AC 2012-4514: LOW-SES FIRST-GENERATION STUDENTS' DECISION TO PURSUE ENGINEERING

Ms. Michele L. Strutz, Purdue University, West Lafayette

Michele L. Strutz is a 2009 NSF Graduate Research Fellow and will graduate this summer with her Ph.D. in engineering education and a secondary doctoral focus in gifted and talented education from Purdue University. Strutz's research interests include stEm talent development and identification. Prior to completing her master's degrees in gifted and talented education and in curriculum and instruction, Strutz worked as an engineer for 13 years in Laser Jet Printer product development and marketing at Hewlett Packard Co., computer systems design at Arthur Andersen & Co., sulfuric acid plant engineering at Monsanto, and traffic engineering in the City of Cincinnati. Her positions in the high-tech field stemmed from her undergraduate degrees in civil engineering and mathematics from Vanderbilt University. Contact information: mstrutz@purdue.edu.

Dr. Matthew W. Ohland, Purdue University, West Lafayette

Matthew W. Ohland is Associate Professor of engineering education at Purdue University. He has degrees from Swarthmore College, Rensselaer Polytechnic Institute, and the University of Florida. His research on the longitudinal study of engineering students, team assignment, peer evaluation, and active and collaborative teaching methods has been supported by more than $11.6 million from the National Science Foundation and the Sloan Foundation and his team received the William Elgin Wickenden Award for the Best Paper in the Journal of Engineering Education in 2008 and multiple conference Best Paper awards. Ohland is Past Chair of ASEE's Educational Research and Methods division and an At-large member the Administrative Committee of the IEEE Education Society. He was the 2002-2006 President of Tau Beta Pi.

Low-SES First-Generation Students' Decision to Pursue Engineering

Abstract

"The ability of this nation to provide a growing economy, strong health and human services, and a secure and safe nation depends upon a vibrant, creative, and diverse engineering and science workforce". [1] To contribute to technological advancements, engage in global collaboration, solve complex problems, encourage a more socially just profession, and respond to the predicted shortage of American engineers, it is necessary for this nation's engineering workforce and university student bodies to be more diverse in its racial, gender, and socioeconomic (SES) representation. The lack of representation in SES is the focus of this research.

The purpose of this qualitative study was to give low-SES students an opportunity to share their stories about the influences that prompted them to choose to study engineering. The research question this study addresses was: *What are the influences on the lived experiences of low-SES first-generation students who pursue engineering study?*

This study used a phenomenological inquiry approach, purposive criterion sampling, and descriptive and topical coding. Interviews were semi-structured, and consisted of open-ended questions. Transcripts were coded to identify general and unique themes that resulted in four assertions. These low-SES first-generation students were influenced to pursue engineering study by 1) elements of engineering experienced in informal learning settings; 2) their self-identified attributes and interests and their advanced skills; 3) their understanding of the image of the field of engineering; and 4) STEM-knowledgeable individuals who offered encouragement, support, and perspective.

These assertions led the first author to conclude that low-SES first-generation students who make it to college to study engineering are similar to their higher-SES peers, but low-SES students cannot have any other setback besides being low-SES and still be successful in engineering. The first author also observed that these four assertions seem to be related to forms of capital.

All of these participants were eager to spend time sharing their story with the first author. They expressed appreciation that the first author cared about the influences that affected their journey to engineering and that the first author wanted to research their lived experiences. The first author felt honored to act as the phenomenologist in understanding the influences on these students in their pursuit of engineering study.

Introduction and Literature Review

Including socioeconomic status in the diversity discussion

"The ability of this nation to provide a growing economy, strong health and human services, and a secure and safe nation depends upon a vibrant, creative, and diverse engineering and science workforce". [1] To contribute to technological advancements, engage in global collaboration, solve complex problems, encourage a more socially just profession, and respond to the predicted shortage of American engineers, it is necessary for this nation's engineering workforce and university student bodies to be more diverse in its racial, gender, and socioeconomic (SES) representation.

