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I Think I Can, I Hope I Can: Professional Efficacy, Hope, and Identity among Undergraduate Engineering Students

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Abstract: *This study explored relationships between hope, self-efficacy, and professional identity among a group of undergraduate engineering students at a western institution of higher education in the United States (US) over the span of an academic semester. We conducted a mixed-methods study with undergraduate engineering students to measure aspects of hope, and self-efficacy. Furthermore, we investigated how they perceived their own professional identity in terms of what it means to be an engineer and engage in the profession. Participants reported high levels of hope at mid- and end-of-semester. Those pursuing degrees requiring professional licensure reported higher levels of willpower compared to students pursuing non-licensure degrees. Students experienced increased self-efficacy towards engineering skills and processes over time. Participants' perceptions of engineering professional identity remained consistent over the semester. Their sense of engineering work and goal orientation fell primarily into one of three archetypes: Pragmatic, Creative, and Altruistic.*

Keywords: Hope, Self-efficacy, Professional Identity, Engineering Education

INTRODUCTION

Over the past decades, the need for engineering professionals has increased in demand. As such, engineering educators are tasked to produce technically competent professionals and nurture students' development of 21st century skills (i.e., teamwork, communication, problem solving, and critical thinking). To understand the complexity and efficacy of engineering courses, researchers have explored separately both motivational and perceptual factors related to undergraduate education in engineering. For example, Villanueva and Nadelson (2017) explored undergraduate engineering students' perceptions of engineering professional identity. For this study, we were interested in motivational factors such as hope and self-efficacy of undergraduate engineering majors. However, rather than studying these motivational factors in isolation, we chose to study the potential relationships among hope, self-efficacy, and professional identity of undergraduate engineering students.

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A person's belief about the self is suggested to help an individual achieve one's goals (e.g., Snyder, et al., 1991). Within expectancy constructs, attainment of future positive states requires that individuals plan for and execute the attainment of a goal (e.g., hope), which may or may not be connected to specific behaviors related to that goal (e.g., self-efficacy) (Bandura, 1997; Snyder, 1995; Snyder, 2002). As Bandura suggests (1997), "outcomes and efficacy expectations are differentiated, because individuals can believe that a particular course of action will produce certain outcomes, but if they entertain serious doubts about whether they can perform the necessary activities, such information does not influence their behavior" (p. 193). Snyder (1995, 2002) suggests that goals can substantially vary in scope as well as different domains of human life (e.g., professional, academic, familial, personal). As such, domains matter in how outcomes and efficacy expectations are manifested among individuals.

For this work, we selected engineering because literature suggests that among the different science, technology, engineering, and math (STEM) disciplines, engineering involves a "complicated and social negotiation between how academic engineers talk about what they do, and how their practice is impacted by how they talk about it" (Pawley, 2012, p. 81). In addition, a limited understanding exists of how higher education engineering courses equip students to visualize their future roles as professionals (Cech, 2014). It is possible that some engineering students perceive discord between their professional and personal interests, or perhaps they feel more personal satisfaction when seeking a more "fulfilling" field (Meyer & Marx, 2014). The latter two reasons suggest that in the domain of engineering professional identity, an interplay exists between outcomes and efficacy expectations (Bandura, 1997) that may not be fully understood. This research study explored the relationships between hope, self-efficacy, and professional identity of undergraduate engineering students.

Theoretical Framework

Hope as Motivation and Choice

Researchers in psychological literature have defined hope as "the perceived capability to derive pathways to desired goals and motivate oneself via agency thinking to use those pathways" (Snyder, 2002, p. 249). Hope is not optimism. Optimism occurs when individuals have the belief that something positive will happen *to* them. However, optimism does not involve having clear plans for how to achieve a goal. This potential lack of clarity may result in becoming frustrated or flustered when challenges arise during goal pursuit (Snyder, 1994).

Similarly, hope is not an emotion. Like some emotions (e.g., happy, joy), hope has a positive valence but is more complex that an emotion. Emotional responses are quick, automatic, and can occur unconsciously (Rosenberg, 1998). Emotions typically occur in response to a person or an event (Linnenbrink & Pintrich, 2004). In contrast, "hope is a process constantly involving what we think about ourselves in relation to our goals. Our thoughts, in turn, can influence our actual behaviors. At time, the external environment obviously has an enormous impact on us" (Snyder, 1994, p. 12). Therefore, hopeful people can adapt to challenging situations because they can think of alternative ways to reach their goal. From this perspective, the process of hope then becomes a motivational factor in educational settings.

