Another direct pathway student reported that, in her view, undergraduate education tended to decrease confidence instead of increase it. She stated that

> [T]he thing with undergrads is that undergrads don't have any confidence whatsoever. The whole purpose of your undergrad is to destroy you and then show you, you can still make it.

She went on to refer to her teachers and professors as "some of the smartest people I've ever met" and indicated that this was intimidating to her at times.

Discussion

In these findings, there are several things that stand out. The first of these is the lack of a difference between confidence of returners and direct pathway students. As reported in [10], the undergraduate GPA for returners was lower than that of direct pathway students. Despite this,

their confidence was statistically the same, which aligns with the lack of correlation between confidence and grades overall. In fact, as stated, no external factors explained or correlated to confidence. This lack of correlation did not only cover external validation in the academic environment, but also extended to personal factors such as the level of supportiveness of people in a participant's life. This leads to the conclusion that, for the participants in this study, confidence is an internally developed characteristic, based on a person's perception of their own experiences, and not a construct that is built from external validation.

In the analysis of interview data, of those who discussed confidence, two direct pathway students discussed factors that decreased confidence, while five spoke of increased confidence. Three returners spoke of confidence, and all did so in terms of increased confidence. While the number of participants is small, this suggests that the increased work experience and/or life experience of returners tends to increase their confidence beyond that of direct pathway students; this should be studied further, in order to better determine what career and life experiences build confidence.

It is also important to note that work experience was a significant source of confidence, even for direct pathway students. Based on the definition used in this study, these participants had less work experience; however, it appears that even small amounts of work experience can have a large impact on confidence, as internships were specifically cited by some participants as a source of confidence.

It is also notable that military academies, among undergraduate institutions, were a significant factor in students' confidence. This aligns with the conclusions reported in [23], which focused specifically on leadership and related skills developed through military service; however, in this case, the focus was on the academic experiences at the academies, rather than on the service itself. This could be influenced both by the focus and curriculum at the academies, and by the nature of the student body at the academies, which differs from the general student population.

Conclusions

As seen in this work, returners in engineering master's programs have a high level of confidence, equal to that of direct pathway students, despite having a lower average GPA as undergraduates. This level of confidence is not correlated to or explained by any external factors, but appears to be developed based on subjective perceptions of experiences. These experiences include both work and educational experiences. Similar factors impact the confidence of direct pathway students, although they also report decreased confidence due to their experiences, which was not seen from returners.

Future work should further investigate confidence in graduate students and the ways in which their varied career and life experiences impact it, with the goal of both understanding and promoting confidence in the graduate student population.

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