
AC 2011-290: A MULTI-INSTITUTION COMPARISON OF STUDENTS' DEVELOPMENT OF AN IDENTITY AS AN ENGINEER

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A Multi-Institution Comparison of Identity Development as an Engineer

Abstract

Engineering identity research was conducted looking at both traditional engineering students and students enrolled at a military academy. As much of the prior research has applied multiple identities as the theoretical framework, the current study also applied this approach towards its goals of understanding the commonalities and differences among students within these two groups. This research aims to fill a gap in the collective knowledge as to the factors that contribute to the development of a student's professional identity and more specifically identification with engineering. We hypothesized that students associated with military routines would have a stronger professional identification within their chosen academic major than students not associated with these routines. The results of this work can be used to guide administrative / curricular structures for engineering education to support students' identification with engineering, which is believed to increase a student's likelihood for educational and professional persistence post-graduation. Semi-structured interviews were performed at three universities to gain a better understanding of how students develop their professional identities. Specifically, the student participants were from a cross-section of levels toward degree completion and were from two departments of engineering (civil and mechanical), as well as history for reference. Two universities served as the main research sites; the first a military university in the northeastern United States and the second a private university in the mid-western region. The third university was a large public university in the southeastern United States that served as an expansion of the study. The results of our study show some distinct similarities and differences in the identity development of students. Identifying as a family member or with a geographic region seemed universal, and there was a more distinct professional identity for engineering students than history students. One clear difference was the approach to how students selected their institution of higher education. Also, it was clear that organized activities that contributed to a shared / common developmental experience was useful in identity development. These initial findings spark many more questions relating to identity development, which could be further explored looking at student's development over time.

Introduction

Research has shown that identifying with engineering contributes positively to students' persistence in earning an engineering degree.^{1,2} While some students may enter engineering programs with the belief that he or she is "an engineering-type person," this is not true for all students.³ Therefore, engineering educators and administrators need ways to encourage students' engineering identity development. However, current research lacks a clear understanding of how students' develop identification with engineering and what universities can do to enhance students' identification with the profession.

To begin closing this gap, we designed a multi-institution study that enabled us to examine and compare a military academy where there are successful practices for helping students develop an identity, more specifically a military identity, to settings where such intentional practices do not exist. While a military identity is not the same as an engineering identity, it is a professional

identity and is related to future career work. The military academy in this study is located in the northeastern United States. The primary comparative university setting is a private university in the mid-western United States where students have a strong identification with their university's reputation. A secondary comparative setting included a public university in the southeastern region of the United States. The first two locations served as primary research sites with the third location serving as a place to test and expand findings. Guided by theories of collective identities, our primary research question is:

What factors contribute to the development of a student's positive professional identity and then specifically identification with engineering?

To answer this question, we examined differences in university contexts and experiences of students. To situate engineering within the broader category of professional identity, we studied engineering students as well as students majoring in history, a discipline clearly outside of engineering but common across the participating institutions. We hypothesized that students associated with military routines would have a stronger professional identification within their chosen academic major than students not associated with these routines. We designed our study to elicit differences in how professional identities develop at the various institutions. Given the exploratory nature of our study, we adopted a qualitative case-study approach based on one-on-one interviews.

Background

Within the field of professional identities, our research lies at the intersection of engineering identity and military identity and fits within an overarching theme of multiple identities. Research has shown that identifying with engineering contributes positively to students' motivation in the classroom and persistence in earning an engineering degree.^{1,2} Research has also provided specific identity development patterns among military academy cadets that include a shift from self-interest to shared meaning in identity and include evidence that demonstrate that length of exposure to the military increases cadets' identification with the military but does not decrease their identification with their other previously held identities.^{4,5} The authors recognize that students at various military academies carry the title of cadet, midshipman, etc. The general term "cadet" is used in this manuscript to describe a student enrolled at a military academy.

While research on engineering students shows the importance of identification with engineering, this research lacks a clear understanding of how such identification develops. Research on military cadets shows clear patterns in identity development yet also lacks an understanding of the factors that directly contribute to this identity development. Our research seeks to fill both gaps by examining the factors that contribute to professional identity development among military cadets and engineering students.