Another important distinction needs to be made between self-efficacy and hope. Self-efficacy is the belief that one can plan and attain a goal (Bandura, 1997). Hope also includes the belief that one can plan for, pursue, and attain a goal. However, hope goes beyond just beliefs to include the important element of action. Furthermore, hope has been described as consisting of three factors: willpower, waypower, and agency (Snyder, 2002; Lopez, 2013). Willpower is defined as persistence or motivation for setting and attaining goals. This suggests that those with high hope will see their way around an obstacle to ascertain another route when faced with barriers. Individuals with high hope are likely to persist in the face of difficult challenges (Magaletta & Oliver, 1999).

In addition, waypower is the ability to generate multiple avenues toward attaining a goal. Indeed, "high-hope thinking provides a special advantage when we face obstacles in our goal attainment. High-hope individuals think of alternative routes to their goals and then apply themselves to the pathway most likely to work" (Snyder, 1994, p. 11). Engineering students with high hope will likely persist in the face of challenges and continue to generate creative solutions toward goal attainment.

As the third factor of hope, agency provides choice in how individuals pursue their goals (Snyder, 1994; 2002). Through agency, we shape our lives by taking responsibility for moving toward our goals, motivating ourselves, and building capacity for persistence (Lopez, 2013). Lopez (2013) further noted, "Agency makes us the authors of our lives" (p. 25). Taken together these three factors move us beyond optimism as these factors provide action, motivation, and direction toward goal attainment.

Self-efficacy in Engineering Processes

As noted earlier, self-efficacy is the individual's belief that they can plan and successfully achieve a goal (Bandura, 1997). Individuals who hold moderate to high self-efficacy are likely to persist in goal attainment, even when obstacles and challenges present themselves during goal pursuit. In relation to engineering students, previous research suggests that pre-professional engineering students often lack the skills and informational capital needed to recover from setbacks and failures during engineering design learning activities (Villanueva, et al. 2018). Such lack of skills and understanding of engineering processes may be associated with low levels of self-efficacy (Villanueva & Nadelson, 2017).

It is common in the self-efficacy literature that low levels of relevant content knowledge and/or skills are related to low levels of self-efficacy (Usher & Pajares, 2008). In turn, students with low self-efficacy are more likely to quit when faced with difficult challenges (Bandura, 1997; Pajares & Kranzler, 1995). Similar to hope, students with high self-efficacy are likely to continue to persist to goal attainment even when difficulties present themselves. However, little is known about undergraduate engineering students' self-efficacy development over time (Authors, 2018; Authors, 2019) and its possible relationship with hope and with professional identity.

Professional Identity in Engineering

Through a systematic literature review Morelock (2017), found that engineering identity studies could be articulated into four categories. The first category related to how engineering professional identity connected to gender, academic, and occupational identity, among others. The second category of engineering identity studies illustrated self-perceptions of the engineering profession. A third category suggested the presence of cognitive, affective, and performance domains. Lastly, the fourth category articulated engineering professional identity through individual actions and decisions.

Recently, a fifth domain has been proposed as an expansion of the second category related to self-perceptions of the engineering profession. This fifth domain, perceptions based in time, has explored how students perceive their engineering education, and how they use these perceptions to guide how they view their professional role in the future. Villanueva and Nadelson (2017) proposed that due to the historical influences in engineering education, students will perceive the engineering profession as either that of a Mediator, a Designer/Tinker, or a Social Servant. Mediator perceptions tend to view engineering as a field that applies scientific and mathematical principles (a term referring to engineering curriculum incepted in the *early* 1800's). A Designer/Tinkerer perceives engineering as a field that "builds or fixes objects or things, refines products, or creates inventions" (Villanueva et al., 2018, p. 3), and is reflective of curriculum changes to engineering in the *late* 1800s. Social Servant perceptions (a term referring to the inception of 21st century engineering in the early 1900s) center around the multidisciplinary blending of scientific and mathematical with designing/tinkering for the distinct purpose of benefiting society. We argue that this temporal perception of a profession may guide a students' motivation to attain a goal, and in turn, may influence the interrelationship of hope, self-efficacy, and professional identity.