The U.S. cannot claim a diverse engineering workforce, and its engineering student bodies are certainly not diverse despite the legislation and programs put in place to increase racial, gender, and socioeconomic (SES) representation. Programs and resources that increase gender and racial diversity in engineering have the advantage of creating an environment for the social interaction of people who have some shared experience as well as an interest in engineering. As a result, women and students of color in engineering have a variety of local and national programs from which they might seek support. Low-socioeconomic and first-generation status are both less visible and more likely to be concealed, so there are few formal programs to support or mentor low-SES first-generation students who want to pursue engineering. With an estimated projection of 1.67 million engineers needed to support the U.S. job market by 2016, there is some urgency to better understand how to encourage socioeconomic diversity in the engineering workforce and student bodies.

Improving diversity in engineering to include low-SES first-generation students – not to meet an 'increasing diversity' quota, not to 'play the diversity card', but to give them a fair chance to be engineers too – will affect engineering positively because of their unique perspective based on their socioeconomic experiences. Stanley et al. report the benefits of diversity in both classrooms and in the work place. Students demonstrate the "greatest engagement in active thinking processes, growth in intellectual engagement and motivation, and growth in intellectual and academic skills" [2] in classrooms with highly diverse student populations. David Swain, Boeing CTO, adds that workforce diversity amplifies the "likelihood of developing the best ideas". [3] Wulf states that "Diverse engineering teams will build a better quality product" [4] and "We will engineer better with a diverse workforce". [4]

Despite the documented challenges of low-SES first-generation students, there are a number of these students who are studying engineering and doing well. Understanding the lived experiences of these students is key to learn about their journey to engineering. One element of their lived experiences is the influences that prompted these students to want to study engineering. These influences are not well-researched, yet the findings from their rich descriptive stories may provide insights that could help key stakeholders in guidance counseling offices, classrooms, families, mentoring programs, engineering, politics, and government funding programs. They may also be helpful to other low-SES first-generation students who want to pursue engineering.

Making career decisions

Some theorists believe that making career decisions is a developmental process that lasts a lifetime. [5] Super's Career Development model is based on a life-long process where individuals reflect on their changing self concepts as they pass through stages of growth, exploration, establishment, maintenance, and disengagement with each career decision and transition. [6, 7] Super used the "growth" and "exploration" stages to develop a children's model that he believed "contribute[s] to career awareness and decision making". [8] This model includes stages of curiosity, exploration, using occupational information, identifying helpful people, naming likes and dislikes, recognizing locus of control, and understanding one's self-concept. [8]

Identifying helpful people for career guidance

General population

Several studies show that career guidance often begins as early as 5th to 8th grades; however formal career counseling typically occurs in high school. Students are heavily influenced by individuals with whom they interact with often. [9] Teachers and counselors are a significant source of guidance as students make career choices. [10] Parents also facilitate their children's education and career decisions, and many consider themselves as the most important influence. [11, 12, 13, 14]

Several studies identify the primary influencers of students' college major and career decisions. The results of a 2005 study that examined Missouri students' postsecondary plans showed that parents, siblings, and other members of the family were primary influencers, and teachers, friends, counselors, and peers were secondary influencers. The priority of these influencers shifted as students aged: seventh graders relied heavily on their family; ninth graders thought their family was primarily important although a few other individuals started to become influential; and eleventh graders identified family members first, themselves next, followed by a larger variety of individuals. [9] Two studies designed to identify the influencers on students' decisions about whether to attend an agricultural science college found that the primary influencers were parents, friends, relatives, teachers, and school counselors. [15]

Low-SES population

In a 2001 study of low-income students who attended Achievers High Schools in Washington State, over 54% of the students stated that teachers (20.74%), parents (19.31%), and school counselors (13.60%) were the influencers who were the most helpful in how they learned about college. [16] In another study, it was shown that although the lowest SES groups are less likely to receive parental encouragement to go to college, [17, 18] those parents that do encourage their children increase their chances of degree completion by 4%. [19]

First-generation population

First-generation students think they have less encouragement from their parents to attend college than their continuing-generation peers. [20, 21] Billson & Terry [22] report that only 61% of first-generation students felt that their parents were emotionally supportive of their educational objectives. First generation students have fewer family or friends who can offer insight regarding college-going experience. [21, 23]

With the expectation that low-SES and first-generation students receive less encouragement to pursue college study and to choose engineering, this work seeks to understand how those students come to choose to attend college and enroll in engineering.