Multiple Identity Theory

Our research is grounded in multiple identity theory. There is a great deal of research on multiple identities based on varying contexts. For example, Gee provides the outline that there

are four major identities, nature (a state), institution (a position), discourse (an individual trait) and affinity (experiences) and that they all exist and interact to form who we are.⁶ Jackson provides a more generalized view on multiple identities that demonstrates that we have multiple social identities such as peer, religious, romantic and family identities that fall into a hierarchy depending on our commitment level to each identity which can be influenced by many aspects of our current context.⁷ Previous work on engineering identity has also been framed by the notion of multiple identities. Matusovich, Steveler, Miller and Olds³ used Gee's⁶ identity theory to frame their research, and Capobianco⁸ used Gee's⁶ theory along with other multiple identity frameworks as the basis of her work. The research by Tate and Linn⁹ was influenced by Gee's⁶ explanation of multiple identities, but they ultimately created their own framework by focusing on academic, intellectual and social identities. Other multiple identity theories have also been used to frame and anchor varying engineering identity research^{1, 2}, but the details of those theories only loosely fit with the ideas presented for this investigation. The research presented in this article is framed by Gee⁶ with more emphasis placed on Jackson's⁷ specific views of multiple identities because her theory is directed to identities in a social context, which aligns with our research. The theoretical frameworks used in military identity research are very similar to those used in engineering identity research. Helms¹⁰ based her work on Gee's⁶ multiple identity theories, and Franke⁵ used an alternative approach, but it still related his work to the concept of varying identities. The theory of multiple identities has been used consistently to anchor work in both arenas of our study, so framing our research in multiple identities was appropriate.

Engineering Identity

The identity of an engineering student or a professional engineer has been detailed and characterized in a variety of ways. For example, research by Tate and Linn⁹ specifically examines the identity of women of color in engineering. They studied the identities of 5 upper level (junior and senior) women of color at a large public university through interviews and were able to conclude that academic, intellectual and social identities all played a key role in their education and future goals.⁹ Other studies have found similar results as they relate to educational experiences and career intentions. A study by Capobianco⁸ also examined women engineering students and how they envision their future professional identities with the goal of impacting programs, curricula and classroom practices to better complement those identities. The research was a longitudinal case study of 4 female engineering students, which aimed to provide an understanding of the female engineering students' identity comprised of academic, institutional and gendered identities influenced by role models.⁸ Other research relating to engineering student identity has examined a wider population of engineering students. Matusovich, Steveler, Miller and Olds³ provide information on engineering students' view of themselves as future engineers and how that impacts their choice to pursue engineering. Semi-structured interviews were conducted over 4 years with 10 engineering students, 5 female and 5 males.³ Their work identified that many engineering students are uncertain about what it means to be an engineer even at the end of their undergraduate engineering programs, which can lead to an overall lack of direction or persistence into being a professional engineer in the future.³ Finally, ethnographic interviews by Tonso¹¹ examined engineering student identities and aimed at recognizing the unique student culture of engineers.

These research examples all point to the idea of future engineers. Engineering students have identities today, but how these identities impact their future career choices is important to understand. Davis, Beyerlein and Davis¹² provide an engineering profile to serve as a guide for what an engineering student should be when they graduate. The profile was created through multiple focus groups that were based on ABET criteria, professional engineering society opinions on what ethical engineers should be, opinions from industry, and defined competencies for a public university.¹² The profile is designed to direct outcomes of universities for faculty and employers.¹²

Finally, multiple research projects originating through a team at James Madison University have recently contributed a great deal of research to the body of knowledge relating to engineering student identities. Many of these projects are focused on freshman engineering students^{2, 13-15} with the main objective of informing the vision of engineering identities to improve recruitment and retention.^{1, 2, 13, 14} The research also concentrates on comparisons between male and female engineering student identities^{2, 14} and comparisons between students who persist in engineering and those who switch out of engineering for various reasons.^{1, 2} While much of the information gathered by these works is related, it does differ in context. Some focus on professional identities¹³, some on meaningful experiences as an engineering student that impact identity and perseverance in engineering¹, others on students' goal orientation and how that relates to engagement and overall motivation² and finally, how identity information can be applied to program enhancements.¹⁵ All of these specific research topics are grounded in various identity theories, but all hope to improve our understanding of the engineering students' identity.