Purpose of Research

The purpose of this study was to explore the relationships between hope, self-efficacy, and professional identity among a group of undergraduate engineering students at a western institution of higher education in the United States (US) over the span of an academic semester.
The research questions for this study are: (1) To what extent do undergraduate engineering students experience factors of hope (e.g., willpower, waypower)? (2) To what extent do undergraduate engineering students experience factors of self-efficacy? (3) How do engineering students articulate their sense of professional identity?

We hypothesized that undergraduate engineering students would show moderate to high levels of hope and self-efficacy at the beginning of the semester that would either be maintained or would increase over time. We would expect moderate to low levels of professional identity at the beginning of the semester because they were still learning the skills and attributes of engineering professionals. However, we expected moderate to high levels of professional identity by the end of the semester based on increased understanding of engineering as a profession.

Method

Participants

Participation in this study was voluntary and instructors agreed to provide equivalent extra credit opportunities if students opted to not complete the instruments, according to Institutional Review Board (IRB)-approved guidelines for human subject research. Participants were junior and senior engineering students (n = 77) enrolled in undergraduate professional engineering courses at a western US university. Participants were self-identified as primarily White (n = 70) and male (77%). Thirty-three percent of participants had completed three years of university coursework, 20% had completed two years of university coursework, and another 21.40% had completed four years of university coursework. Participants were purposefully selected at these academic levels because most professional-related coursework in engineering does not occur until their junior and senior years of an undergraduate engineering education. We also wanted to attain the perspectives of those students who had continued to persist in engineering past their early undergraduate years as we anticipated these individuals to have higher levels of hope than individuals in the early years. Table 1 indicates which engineering disciplines have a professional licensure requirement at the end of their undergraduate degree. Specifically, Mechanical, Civil, Electrical, Aerospace majors had licensure requirements, while Computer, Biological, Environmental engineering did not.

Participants were enrolled in one of two professional engineering courses (technical drawing and technical communication). The technical communication course was a non-technical course intended to foster technical communication skills in the engineering profession. This course is mandatory for engineering majors (Juniors and Seniors). The technical communication course was taught by a female instructor who had over 15 years of experience teaching professional and technical engineering courses although she did not have an engineering background. In contrast, the technical drawing (AutoCad) course is the first professional engineering course for engineering majors. It is a required course for Juniors and Seniors within the engineering degree major. The instructor for the technical drawing course was a male who had over 20 years of instructional experience in engineering, primarily for mechanical and civil engineering majors.

Table 1
Engineering student breakdown by field and certification

Engineering Major	License Required	Frequency	Percentage
Aerospace	Yes	1	1.30%
Biological	No	4	5.19%
Civil	Yes	33	42.86%
Computer Science	No	8	10.39%
Electrical	Yes	3	3.90%
Environmental	No	4	5.19%
Mechanical	Yes	21	27.27%
Undeclared	-	1	1.30%
Other	-	2	2.60%
		77	100.00%

MATERIALS

THE FUTURE SCALE

The Future Scale (Snyder, et al., 2006) consisted of twelve Likert scale items, with values ranging from 1 = Definitely false to 8 = Definitely true. A sample item is: *If I should find myself in a jam, I could think of many ways to get out of it.*

SELF-EFFICACY SCALE

The Self-efficacy Scale (Tschannen-Moran & Hoy, 2001) consisted of eleven Likert scale items, with values ranging from 0 = Cannot do at all to 100 = Highly certain can do. Items were modified to correspond with problem solving approach presented in this engineering course. A sample item is: *Identify the key features needed to tackle the design problem.*

PROFESSIONAL IDENTITY IN ENGINEERING SURVEY

The Professional Identity Survey was adapted using the Engineering Professional Identity Survey developed by Villanueva and Nadelson (2017). The survey consisted of six open-ended items. An example of an open-ended item is: *Do you consider yourself an "engineer"? Why or why not.* For this survey, we followed recommendations by Villanueva and Nadelson (2017) wherein we determined the level to which students' current responses for all six free-response items were scored on a four-point scale. In this coding scheme, a "0" represented students that don't perceive themselves as "engineers"; "1" represented students' perceptions of them becoming "a little bit like engineers"; "2" represented students' perceptions of themselves as "engineer-in-training"; and "3" represented students' perceptions of themselves as "fully trained engineers".

