

AC 2009-993: PRELIMINARY FINDINGS ON FRESHMEN ENGINEERING STUDENTS' PROFESSIONAL IDENTITY: IMPLICATIONS FOR RECRUITMENT AND RETENTION

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Preliminary Findings on Freshmen Engineering Students' Professional Identity: Implications for Recruitment and Retention

Abstract

Despite a significant increase in efforts to recruit and retain more engineering students through initiatives such as learning communities, mentoring, and pre-college programs, the decline in engineering enrollment continues. Recent research suggests that students' identity and identification with engineering plays a critical role in their decision to pursue engineering and to persist once they start their professional education. This study further examines the role of identity among freshmen engineering students through the lens of identity theory. Whereas prior work focused on the development of a singular engineering identity, we draw on current research in social psychology to investigate the multi-faceted nature of identity, with one person being able to maintain several identities simultaneously, and its role in recruitment and retention. We undertook a qualitative study and conducted a combination of focus groups and interviews (N=36), focusing on engineering, science, and non-STEM students, including students who switched out of engineering. Questions were directed towards attempting to understand the factors involved in the development of a professional identity. In this paper, we present in-depth case studies of two female students to highlight the concept of multiple identities and their formation. Through this deep representation of professional identity, we found that exposure to engineering and overall familiarity with the field proved to be one of the largest factors effecting retention. Our preliminary findings point to the conclusion that recruitment and retention can be improved by increasing the presence of engineering in K-12 settings and undergraduate institutions respectively. We suggest directions for future work and discuss our plans to explore the development of the professional identity over time (from freshman to senior year) as well as additional levels of identity formation and transformation.

Introduction

The need to protect the competitive ability of the U.S. and maintain its technological edge against challenges such as outsourcing and the comparative decline of U.S. engineers and scientists is increasingly becoming a national concern. This is evident from concerns raised by the academic community through publications such as *Rising Above the Gathering Storm*¹, through the mainstream media, via *The World is Flat*², and current policies, as evidenced by the passage of The America Creating Opportunities to Meaningfully Promote Excellent in Technology, Education, and Science Act (COMPETES) in August 2007³. COMPETES allocates over \$40 billion to improving STEM educators, STEM education, and STEM work opportunities. This bill highlights and attempts to address the concerns of decreasing retention and recruitment rates of STEM students in higher education institutions.

According to the most recent Science and Engineering Indicators report of the National Science Foundation (NSF), the percentages of all freshmen intending to major in engineering or computer sciences dropped in recent years⁴. Despite an increase in the numerous efforts to recruit and retain more engineering students, such as learning communities, mentoring, pre-

college programs, the declines in engineering enrollment continues. Specifically, although women have outnumbered men in undergraduate education since 1982, they have earned only about half of all S&E bachelor's degrees since 2000 and less than one-fifth of engineering degrees⁴. These declines are evident not only in the enrollment of women but also among racial and ethnic groups. In the case of minorities, only 4% of engineering bachelor's degrees were earned by Black, Hispanic, and American Indian/Alaska Native students⁴. With engineering being among the least gender-equitable professions in the United States, great strides must be made to improve enrollment and diversity in engineering.

Though recruitment of students into STEM fields is a large concern, retention of students is equally important. However, we have little evidence that explains why some students are retained to matriculation, whereas others are not. Though quantitative measures such as SAT scores or overall GPA can help to predict initial enrollment in a STEM field, their predictive value is not reliable in regards to perseverance within a field. Seymour and Hewitt identified no gender differences between retained students and those that left the major⁵. Campbell noted that switching from STEM to non-STEM majors accounted for only half of the minority loss, whereas the other half of minorities dropped out of college altogether⁶. Central to these issues of recruitment and retention is the task of recognizing the factors students use to choose their majors and evaluate their progress in the first place.

One of the factors that have emerged as significantly related to students' interest in engineering is their (perception of) identity as engineers. Identity has been shown to play a large role in interest in engineering, or a related STEM field, thus contributing to perseverance in the major as well^{7,8}. Other studies, such as Tonso's, have begun to investigate engineering identities and differences within, as pertaining to gender⁹. She interviewed engineering students and acquired a student-generated list of current engineering identity labels. It was apparent that the majority of the identities referred to males only and tended to be derogatory when referring to females⁹. Several of the categories excluded women, thus contributing to some discord and difficulty with identification with engineering for females.