Military Identities

Another element to this research is the military component of identity. Lewis et al.⁴ examined the development of United States Military Academy (USMA) cadets in a longitudinal study that included multiple interviews of cadets at a variety of stages in their academic and military careers. The findings, as they relate to identity, showed that through a cadets' time at the Academy there is a shift from self-interest to shared meaning in identity⁴ which seems to be at least partially in response to the cadets' social environment. Franke⁵ researched the identities of USMA cadets as well and found that length of exposure to the military increased cadets' identification with the military but did not decrease their identification with their other previously held identities. Helms¹⁰ specifically studied 6 women cadets at USMA during their first year at the Academy to help determine the identity of those women and their self-reflection on their experience as a student in the university and in the military. The research on military identity points to the notion that there is a difference in the identity of military college students compared to those of traditional college students⁴, but what is the extent of this difference and how is it specific to engineering?

Multiple identity theories have been used to frame research involving both engineering students in traditional college settings and students at military focused universities. By answering our research question, where we determine what factors specifically contribute to the development of student professional identities, we will be able to expand our research to improve the engineering experience as a whole. By developing and conducting our research using multiple identities, we

ultimately hope to improve engineering students' identification with engineering leading to increased motivation and retention.

Methods

Within the framework of multiple identities, our study is designed to elicit similarities and differences in the development of military and engineering professional identities. We examine and compare 1) a military academy (MilA) in the northeastern United States, where there are known and successful practices for helping students develop a military identity, 2) a private university (PriU) in the mid-western United States where students have a strong identification with their university's reputation, and 3) a public university (PubU) in the southeastern region of the United States. The first two sites, MilA and PriU, served as the primary research sites while the third site, PubU, allowed us to test and expand our findings. Such an approach is consistent with case-study methods.^{16, 17} Although specific research context varies across the three sites, similar data collection and analysis protocols were used to maximize comparability of the data.

Within these three settings, we focus on Civil Engineering and Mechanical Engineering as these are two of the largest, oldest, and most common fields of engineering. We also interviewed students majoring in history to see the differences between their identities and those of engineering students. Studying students in history, a discipline clearly outside of engineering but common across the participating institutions, enables us to situate engineering within the broader category of professional identity, i.e., are our finding unique to engineering students or more common across college students in general?

Context

The three data collection sites vary in size, student population and overall collegiate mission, which provides a broad and rich sampling of contexts and participants for the study. Similarities between the sites are also noted.

MilA is a public academy with a strong teaching focus opposed to a research driven mission. This public university is classified as an arts and sciences plus professions university by the Carnegie School Classification.¹⁸ MilA has a tradition as an engineering school but currently offers more than 40 different majors. The student body includes approximately 4,500 undergraduate students. In contrast, PriU is a private university classified as a balanced arts and sciences/professions university by the Carnegie School Classification.¹⁸ PriU is a research-focused school with a student body of approximately 10,000 undergraduate students. Like MilA, PubU is a public university. However, unlike MilA or PriU, PubU is classified as a professions plus arts and sciences university by the Carnegie School Classification.¹⁸ The dominate major is engineering in a student body of approximately 24,000 undergraduate students. PubU is the largest of the three sites and has a research-focused school mission.

Most of the students at MilA are traditional students, i.e., they attended college right after high school. Within engineering, demographics are similar to other engineering programs nationwide. Nearly all graduates from MilA will immediately serve in the military. At PriU, the minority and female populations in engineering are approximately 15% and 25% respectively. Like MilA,

most of the students at this university are also traditional students attending college right after high school. Most graduates will pursue futures in graduate school or industry. Many of the students at PriU have a strong religious affiliation. At PubU, the minority and female populations in engineering are approximately 16% and 16% respectively. Most of the students at this university are traditional students as well, but non-traditional students (older students returning to school, transfers from Community College) are not uncommon. Most of graduates pursue advanced degrees or obtain jobs in industry. These varying student populations provided for unique participants with a wide range of educational and personal experiences.