Procedure

Participants were recruited through announcements in their classes and through an email invitation (through permission of the instructors) via Canvas course webpage. The invitation included the letter of consent, a link to a Qualtrics survey that included The Future Scale (Snyder, et al., 2006), the Self-efficacy Scale (Tschannen-Moran & Hoy, 2001), the Professional Identity in Engineering Survey (adapted from Villanueva & Nadelson, 2017) and a demographic questionnaire. Each instrument took approximately five minutes to complete, and the questionnaires ranged between 5-10 minutes to complete. In total, participants took between 20-25 minutes to complete the surveys.

We collected data at two timepoints during the semester: (1) middle of the semester and (2) end of the semester. These timeframes were used because the courses selected for this study represent the first 'professional-type' courses in engineering (Villanueva, et al., 2018). \We wanted to allow for sufficient time for students to familiarize themselves with the norms, views, and beliefs about the engineering profession via these courses. Originally, we intended to compare the two courses side by side but because we did not have enough participants for each course, we opted to combine them since the age group and stage in undergraduate program was similar.

Quantitative Results

We used a concurrent triangulation mixed-method design (Creswell, 2009) with a pretest/post-test design for quantitative data and a thematic and axial coding (Berg, 2001) for the Professional Identity Survey. For the Professional Identity Survey, we employed a method similar to Villanueva and Nadelson (2017), in which we used a constant comparative approach from the *a priori* codes established by this work but remained open to the emergence of additional codes. These codes were transformed numerically and used with the other Likert scale items to conduct statistical analysis (see below).

Hope analysis

We conducted a dependent t-test comparing levels of hope at the beginning and end of the semester. The Hope total scale scores were not significant [$t(75) = 0.10$, *ns,* $d = .01$; pretest $M = 53.24$ ($SD = 5.76$); post-test $M = 53.29$ ($SD = 6.70$)]. Likewise, the waypower subscale [$t(76) = 0.54$, *ns,* $d = .06$; pretest $M = 26.88$ ($SD = 2.88$); post-test $M = 26.71$ ($SD = 3.69$)] and willpower subscales[$t(76) = 0.71$, *ns,* $d = .08$; pretest $M = 26.36$ ($SD = 3.45$); post-test $M = 26.57$ ($SD = 3.60$)] did not show significant differences across time. Students' reporting of hope started high and remained high from pre- to post-test. This ceiling effect in the levels of student hope caused us to be curious about whether or not any differences existed between the different engineering majors. We then conducted ANCOVA to examine any differences. What was interesting is that we found that students majoring in degrees that required a license at the end of their program had higher levels of willpower than their non-license peers. Engineering fields with licensure requirements are available in Table 1.

Self-efficacy analysis

Students demonstrated significant gains in student self-efficacy [$t(43) = 3.97$, $p = 0.0003$, $d = .61$; pretest $M = 654.19$ ($SD = 169.86$); post-test $M = 706.74$ ($SD = 161.98$)]. Student gains in self-efficacy were found between the pre- and post-test periods. Correlations of surveys were significant within the two Hope subscales of waypower and willpower and within the same survey administrations; however, correlations between the Hope and the Self-efficacy scale were not significant. All correlation coefficients are in Table 2.

Table 2

Correlation coefficients of the Hope and Self-Efficacy scales for Time 1 and Time 2

	Time 1				Time 2			
	Way	Will	Hope Total	Self-Efficacy	Way	Will	Hope Total	Self-Efficacy
Way 1		.67*	.91*	.11	.67*	.45*	.62*	-.04
Will 1			.91*	.19	.59*	.73*	.73*	.13
Hope Total 1				.17	.70*	.68*	.75*	.06
Self-Efficacy 1					.02	.08	.06	.86*
Waypower 2						.76*	.94*	.08
Willpower 2							.94*	.14
Hope Total 2								.12
Self-Efficacy 2								

Note. $*p < 0.01$

Professional Identity Analysis

We compared themes for differences in the Professional Identity scale between the two administrations. T-test comparisons were conducted to compare the pre- and post-test administrations of this survey to examine any changes in participants' perceptions.