It is important to note the multi-faceted nature of identity, with one person being able to maintain several identities simultaneously. However, current research has not yet addressed the multiple identities of engineers, nor identity formation, within the context of recruitment and retention. Deaux views identity as having two layers: social and personal¹⁰. Social identity consists of roles and membership categories that one deems themselves a representative of, whereas personal identity consists of self-descriptive behaviors and traits. Identity should not be considered one or the other, but rather combinations of different aspects of an individual. Additionally, Lee has found that identity also varies with gender⁷. Female students were more likely to regard themselves as females and less able to view themselves as science students, whereas male students were more likely to identify with their professional identity and less likely to think of themselves as males. Furthermore, female students were found to be more responsive to the program's educational interventions, whereas males were more driven by their scientific identity. These findings indicate only to a small extent to which specific identities can compete or combine in order to contribute to a larger, more comprehensive idea of self.

Within this study, we attempt to integrate the two ideas of social and personal identity, to gain a more comprehensive viewpoint. Particularly, we are interested in better understanding what shapes the identity of engineering undergraduates, how self-identities and conceptualized and more importantly, amongst other identities, where does the “engineer” identity stand. Under which situations is a particular identity activated? In order to improve recruitment and retention, particularly of underrepresented students (women and minorities), we must be able to understand the interaction and relationships between these multiple identities.

Dutton investigated factors that contribute to members’ identification with their work, profession and organization and discovered that a person’s identification with an organization is closely tied to two factors: the distinct and enduring traits of an organization and how the organization is perceived by outsiders ¹¹. Dutton points out the existence of multiple identities, but highlights the professional identity in particular. A professional identity is in fact how closely an individual relates to a particular field, profession, or occupation. Dutton lists 13 propositions with which she uses to describe the strength of the professional identity, what can help to strengthen the identity, and what a strong professional identity can provide. For example, exposure to a field can increase the perceived image of a field, which in turn can strengthen an individual’s professional identity. Alignment of personal beliefs with those of the profession can also serve as one method of strengthening professional identity. As a whole, Dutton cites exposure and perceptions of the career as fundamental to creating, sustaining, and strengthening a professional identity. However, some students persist in the engineering major despite a poorly formed professional identity. In order to understand this resiliency, we must fully comprehend the factors that comprise the professional identity.

Also important to understanding professional identity is its development and evolution across time (for a comprehensive depiction, see Figure 1 below). What factors become more integral to identifying as an engineer between freshman and senior years? This paper is directed at the freshman portion of that equation, looking specifically at the multiple identities of STEM freshmen, the professional identity in particular, and how strongly students identify with their professional identity. The two main research questions that guide this paper are:

1. How strongly do science and engineering freshmen identify with their major and professional identity?
2. How might the identities of underrepresented science and engineering students vary and to what extent do these identities shape their decisions to persist in STEM fields?

It is these in-depth questions that this study attempts to address through interviews and focus groups. Of particular importance is the identity formation and transformation in response to influencing factors, such as social networks, group commitments, social contexts (academic and non-academic), values, etc. Although the large study is focused on understanding that identity formation and transformations from freshman to senior year, this paper is focused on STEM freshman students only.