Participants

At MilA and PriU, the focus was on Civil Engineering, Mechanical Engineering, and history majors. Students in their second, third and fourth years of collegiate study were included. At MilA students do not enter engineering studies until their second year, so the sample includes cadets in first, second and final years of engineering programs. At PriU, students enter a general first-year program (while taking engineering preparation courses) for their freshman year and then transfer to specific majors at the start of their second year so the study population includes students in their second, third, and fourth years of engineering programs. At the third location, we expanded our engineering student sample to include first-year students who are in a general engineering program and a fourth year student in Aerospace Engineering. Study participants were recruited in a variety of ways including direct contact by faculty and researchers and through student organization leaders.

A total of 20 participants were interviewed. This includes 6 at MilA, 11 at PriU, and 3 at PubU. Demographic information for each participant is included in Table 1. Pseudonyms have been assigned to protect participants' identities.

Table 1: Participants

Pseudonyms	University	Academic Major	Class of	Male / Female
Emma	MilA	Civil	Junior	Female
John	MilA	Mechanical	Junior	Male
Madison	MilA	Mechanical	Senior	Female
Markus	MilA	Civil	Senior	Male
William	MilA	American History	Senior	Male
Matthew	MilA	Military History	Junior	Male
Isabella	PriU	Civil	Sophomore	Female
Anthony	PriU	Mechanical	Junior	Male
Peter	PriU	Civil	Junior	Male
Luis	PriU	Civil	Junior	Male
Joshua	PriU	Civil	Sophomore	Male
Jayden	PriU	Mechanical	Senior	Male
Edith	PriU	History	Sophomore	Female
Noah	PriU	History	Senior	Male
Jacob	PriU	Mechanical	Sophomore	Male
Ava	PriU	History	Senior	Female
Alex	PriU	Civil	Senior	Male
Tyler	PubU	Ocean and Aero	Senior	Male
Lucas	PubU	Mechanical or Electrical	Freshman	Male
Jack	PubU	Chemical	Freshman	Male

Instruments

The data collection instrument was a semi-structured interview protocol. One-on-one interviews were conducted at each research site. The interviews lasted approximately 45 minutes. The protocol included an activity where participants listed ten nouns they would use to describe themselves. They were then asked to rank order these words and identify which ones they considered key by choosing a line to divide the words into two categories, the first being extremely important and critical to who they were. They were then asked a series of questions related to the ways they identify themselves, how others would describe them, and how their identities developed. To explicate possible differences in personal motivations for choosing a particular major and/school, participants were asked how and why they chose their major and school. Interview questions can be found in Appendix A. Interviews were recorded with participant approval, and following each interview, structured notes (spreadsheet format) were made for that participant, documenting their responses.

Analysis

Our analysis followed a person-centered approach as described by Miles and Huberman¹⁹ for multi-case analysis. In this approach, data are summarized in tables in such a way to preserve the individual stories but also to illuminate similarities and differences across cases. Each MilA

and PriU case was analyzed separately before looking across cases. Once themes and patterns were identified within these two contexts, they were compared to the three cases from PubU.

In the first phases of the analysis, the ten words listed by each participant were examined. They were reverse scored such that highest score, 10, was assigned to the most salient identity and the lowest score, 1, to the least salient. We grouped the words into common categories such as “family” for mother, father, son, etc. For each participant, we summed up the points within each category. Table 2 shows an example excerpt from the analysis table with data similar to actual study responses. This participant ranked son highest (score 10) and leader lowest (score 1). In the broader category of “family” we have the ranking for son (10) plus the ranking for brother (8) for a total family value of 18.

Table 2. Example Analysis Table: How identity descriptors were combined in broader categories

Name	Identity Descriptors Ranked Highest (10) to Lowest (1)						Example Summative Identity Categories			
	10	9	8	...	2	1	Family	Academic	Professional	Engineer
Ex. 1	son	engineer	brother		student	leader	10+8=18	2	9+1=10	9

We assigned identity descriptors to broader categories for all participants before looking for patterns in high and low point totals by school, major and year. The list of broader categories included all of the following with definitions as noted:

- **Academic:** identity related to a role in an academic setting such as student, learner, etc.
- **American/Immigrant:** calling oneself an American, immigrant or international student
- **Athlete:** association with a member of a school, internal or club team, team or just “athlete” in general
- **Character Traits:** identity roles that describe ways of being such as helper, loner or giver
- **Engineer:** specific mention of an identity as an engineer (note these also count under the even broader category of “professional”)
- **Ethnicity:** ethnic identity such as Hispanic or African American
- **Family:** identity associated with family relationships such as son, aunt, sister, etc.
- **Friend:** identification with being a friend
- **Geographic Region:** identify as coming from a specific region such as Texan or Chicagoan
- **History:** specific mention of a history related career such as historian or history teacher (note these also count under the even broader category of “professional”)
- **Hobbyist:** identity role related to an enjoyed activity such as photographer, fisherman, hunter
- **Leader:** specific role as a leader or follower (note these can also count in “Professional” if used in the sense of a career)
- **Military:** specific mention of a military role such as officer or soldier (note these can also count in “Professional” if used in the sense of a career)
- **Political:** identification with a specific political view such as democrat

- **Professional:** identity descriptors related to future career rolls such as engineer, historian, soldier, leader, history teacher
- **Religion:** identifying ones religious affiliation such as Catholic or Christian
- **Romantic Partner:** identification as a romantic partner such as boyfriend or girlfriend
- **School:** identifying with the specific school or school mascot such as Badger or Husky (note giving specific examples would identify the schools therefore these examples are fictitious for the participating schools)

In the second phase of the analysis, themes and patterns in how students talked about campus-related activities were evaluated for possible roles in contributing to identity development. An open coding system was applied, and the results were considered by institution, major and year.

Results

How Participants Describe Their Multiple Identities at MilA and PriU

In the first phase of the analysis, we looked at the words students used to describe themselves in order to understand how they see themselves and what identities they believe that they have. We found several patterns among the word choices. First, we report findings related to non-professional identities. Identifying as a family-member (son, sister, aunt, etc.), friend, student, and by geographic region (e.g. Chicagoan) are equally important across the two primary schools. Geographic reason is particularly interesting since both schools draw students from across the country, not from specific regions. It should be noted that family and geographic region were common examples given during interviews so this could contribute to it showing up with higher frequency. For example, interviewers specifically asked for nouns and gave examples such as “son” or “daughter” or “Texan”. Additionally, PriU participants mentioned being an American (or conversely being immigrants) more often in their list of 10 identities. At first this seems surprising given that MilA participants have chosen a school that leads directly to military service for the country. However, it might be that cadets at MilA believe their patriotism is obvious and need not be stated. For example, Matthew, a MilA participant did list American as a key aspect of his identity and when asked about it said, “Obviously I came here so I value that.” Finally, several PriU participants include romantic partner (boyfriend or girlfriend) while no MilA participants did. This is not surprising given that the specific requirement that cadets not be married (or have children) while at the academy and the “Don’t Ask, Don’t Tell” policies of the military could contribute to an atmosphere where relationships are not discussed between cadets and faculty.

With regard to professional identities, identification with engineering appears to be higher at PriU than at MilA as engineering identity is more often listed higher on the rating list at PriU than MilA. At both PriU and MilA, we see a lower identification with history for history students than corresponding identification with engineering for engineering students. Recognizing that the sample of history majors is smaller, we found only one history major at each school specifically mentioned a history-related identity. This is particularly salient at PriU where there was a higher identification with engineering.

Considering professional identity as a broader category and including words such as “leader”, “servant” and “soldier” when used in reference to career, we find that professional identity overall is higher at MilA than PriU. As an example of considering “soldier” a professional identity, consider this quote from John as he was explaining why “soldier” was the top word on his identity list, “...the big picture of this school is to be a soldier. I mean, that is why, at least for me, that’s why I came in here is to be a soldier. So um, again, that is number one. We have a responsibility when we leave this school.” John came to MilA to be a soldier and from the context of his quote suggests that he looks forward to fulfilling his military obligation upon graduation. This last finding with regard to professional identity being stronger at MilA than PriU is consistent with our hypothesis and with literature reports of identity development in the military academy.