Method

This qualitative research explored the phenomenon of low-SES first-generation students who choose to study engineering. The purpose of this study was to give low-SES students an opportunity to share their stories about the influences that prompted them to choose to study engineering. The research question this study addressed was: *What are the influences on the lived experiences of low-SES first-generation students who pursue engineering study?*

Methodological framework

Since the first author wanted to "identify the meaning, structure, and essence of the lived experience of this phenomenon for this person", [24] she chose phenomenology as her methodological framework. Phenomenology is the description of the lived experience. [25] The aim of phenomenology is the description, reflections, and understanding of the lived experience of a particular phenomenon and focuses on making *meaning* of what the participant reports. [24] The first author chose phenomenology because she was interested in the essence of the lived experience of low-SES students choosing engineering -- not in the different ways that each student experiences it, which is the focus of phenomenography. [26]

Sampling Framework

Creswell [27] explains that choosing participants who have experienced the phenomenon being studied is necessary in phenomenological research. This can be accomplished by using purposive, criterion sampling. Purposive sampling "focuses on selecting information-rich cases whose study will illuminate the questions under study". [24] Criterion sampling is one type of purposive sampling that looks at all participants who satisfy a set of criteria. [28]

The phenomenon of interest is low-SES first-generation students choosing to study engineering. Three criteria were used to achieve participant homogeneity: 1) the student is considered low-SES by the University as evidenced by their participation in a need-based scholarship program; 2) the student is enrolled in an engineering major; and 3) neither of the student's parents have completed a college degree. Using purposive criterion sampling provided the first author the opportunity to meet with and interview participants who experienced the phenomenon that she was researching.

Trustworthiness

The measure of rigor in qualitative research is trustworthiness, which has four dimensions: credibility, transferability, dependability, and confirmability. [29, 30]

To ensure credibility, the first author used a well-established research method, phenomenology, prolonged engagement with the participants, debriefing sessions with her advisor and a postdoctoral research mentor, and reflective memoing of pre-interviews, interviews, data coding and explication, assertion development, and committee member meetings. [29] Transferability was demonstrated as the first author used exhaustive purposive criterion sampling of participants who experienced the phenomenon, collected thick descriptive data from participants who were interviewed, developed thick description supported by participants' direct quotations, [30] and described "all the contextual factors" [29] of the study to help readers determine if the findings are transferable to another context. [31]

Dependability was shown with detailed documentation of the "research design and its implementation, … operational detail of data gathering, … [and] reflective appraisal of the project". [32] Throughout the project design, data collection and examination, and data explication, the first author's dispositions and biases were documented in a notebook and were tested in her debriefing sessions with her advisor and mentor, and in conversations with her graduate student peers, establishing confirmability. [33]

Interview procedure

In phenomenological studies, in-depth interviews are used to collect rich, thick data. [34] Exploratory qualitative interviews [24] were used to capture the participants' experiences of choosing to study engineering being a first-generation students coming from low-SES backgrounds. [35, 36]

The interview was semi-structured in that an interview guide was used; however, the participants were asked open-ended questions [34] to facilitate obtaining in-depth responses about their feelings and perspectives of their experiences. [24] The interview guide consisted of a list of key open-ended questions [37] but additional probing questions were used to follow-up on some participant's responses.