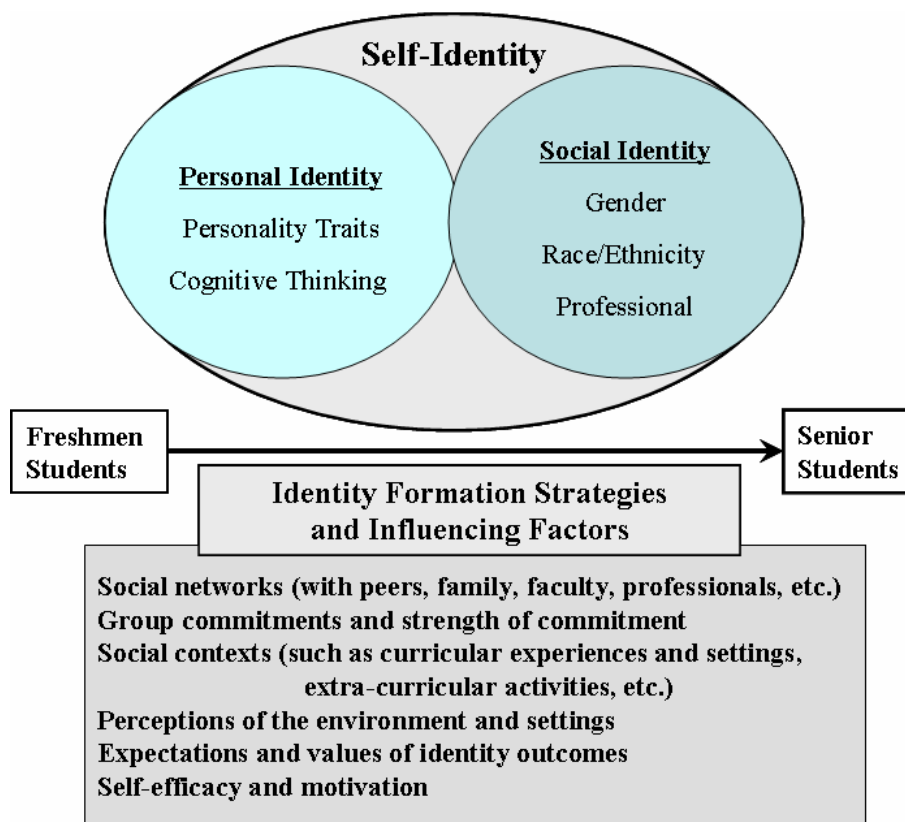


Figure 1: Schematic illustrating the multiple identities of students moving from freshman to senior year. Of particular importance is the identity formation and transformation in response to influencing factors that shape student’s identities.

Methodology

Data were collected in 30-45 minute focus group and interview sessions. Participants consisted of 36 freshmen students (21 female, 15 male) at a large, rural, liberal arts undergraduate institution. Of these participants, four were minority, three declined to state, and the 29 were listed as Caucasian; 21 students are current STEM majors and the remaining 15 are non-STEM majors. Recruitment was handled through e-mail requests and a university-based hosting service for studies. Researchers utilized a semi-structured interviewing protocol, allowing for slight modifications to standard questions.

Purposefully selected case studies were chosen as the unit of measurement due to the richness of information contained within particular interviews. We utilized a form of extreme case sampling, as described by Patton¹². Two females, one engineering major and one who switched out of engineering, were chosen on the grounds of being information-rich cases; they offer a minority perspective, while providing the positive and negative retention outcomes. We felt that the detailed information received from these case studies would overpower the lack of randomization and therefore widespread ability to generalize across populations. Overall, focus group questions were directed towards attempting to understand the factors involved in a professional identity, namely those that contribute to its’ strength.

Results

In the following section, we present two case studies. Both are female undergraduate students currently attending a large, rural, liberal arts undergraduate university. They both revealed strong academic backgrounds - Kim (engineering switcher) having scored a 610 on her math SAT and a 540 on the verbal, and Emily (engineering freshman) having scored a 560 and a 630 respectively. They both came from supportive families with environments conducive to learning and development. However, many of the similarities end there. *Herein, we compare and contrast these two students, their backgrounds, and environments in order to more fully understand the composition and evolution of the “engineering identity”.* Particularly, we examine the experiences of the students that have helped form their identities and guide their academic decisions.

Emily’s Path to an Engineering Career

Emily identified her interest in engineering as having roots in her youth. As an electrical engineer, a close relative of hers served as an important factor in fostering Emily’s engineering interests. Emily seemed to have a natural inclination towards engineering; even in early childhood, she preferred to play with Legos instead of Barbie dolls. At older ages, trips to the toy store were replaced by brainstorming sessions of wish lists, then building those toys at home. Through her upbringing, her science and math interests were further encouraged and cultivated by her parents through numerous science camps.

In high school, Emily took the initiative, and with the help of her counselors, focused her interests of math and science towards engineering. Throughout high school, she completed honors math and science courses as well as an all-female engineering class her senior year. From this experience, Emily was granted the chance to explore engineering free from the fears that she had of co-ed classes. Though generally an outspoken person, Emily still maintains reservations about speaking out in a co-ed class, or asking for help from a male, for fear of “feeling totally stupid”. She was able to effectively discover engineering at a very basic level in a cooperative and non-threatening environment.

Upon entering higher education and being faced with the daunting task of selecting a college and a major, Emily had the full and total support of parents, friends, and high school counselors. Her counselors helped guide her through a major selection, pointing out strengths and weaknesses, leading her towards choices that might suit her strengths.

Emily’s Experience as an Engineering Student

Having settled into college life, Emily began to further explore what it meant to “be an engineer”. She holds two very different views of engineers, with one being stereotypically reclusive, nerdy, and solitary. The other image consists of her aspirations in what she desires to be as an engineer, well-rounded and personable with good communication skills. Overarching these two personas are more general characteristics including a passion and love for learning and the work of engineers and an understanding of being fallible. Emily believes that mistakes can provide the best inspiration for improvements, which is at the core of what she identifies with engineering.