How Identities Develop at MilA and PriU

When we look deeper in the interviews to understand *how* the identities described by the students developed, we again see some patterns. Consistent with the finding that engineering identities may be more salient at PriU, we find that PriU students choose their school for reasons related to engineering, but MilA cadets did not. PriU students acknowledge their school as having a good engineering program as well as a nice campus. For example, Luis said, “I applied to Colleges that had Civil Engineering.” He then went on to say that PriU was a high level school that he was unsure he would get into then he did, and the campus visit “sealed the deal.” From the perspective of PriU, this is a bit surprising as PriU is a predominantly liberal arts university with engineering encompassing only 15% of the student body.

With regard to sources of identity development, MilA cadets can give specific examples of activities contributing to identity development while PriU students struggle a bit more to give concrete examples of experiences. For example, a number of MilA cadets site Cadet Basic Training (CBT) as contributing to their leadership identity. CBT transitions incoming civilians to cadets, and begins to inculcate the skills and values necessary to develop leaders of character fully committed to military service. This intensive 7 week program is equivalent to the basic training associated with all forms of the US Military. For example, when talking about his experience in CBT, Matthew says “It made me feel like proud to you know, felt like I had done something”. Having also had a leadership role in CBT as a second year student, Matthew also talked how this role in CBT helped him develop as a leader. Further evidence for the military system as developing a leadership identity comes from a PriU student participating in ROTC who credits ROTC with contributing to his identity development. Joshua talks about the structure of the ROTC program:

As a freshman, you are just kind’of like getting accustomed to things. Sophomore year you are taking more of a responsibility. You’re become team leaders and you are responsible for your little team of freshmen and you are also talking more with the upperclassmen who are the overseers of the team leaders and platoons and everything. Just like the whole chain of command.

He goes on to talk about what he is expected to know and how he is expected to use that knowledge to help the freshmen.

We can then ask how CBT contributes to identity development. While it is a highly structured activity, we also find that reflection on CBT is critically important. MilA cadets talk about realizing later just how much they accomplished or just what they could do. In talking about the summer military program in general Matthew said “Being able to like reflect on what I’ve done since this is like, since this tests you, in different ways than you would at, um like other institutions I think, um you have more to reflect on and this has helped me to develop and mature I think.”

Transfer of Findings to a PubU

To check the transferability of our findings, we conducted interviews at a third research site, PubU, using the same interview protocol. Like PriU, there are no specific programs in place beyond regular coursework and elective activities to help students develop a professional identity. Therefore we anticipated outcomes for PubU that are similar to PriU.

We did find similar patterns among PubU as seen across the other two schools with regard to word choice. Identifying as a family-member (son, sister, aunt, etc.), friend, student, and by geographic region (e.g. Chicagoan) is equally important at PubU as the other two schools. PubU tends to draw more in-state students than out of state but also has a very large international population. With regard to nationality, one of three PubU participants (Luke) mentioned being “American” as central to his identity. He explained that this emerged in college; the high percentage of international students at VT made being American more central to him “Tech has a lot of like international students so I feel, ah, I feel like my nationality is more important here than it has ever been in like anywhere else that I’ve ever gone to just ‘cause there’s such a diverse like group of people here.” Similar to PriU, one PubU student mentioned being a romantic partner, again not something seen at MilA.

With regard to professional identities, identification with engineering appears to be similarly high at PubU as it is at PriU. As an example, Lucas talked about how he sees himself as an engineer even though faculty may not see him this way since he does not have a degree and/or license:

Some of [the faculty] especially the ones who are like have engineering degrees might disagree because ya know I haven’t like earned my degree yet, so they might feel that that doesn’t qualify me as an engineer but ya know I think of it as uh I, I like to solve problems and um engineering is what I like to do so I think of myself as an engineer.

Adding data from PubU, our finding holds that when considering professional identity as a broader category and including words such as “leader”, “servant” and “soldier” when used in reference to career, we find that professional identity overall is higher at MilA than the other two schools. While one of the three students at PubU mentioned “leader”, this was more in the context of the student groups in which he currently participates than as a central role in his career.

With regard to identity development, we find both consistencies and differences between PubU and the outcomes from the analysis of PriU and MilA. Consistent with PriU, we find that students at PubU choose PubU for reasons related to the engineering programs. For example, Tyler chose PubU because it has a very strong program in his major area. It is perhaps less

surprising at PubU that students choose the school for reasons related to engineering than PriU because PubU has a reputation as a predominantly technical university.