Preliminary analysis of students' self-reported answers of their professional identity showed that at the middle of the semester, 44% of students did not consider themselves to be an engineer. Towards the end of the semester, this percentage reduced to 38.00%, and this change was not significantly different ($t = 36.25$, $p = 0.17$). Also, at the middle of the semester, only 18.00% of students attributed the field of engineering as being one to serve society (Social Servant) and often described the technical aspects of the field such as critical thinking and problem-solving (Designer/Tinkerer). At the end of the semester, this percentage was increased to 37.00%. This change was not significant ($t = 114.79$, $p = 0.17$).

While the changes were not statistically significant, we identified practical significance in the sense of the themes derived from the responses. Thematically the responses fell into categories of the work of engineers as being either Pragmatic, Creative, or Altruistic. These themes are further detailed in the following qualitative results section.

Qualitative Results

In the Professional Identity in Engineering Survey, participants were asked to define engineers and the profession of engineering in terms of engineer traits and engineering process. We also asked them to articulate their professional goals in becoming an engineer, among other questions regarding their identity as engineers. Two researchers viewed the open-ended responses and coded the responses independently. Subsequently we compared our thematic analysis and where we found discrepancies, we involved a third researcher to reconcile the differences.

Participant responses from the engineering professional identity data were fed into a spreadsheet below each survey question. In the initial reading through the responses, we began to recognize similarities among the participants that fell into one of three emergent categories. We noted that participants were either practical and logical with their responses, or their responses indicated a level of creativity, or were focused on the benefits of engineering for humankind. We continued through the data, which revealed three archetypes of identity as being either Pragmatic (60%), Creative (9%), or Altruistic (31%). In the cases in which participant responses overlapped characteristics of the archetype, we coded them according to the predominant orientation (Table 3). No other subcategories were present in the data.

Also in our coding process, we noticed that the archetypes appeared whether students referred to engineering skills, processes, or goals. As such, the descriptions shared below encompass all three subcategories of skills, processes, and goals. For illustrative purposes we have selected three representative identity archetypical statements for each of the subcategories. In addition, Tables 3, 4, and 5 contain other illustrative participant quotes to make visible the contrast in the three archetypes.

Table 3

Contrastive Analysis of Professional Identity Perspectives of Engineer Skills

Pragmatic	Creative	Altruistic
The ability to recognize a problem, analyze and break it down, and formulate a solution. In essence, to think critically.	Problem-solving skills. The ability to stick with something even when it's difficult	To be a trusted person who knows how to work hard. Someone that will make good decisions when no one is watching.
Problem-solving, math, imagination, being thorough. I think though that the most important skill that an engineer can have is math. If you can't think in the methodical, analytical way you do when you're doing math, engineering will be difficult.	Professional engineers need to be creative in their problem solving. Issues come up all the time in every project that must be worked around, and sometimes the solution requires a lot of creativity and dedication.	I would say one of the essential skills a professional engineer should have is to be able to solve problems that come up. Mostly these problem-solving skills might be in analytical problems but also in social and ethical problems.
Problem-solving skills. The ability to stick with something even when it's difficult.	Communication, creativity, technical expertise, and innovation.	Problem solving, teamwork, creating an easier life for people.

THREE ARCHETYPES RELATED TO ENGINEER SKILLS

In the first subcategory of Professional Identity, Engineer Skills (Table 3), the predominant archetype identified was Pragmatic. Within this subcategory, the most occurring terms were related to perceptions connected to math and science, logical thinking, and problem-solving skills. In relating problem-solving skills, the pragmatic focus was on logic and systematicity, and persistence. As one pragmatically oriented student noted, "Engineers should have skills in critical thinking and problem solving. Engineers should be skilled in professional computer programs used in their field such as Autodesk products."

The Creative archetype related mostly to thinking outside of the box and creative problem-solving. The difference in problem-solving under creativity is the focus on innovation in comparison to logical aspects of pragmatism. An example of this archetype came from a student who said, "Professional engineers need to be creative in their problem solving. Issues come up all the time in every project that must be worked around, and sometimes the solution requires a lot of creativity and dedication."

In contrast, the Altruistic archetype related to doing the right thing even when no one is looking and using engineering skills to serve the greater good in society. When asked what the skills of an engineer are, one altruistically focused student related, "To be a trusted person who knows how to work hard. Someone that will make good decisions when no one is watching. They know how to do their job and do it well."