As a freshman, involving herself with the engineering community at college proved worthwhile for Emily. She immediately took part in engineering activities, including a design competition which was popular amongst many engineering students. From this experience Emily gained peer connections as well as valuable hand-on experience in college. She continued to actively participating in other student organizations in engineering and is attempting to form one of her own.

Kim's Experience as an Engineering Student

On the other hand, Kim also began as an engineering major, only to be turned away after her summer orientation as an incoming freshman. Kim had a fairly standard childhood, with no particular early inclinations toward engineering or a science field. Her main influence on originally choosing engineering came from her experiences in physics courses during high school. She has a natural aptitude toward math and science, which when paired with hands-on activities during her AP Physics class peaked her interest towards engineering.

From her high school classes and preliminary knowledge, engineering appeared to her as an occupation that involved heavy hands-on activity, field work with irregular and flexible hours, and ample job opportunities after college. Kim was originally enthusiastic and excited about engineering and chose it as her major for undergraduate education. Her parents did not play a role in her decisions, though they remained supportive nonetheless. However, despite Kim's original interest in engineering, her experience at the summer orientation program turned her away from engineering.

The University's summer orientation program served the purpose of introducing students to undergraduate life, the university, as well as to students' chosen majors. Kim, having registered engineering as her major, attended the engineering orientation, where she met professors and gained her first glimpse of engineering. She was immediately overwhelmed with the wealth of information given to her. After a tour of the facilities, the students were presented with the 4-year curriculum, at which point Kim began to doubt her original commitment. As the first in her family to go to college, she labeled herself a slow learner. Being fully aware of her capacities, she saw herself with a lack of options within engineering. Although she had the interest, she believed the upcoming engineering schedule to be too fast-paced, thus being a poor fit for her. Kim was not necessarily wary of her capability to succeed; she simply believed the program to be too quick for her to keep up with.

On top of this academic fear, she felt very intimidated by her peer group. Kim specifically stated that it was not the minority aspect (being a female in a male dominated field) that intimidated her, but rather the fact the she felt her peers had much more experience with college and engineering specifically. Of the students she was able to converse with, many had parents who were engineers, were not the first in their family to attend college, or at least had a good foundation in engineering and could understand much of the jargon that Kim was only first exposed to at orientation. From the very beginning, Kim not only felt overwhelmed by the daunting task of adapting to college while undertaking a major she knew little to nothing about, but also she felt that if she majored in engineering, she would already be a step behind her peer group.

Kim's Departure from Engineering

Having only a limited knowledge of engineering and the multiple disciplines within, Kim felt lost in the breadth of options that engineering presented. More specifically, she had no true image or idea of what an engineer really did, nor did she have any information or knowledge of the engineering concentrations. The University's program does not force students to choose a sub-discipline, however, in this case, Kim's lack of familiarity with engineering led to unclear thoughts of the specific opportunities or path she could take after her undergraduate education. She did not know what exactly it was an engineer did, what any of the sub-disciplines consisted of, or what specific job opportunities awaited a newly graduated engineer.

Her lack of specific knowledge of engineering as a career coupled with a fear of being unable to keep pace with the proposed curriculum led Kim to investigate other options. She researched the field of Information Analysis and felt much more comfortable pursuing a career there. Opportunities for the future are clear, such as positions within the CIA or the FBI, as well as internship prospects due to the connections that she and her parents had. She also stated that engineering was still a valid option, were she to switch majors again; however, she would need much more information in order to pursue it seriously.

Discussion

In order to understand the influence of the professional identity, we must analyze its origins and evaluate its strength. Therefore, it would serve us well to directly compare Kim and Emily in order to fully grasp the details. We can discover similarities and differences in experiences that may have affected development of their professional identities as well as particular experiences that either strengthened or weakened their identities. Here we have two cases, both females, both with an affinity towards math and science, and both derive enjoyment from similar hands-on activities. However the end results are drastically different. Upon first glance, Kim and Emily seemed very similar in their desires and goals. Through deeper inspection, it can be seen that the two women had very different backgrounds and experiences which led them both to originally choose engineering. Emily had much more knowledge of the field and had a better grasp on her choices within engineering and how to navigate the major.