While we anticipated that PubU students would struggle similarly to PriU students in providing specific examples of sources of identity development, this was not the case. Tyler talked about his internship experience. Lucas cited a number of specific engineering-related activities in which he participated in high school. Given that he is a first-semester freshman, it is not surprising that he may not have had many on-campus experiences. Jack talked about the Student Transition Engineering Program (STEP) as contributing extensively to his development as a student, hard-worker, and supporter (someone who helps and supports colleagues). Jack talks about STEP similarly to the way some MilA participants talked about CBT.

STEP is a voluntary program for incoming engineering students with enrollment limited to 100 (as compared to an incoming class of approximately 1200 engineering students). STEP is a 5 week program designed to help incoming students become familiar with the university setting, expose them to subjects that are traditionally challenging in the first semester and provide opportunities for personal and professional development such as study skills and time management. Students often describe the program as “intense” as the workload is very heavy and activities are scheduled such that students have little free time. Jack described the program as “eye opening” with regard to what it means to be a student. Similar to MilA participants and CBT, Jack talked about how succeeding in STEP helped him understand what he could do. He said, “I did fairly decent in STEP, I was like ‘I can do this!’.”

Summary of Results

Our results show several patterns in the way students express their multiple identities. With regard to non-professional identities:

- Identifying as a family-member (son, sister, aunt, etc.), friend, student, and by geographic region (e.g. Chicagoan) are equally important across the three schools although this may be related to these types of words being given as examples.
- PriU and PubU participants mentioned being an American (or conversely being immigrants) more often in their list of 10 identities. While this may be due to MilA cadets believing their patriotism is obvious and need not be stated, the PubU students offers the a university context-based reason, i.e., there are so many international students at PubU that being American became a distinguishing identity for him after starting college.
- Finally, several PriU and one PubU participants mention a romantic partner (boyfriend or girlfriend) while MilA participants did not.

With regard to professional identities:

- Identification with engineering is higher at PriU and PubU than at MilA. However, considering professional identity as a broader category and including words such as “leader”, “servant” and “soldier” when used in reference to career, we find that professional identity overall is higher at MilA.
- At both PriU and MilA, we see a lower professional identification for history students than for engineering students.

Our findings also highlight how professional identities develop. Our results show:

- PriU and PubU students choose their school for reasons related to engineering but MilA cadets do not. This basic difference likely contributes to both the strength of identification with engineering and the types of experiences participants would describe as contributing to identity development.
- With regard to sources of identity development, MilA cadets and PubU participants gave more specific examples of activities contributing to identity development while PriU students struggle to give concrete examples of experiences. The types of experiences all participants described tend to be non-classroom based.
- Participating in organized activities like CBT and STEP contribute to identity development. Reflecting on program experiences is a significant part of the impact of these programs.

Ultimately our findings show that school context can make a considerable difference in how participants talk about their identities and identity development with the most significant differences being between MilA and the other two schools. Our results also show that intense immersion programs like CBT and STEP, contribute significantly to identity development. This last finding is perhaps the most significant as it suggests that actions could be taken to help students develop engineering and/or professional identities.

Discussion

The theoretical foundation of this study was based on multiple identities with varying contexts, a cross section between Gee⁶ and Jackson.⁷ Gee indicates four major identities (1) nature (a state), (2) institution (a position), (3) discourse (an individual trait) and (4) affinity (experiences) while Jackson's⁷ more generalized view relates to multiple social identities such as peer, religious, romantic and family identities which vary in commitment levels / relative importance an individual feels to each. Consistent with these theoretical foundations, family, friendship, religion, romantic relationships, and patriotism were indicated (to varying degrees) by students at the three institutions studied. Not surprising, we find that the individual student experiences contribute to their identity (affinity / experiences) in particular through challenging experiences such as CBT and STEP, but were also mentioned by several students as it related to the difficulty of completing the engineering program.