THREE ARCHETYPES RELATED TO ENGINEERING PROCESSES

When participants were asked "What is engineering?" responses were predominantly in the Pragmatic category, with fewer showing as Creative or Altruistic (Table 4). From the representative samples, participants noted that engineering, from a pragmatic standpoint, is primarily about problem-solving using design principles of mathematics and science. As noted by one pragmatically oriented participant, "Engineering is the process of designing a practical solution to a real-life problem using scientific principles and mathematical analysis."

The Creative archetype brought forward creating something new, taking something and making it better, and coming up with new solutions to current and future problems. For example, one participant noted that engineering means "…designing, building, and creating a space where other people can make a difference. It's building something new and original out of ideas that others hadn't put together before." In contrast, those who answered in more Altruistic terms mentioned using mathematics and science to make the world safer and a better place for all. As one altruistic participated noted, "Engineering is the application of science and math to build and design for the betterment of the world."

THREE ARCHETYPES RELATED TO ENGINEERING PROFESSIONAL GOALS

Participant responses to the question about their professional goals as engineers resulted in the same three delineations of Pragmatic, Creative, and Altruistic (Table 5). In the realm of professional engineering goals, the Pragmatic archetype tended to mention the engineering systems and tools they would use and design in their work. For example, one participant stated a professional goal of, "Become a civil engineer who designs and builds roads and trails in the National Park System."

Participants from the Creative archetype talked more about being innovative, inventive, and designing products. An example of mentioning the more creative aspects came from a participant who noted that a main goal in becoming an engineer was to "Create and design something new."

Table 4
Contrastive Analysis of Professional Identity Perspectives around Engineering Processes

Pragmatic	Creative	Altruistic
Using math and science to solve real-world problems.	Engineering is looking at things in a new way. It is taking something the way it is and making it better. It is using resources the best way possible.	Engineering is the application of science and math to build and design for the betterment of the world.
Engineering is providing feasible solutions to problems.	Engineering is the action of taking knowledge and research on a subject to create something new from it.	Solving problems to make the world a better place
Engineering is the design and building of machines and structures. It involves various sciences, technology, and mathematics.	Engineering is creating things. Engineering is solving problems. Engineering is coming up with solutions that have not been previously thought of.	Building, designing and problem-solving ways to help benefit and keep the general public safe.

Table 5
Contrastive Analysis of Professional Identity Perspectives around Professional Goals

Pragmatic	Creative	Altruistic
I want to become a traffic engineer. I want to obtain my EIT, then PE, and then my PTOE.	Create/design something new. Become an innovator.	To be able to help society in some form. Working with a team of engineers that have a desire to help better the world.
I hope to become a senior engineer in a company that works with geothermal energy. I want to specifically work with the hydraulic systems and structures involved in that process.	Invent and revise the future. Make something new.	My main goals are focused in contributing to society and making this world a better place. I also want to develop soft skills because I know I will be working a lot with people.
I would like to obtain my Professional Engineers license and eventually start my own Civil Engineering company.	I love math and I love designing things, so I think engineering would be a good fit.	To apply my knowledge and research in ways which are beneficial to the world around me and to effectively change lives for the better.

On the other hand, those who tended more toward the Altruistic archetype, mentioned working with people to make the world better. One such participant stated the goal of becoming an engineer was, "To be able to help society in some form. Working with a team of engineers that have a desire to help better the world." We found these differences in orientation to be quite striking and interesting, particularly as we saw these differences consistently applied across the various aspects of engineering.

Discussion and Significance

Since engineering educators are tasked to produce technically competent professionals and nurture students' development of 21st century skills, we propose that factors which may contribute to engineering students' success is their level of hope, self-efficacy, and professional identity as engineers. This research study explored the relationships between hope and self-efficacy in the domain of engineering professional identity perceptions among a group of undergraduate students.

Students reported relatively high levels of hope (in relation to the total scale score) at both the middle and end of the semester. Initially, we interpreted this finding to suggest a ceiling effect in that these students experienced high levels of hope that were constant over time. However, the finer-grained analysis of looking at willpower and waypower as separate constructs uncovered some interesting findings in relation to engineering licensure. Students who were pursuing degrees that would require a professional license (e.g., mechanical, civil, aerospace, and electrical engineering) reported higher levels of willpower when compared to students pursuing degrees that would not require a professional license (e.g., computer, biological engineering; undeclared major). This suggests that more research needs to help determine whether students who are obtaining a license have a stronger sense of hope perhaps because the licensure itself affords them a clearer goal orientation.