In other words, Emily had much more previous exposure to engineering and thus had a steady foundation in which she could begin to form her engineering identity. Perhaps Emily took a fairly atypical developmental path towards her chosen field, however, her case only serves to strengthen the argument of exposure to engineering is critical in forming a healthy professional identity. She started early, with a strong family influence and participation in summer camps. Her identity was further strengthened with a specific engineering class in high school, along with support from her family, friends, and high school counselors. At the point of entering college, Emily had developed a strong professional identity, allowing her to form opinions and views of the typical engineer. She had distinct knowledge of what a typical engineer did and in what way she wanted to stray from those beliefs in order to further

develop her own identity. Emily also participated actively in the engineering community, taking part in student organizations and even attempting to form one.

In contrast, Kim was enthusiastic and had the aptitude, but otherwise lacked the knowledge and fundamentals necessary to feel comfortable pursuing engineering. She had her first exposure to engineering during summer orientation to college and was immediately overwhelmed. She felt engineering was a one-track major which would move too fast for her to keep up with. Additionally, Kim's engineering peer group during orientation seemed to have connections, experiences, and knowledge that she did not, leaving her to feel intimidated and already behind the pack. In her case, Kim had not had the opportunities to form a strong sense of an engineering identity that would allow her to continue with the major. In turn, she researched different majors and switched to one in which she felt she could identify with more and have an easier time developing her professional identity.

What exactly is a professional engineering identity or simply a professional identity in general? It can be thought of as the extent to which one has adopted a profession or field of work/study as their own. Though quantitative measures such as SAT scores or overall GPA can help to predict initial enrollment in a STEM field, they do not have predictive value in regards to persistence within a field. Here, we see that the strength of what we have termed "professional identity" is a main contributing factor to persistence. A professional identity cannot be surmised in a single word or thought, but rather must be interpreted as a conglomeration of background, experiences, knowledge, connections, and "fit" with a particular field, with more of these factors contributing to a stronger identity.

These factors can also be seen within other STEM majors as well, particularly within biology. Through their interviews it was evident that students understood exactly what was involved in being a biology student as well as what opportunities can come to a biology major. In fact, many of them actually had a career in mind, and pursued biology as the best way to achieve that goal. Furthermore, family members were not only supportive, but provided their children with connections and opportunities within the field. It can be thought that this familiarity acts as a platform on which the professional identity can begin to form.

Many of the other STEM majors also cited class as the time when they felt most like a professional in their field. Other factors that we believe to play a part in this discrepancy between STEM majors and engineering students in particular is the presence the fields have in K-12 education. Other STEM fields, such as biology and chemistry, have a large presence in K-12 education, leading to students having a clear representation of what biology is and what opportunities come with an interest in that field.

Only a handful of the engineers interviewed had formed a particularly strong professional identity as of yet. Even Emily with a strong exposure to engineering knew that she wanted to be an engineer, but didn't feel like an engineer quite yet. The other students were unclear or had conflicting beliefs of what engineers actually did. In fact, none stated that they felt like an engineer at all, citing attending class as when they felt most like an engineer. That being said, upon starting engineering, it is critical for engineering students to be immediately introduced to the profession via a comprehensive overview of what engineering is, what engineers do,

and what kind of impact engineers make to society. This type of exposure would not only entice students to engineering, but also retain students that would otherwise drop the major due to lack of knowledge.

Even though analysis is ongoing, preliminary analysis revealed some differences between men and women engineering freshman interviewees. It was noted that the female engineers seemed as enthusiastic about engineering if not more so than the males. Many of the female engineering interviewees participated in community activities; whether the purpose was to further develop their professional identity or to connect with others as a female was left undetermined. Alternatively, it seems as though many of the male engineers rely on their abilities more than females. Lastly, none of the students interviewed appeared to allow their minority social identities (female/ethnic group) to interfere with their decision to major in engineering, at least consciously.

Conclusion

We have come upon an under researched area of engineering that has important implications towards recruitment and retention. In attempting to analyze the “engineering identity” we discovered that the foundation of that identity relies heavily on K-12 exposure via activities, personal connections, or otherwise. With increased amounts of exposure, comes a stronger base on which to build a professional engineering identity, persistence through the undergraduate engineering curriculum hopefully, and ease of developing a professional identity.