Consistent with prior engineering education studies, both PriU and MilA students expressed pride in the difficulty and workload associated with studying engineering. Mentioning the challenge associated with engineering studies and the lack of freedom afforded by that decision was also a recurring theme. Stevens et al. had similar findings appropriately titling their work "Engineering as a Lifestyle and Meritocracy of Difficulty."²⁰ The idea of an extreme workload and high academic preparedness needed for success was also demonstrated in work by Pierrakos, et al.¹ But the concept of shared experiences bonding students together is not a new idea for military training and has also been indicated by other engineering identity studies which have recognized the criticality of a student's sense of belonging to the engineering community¹¹ and the profession.¹ The consistency of these findings with others as they relate to the central experiences that help develop identity have important implications for practice. Engineering faculty and program administrators should recognize that providing opportunities for students to

work together with others that share a similar goal could be affirming of engineering identity. Participants talked very little about classroom experiences as contributing to identity development. Instead, they talked about academic and non-academic experiences as being critical. For example, it was not the specific learning activities in CBT or STEP, it was these programs as a whole.

This research lays the foundation for important future work. Along the lines of shared experiences and challenge, when engineering students were asked if they felt pride in being an engineering student it was not uncommon to hear students report the importance of recognition of others. When MilA cadets were asked about feeling pride in their accomplishments at MilA, they also talked about being recognized as hard-workers. In both cases, it is specifically stated that from the outside people viewed them as smart or hardworking. This leads to future research questions such as “Do the views of others (a social identity in terms of how others view you mentioned by early identity theorists such as Erikson²¹) serve as a motivation for students to pursue engineering degrees?”

The current study adds to the body of literature on engineering identity. Given that this was a preliminary study, having a cross-sectional, multi-institutional sampling was appropriate and yielded both breadth and depth. However, our data represents snapshots in time. Future work could take a longitudinal approach to better understand how engineering student identity evolves with time. For example, while some students talked about the titles of “engineer” and “soldier” as consistent with who they are now, others talked about them as earned titles applied at sometime in the future. As an earned title, these participants believed they could not call themselves an “engineer” or “soldier” now while they are still in school. Understanding how and when the transition from student to professional happens is critical to understanding professional identity development. In a longitudinal study, Matusovich et al³ found that even advanced students do not always understand what it means to be an engineer or what kinds of work engineers do. Additional research is needed to uncover if the transition to engineer is content-knowledge based, experience-based or some combination of the two. Another expansion of the study would involve broadening the research population to students in more engineering majors and majors outside of engineering and history to see if the results found here hold true for other students.

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Appendix A

Interview Protocol

Basic Information:

- Year level
- Engineering Discipline (civil and mechanical are separate here)

Personal Identity:

- Generate a list of ten nouns or phrases that describe who you are. (Maximum amount of time is 5mins.) – for example student / sister / brother / Texan, etc.
- Rank order this list from most important to least important. (where #1 is the single word that best describes who you are)
- Draw a line to separate the 10 items into two groups; one group showing the items that most strongly define them and the other group less strongly defining them.

Collective Identities:

Peers:

- Do you think your peers would use the same types of words to describe you? Why or Why not?

Faculty/Commander:

- Do you think your instructors (or commander for USMA) would use the same types of words, why or why not?

Other Important Group:

- Is there another important group to you (other than peers, faculty). If so, would they use the same types of words to describe you? Why or why not?

Processing the List:

(While asking these, call back references to peers, faculty, commander or other important groups as appropriate)

- Let's talk go back and talk about your list. First, why did you choose these words to describe yourself?
- Why rank them in this order?
- Have your academic experiences factored into your choices regarding this list? If so, how? If not, why not?
- Have you participated in an engineering related internship or research experience? Did that / they contribute to your list?
- What other campus factors have contributed to your choices regarding this list? And/Or "What experiences have you had here at (USMA, VT, or ND) that have helped define who you are?") Do you think it would be different if you were at a different school?

General questions:

- Why did you choose this institution?
- What is your major? Why have you chosen this major?
- Has your engineering educational experience matched your expectation so far?

- How similar / different do you feel to a “typical” engineering student at this institution?
How so? How about with non-engineering students?
- Have you ever considered changing your major?
- What did you hear about civil or mechanical engineering before you chose your major?”
“What were your primary sources of information about academic major?”
- What does it mean to be an engineer (more in general)?
- What makes you proud of being an engineering student?

Future plans:

- Where do you see yourself 5 years after graduation (personal and professional)?
- How about 10 years after graduation?