In contrast, the quantitative analysis of waypower showed no differences between licensure and non-licensure degrees. This finding may be due to the creative nature of engineering as a profession. Courses are structured so that students develop creativity and intentionally seek out multiple ways to problem-solve and design (Villenueva, et al., 2018). This was borne out in some of the qualitative responses of students including, "I want to create and design something new," "I want to invent and revise the future," and "I want to make life easier and healthier for people and their environment." It would seem then that finding multiple paths around obstacles (waypower) would be an integral part of engineering both as an identity and as a profession.

Students appeared to experience increased self-efficacy towards engineering skills and processes over time. The growth in self-efficacy is to be expected for students in coursework over time. What is important to note is that with a high drop-out rate among undergraduate engineering majors, high levels of self-efficacy are encouraging as they would be more likely to persist in their program. Future researchers may want to interview those who have not persisted in their major to better understand where their level of efficacy was in relation to the engineering program and what caused them to decide to change majors.

We also examined to what extent hope and self-efficacy were related to undergraduate engineering students' sense of professional identity. This differentiation is something that could be further expanded in the engineering coursework and may point to a need for instructors to help students situate themselves in their future professional roles as persistent views that are disjointed from their future professional roles may result in withdrawal from the field (Villanueva &

Nadelson, 2017). Also, while we cannot conclude at this point causal relationships between professional identity and hope and professional identity and self-efficacy, the sustained mismatch between students' views of engineering as a profession may result in a false sense of hope and subsequently self-efficacy. More work is underway to this end.

Regarding professional identity, participants were asked to relate their conception of what are engineer skills, what is the engineering process, and what are their professional goals upon completion of their programs. It appeared that participants' perceptions of themselves as engineers was primarily unchanged in the pre-post responses over the semester of coursework. Additionally, according to our qualitative analysis, participants within the Pragmatic archetype, noted the work of engineers being related primarily to the skills of problem solving. The Creative archetype responses indicated that engineers use innovative ideas not previously articulated, which may or may not include innovative technology. The Altruistic archetype indicated that the work of engineers primarily was related to working with other to solve problems that benefit society as a whole.

As we discussed these outcomes, we were reminded of previously suggested historical engineering foci that had some relevance to the meanings constructed by the participants. (Villanueva and Nadelson, 2017). For example, the group we termed as *Pragmatic* was similar to the historic perspective of engineers as *Mediators* of math, science, and technology (a term referring to engineering curriculum incepted in the *early* 1800's). These individuals tend to refer quite often to elements of the scientific method as important in the development of an engineering professional identity. On the other hand, *Designer/Tinkerer* (a term referring to a historical refinement of engineering curriculum in the *late* 1800s) views engineering as a field that "builds or fixes objects or things, refines products, or creates inventions" (Villanueva, et al., 2018, p. 3). We found this to be similar to the group we named *Creative* as they frequently mentioned innovation and ingenuity as important aspects of engineering. Finally, *Social Servant* (a term referring to the inception of 21st century engineering in the early 1900s), blended scientific and mathematical principles with designing and tinkering skills for the purpose of benefiting society. Similarly, participants in our category of *Altruistic* typically viewed engineering as a means of improving life for society as a whole.

In bringing together these analyses, we recognize that these engineering students had moderately high levels of hope. Engineering educators need to continue to provide opportunities to develop problem-solving skills and invoking innovation and ingenuity to continue to encourage high-hope thinking. A question that arose for us in relation to the qualitative analysis is whether the three types arose from the curricular foci or is it more a matter of personality type of the individuals? Future research could incorporate a personality survey or an interest index survey to determine whether any relationship occurs between these and the perceptions we delineated and 21st century instruction.

A limitation of the study was that these students were Juniors and Seniors and thus were likely to complete their majors. We did not follow them through to degree completion to see how these factors may play out over time and what their impact may be on completion or drop-out rate. In addition, we did not work with Freshmen and Sophomores to better understand their levels of persistence in the field of engineering. Future research could examine more closely the beginnings of engineering identity development in relation to self-efficacy and hope. In addition, we recognize the small sampling of particular students from one university setting that may not be representative of other engineering students.

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