Overall, freshman STEM students did not reveal a strong identification with their intended profession, but preliminary analysis reveals that science students had a stronger identification than did the engineering students. This can be attributed to science students having more knowledge about their major and profession, given that their exposure was grounded in science classes and activities during their K-12 education. On the other hand, engineering students appeared to have a limited view and knowledge of the engineering profession. Moreover, their professional identity was grounded on knowing an engineer (primarily someone in their family) and having some exposure to engineering (i.e. summer camps, high school engineering class, meeting an engineer), which for the average student was often minimal. Across STEM freshman, it appeared that students desired classes in their major to begin identifying with their major and ultimately their profession. Other activities, organizations, groups within their major also seemed to aid in strengthening their professional identity. Faculty involvement also aided in developing and strengthening professional identity.

Engineering not having a strong presence in K-12 education seems to be a critical factor in students not having a strong identity to the engineering profession. Stemming from these findings and extrapolations, it can be seen that increases in K-12 exposure to engineering and classes in engineering would be paramount to increasing recruitment and retention in engineering. In order to foster a students’ identification with the field, engineering should have a stronger presence throughout their pre-college education. Once entered into an

undergraduate program, courses focused on the engineering profession, engineering career paths, engineering applications, etc. are essential. This is particularly important because with math and physics courses being the core of courses during the first year, students may not be exposed to engineering courses that enable them to delve into the profession. One intervention that could be useful at higher education institutions includes a crash course, or similar class, over the summer. This could be a day or two of extended summer orientation geared towards any student considering engineering. Another course of action could be to increase the presence of engineering for the K-12 age group, but outside of the curriculum. Creating more engineering summer camps or after school programs could help to open the door for many children. It is important to create that foundation of familiarity with the field in order to have hope for being able to form a strong professional identity. Exposure to engineering, especially early exposure to the profession, is particularly helpful in fostering a healthy professional identity.

In summary, through investigating the cases of two female freshmen engineers in depth and cursory examinations of over 30 other students we have begun to see what a professional identity consists of and how it may vary. The background a student has in a field, including associated experiences and personal connections, contributes to the development of a professional identity. This professional identity is a strong component in identifying students likely to persist through their major.

This should only be considered a preliminary investigation of the engineering identity. We are not only interested in STEM students and comparing variations within those majors to engineering, but also looking at variations within engineering as well. Further studies will include cross-sectional analyses comparing senior and freshmen students from various STEM majors in order to investigate the development of professional identities across time. Furthermore, students may exit engineering at different times, due to different reasons, necessitating an evaluation of these different reasons. In order to develop effective interventions we must have a complete understanding when and why students leave the engineering field. Additionally, it is important to examine different undergraduate institutions, the methodologies within their engineering programs, and the subsequent effect on professional identity growth. Research in this area has only just begun, with findings and implications that have the potential to shape engineering education nationwide.

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Bibliography

1. Committee on Science Engineering and Public Policy. (2006). *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*. Washington, D.C.: National Academies Press.
2. Friedman, T. L., 2005, *The World is Flat*, New York: Farrar, Straus and Giroux.
3. Committee on Science and Technology, U.S. House of Representatives, July 2007, "The America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act (COMPETES)," http://science.house.gov/legislation/leg_highlights_detail.aspx?NewsID=1938.
4. National Science Education, 2008, Science and Engineering Indicators 2008, "Chapter 2: Higher Education in Science and Engineering."
5. Seymour, Elaine, and Nancy C. Hewitt. 1997. *Talking About Leaving: Why Undergraduates Leave the Sciences*. Boulder, CO: Westview Press.
6. Campbell, G., Jr. (1993, March 31). Visions of engineering education in century II. The Porth Distinguished Lecture, University of Missouri at Rolla, MO.
7. Lee, J. D. (1998). Which kids can "become" scientists? Effects of gender, self-concepts, and perceptions of scientists. *Social Psychology Quarterly*, 61(3), 199-219.
8. Stevens Reed, O'Connor Kevin, Garrison Lari, Jocus Andrew, Amos Daniel M., July 2008, "Becoming an Engineer: Toward a Three Dimensional View of Engineering Learning," *Journal of Engineering Education*, pp. 355-368.
9. Tonso, K. L. (2006). Student engineers and engineering identity: Campus engineer identities as figured world. *Cultural Studies of Science Education*, 1, 273-307.
10. Deaux, K. (1993). Reconstructing social identity. *Personality and Social Psychology Bulletin*, 19(1), 4-12.
11. Dutton, J. E., Dukerich, J. M., & Harquail, C. V. (1994). Organizational images and member identification. *Administrative Science Quarterly*, 39, 239-263.
12. Patton, M. Q. (2002). *Qualitative Research & Evaluation Methods*. Thousand Oaks, CA : Sage Publications, Inc.