The interviews lasted 60-75 minutes. All of the participants gave their permission to be interviewed and the interviews were audio taped with a digital recorder. [38, 39]

Coding

The digital audio recording of the interviews were transcribed verbatim by a professional transcriptionist. The first author verified the transcriptions.

After reading the interviews several times and making notes, the first author used open coding to identify general and unique themes. [40] The first author used an inductive approach to allow themes to emerge from the data. Themes were categorized, and from these, four assertions developed. One of those assertions will be explored in this paper. The supporting evidence for this assertion will be participants' statements presented in italics without quotations along with their pseudonyms. Square brackets are used to identify words added by the researcher to clarify context. Ellipses are used to indicate that words were omitted from the data segment.

Results and Discussion

The coding of interviews resulted in four assertions:

- Assertion 1: As children, these low-SES students were influenced by elements of engineering experienced in informal learning settings.

- Assertion 2: These low-SES students were influenced to pursue engineering by their self-identified attributes and interests and their advanced skills.
- Assertion 3: These low-SES students were influenced by the image of being an engineer, the opportunity for a secure future with an engineering position, and the desire to make a difference as an engineer.
- Assertion 4: STEM-knowledgeable individuals, who offered encouragement, support, and perspective, influenced these low-SES students' decision to pursue engineering study.

This paper will focus on Assertion 4: STEM-knowledgeable individuals, who offered encouragement, support, and perspective, influenced these low-SES students' decision to pursue engineering study.

Multiple definitions are embodied in this assertion. *STEM-knowledgeable individuals* are individuals who have familiarity with the science, technology, engineering, and math disciplines. To *influence* is to persuade, confirm, or validate a low-SES first-generation student's decision to pursue engineering. A low-SES first-generation student's *decision* is the act of choosing to pursue an engineering degree. *Pursue engineering study* means seeking to attain an engineering degree.

STEM-knowledgeable individuals

Although the lack of engineering role models has long been cited as an issue in the recruitment of students to engineering, all 11 of the participants identified helpful people who influenced their decision to pursue engineering. The most frequent described influencer was STEM-based teachers followed by mentors/visitors with STEM knowledge, STEM-talented high school friends, guidance counselors, and family members familiar with STEM knowledge. None of the participants listed people in all five categories.

Teachers

Seven of the 11 participants spoke about their physics, chemistry, general science, mathematics, and programming teachers. Several of the descriptions of their teachers included language of encouragement, assurance, recognition, and confirmation in response to the participant's decision to pursue engineering. Four of the participants specifically talked about their physics teachers who were conversant in engineering, led rocketry club, assigned engineering-based projects, and had practiced as a degreed engineer before becoming a science teacher.

> *My AP physics teacher because he was the one who was over the team rocketry club. ... He was just like "I feel like you're making a good decision." ... If I did go back, I'd go talk to my physics professor and let him know how everything is going because I don't think he knows he influenced me that much.* ~Saraz
>
> *At that time my senior year, he ... graduated from [University A] with a doctorate in physics, with a specialty in fluids. ... He was teaching us AP Physics at the*

time. … He once commented that mechanical engineering would completely change me. ~Luke

I would say the people that had the most influence are probably some of my teachers. In high school my physics teacher that I had for two years for both Honors Physics and AP Physics was really, really cool. … In Honors Physics we had to do a Rube Goldberg machine. So that is very closely related to engineering. ~Rob

In high school I did actually have a teacher that supported engineering. That would be my chemistry and physics teacher, he did both roles. He was actually an engineer before becoming a teacher. … He spoke about engineering all the time. He was a biomedical engineer. … He made me feel assured that this was a good career. So, yes, I'm right, it is a challenging career and that's what I was looking for. ~David

Julie, in Chemical Engineering, and Michael, in Agricultural Engineering, described their chemistry teachers as being influential in their decision.

My senior year I would talk to both of them [honors and AP chemistry teachers] about "You guys know I'm good at chemistry. What should I do?" … They all recognized that I was good at it, and that I was interested. And I feel like having someone tell you that you're good at this, I finally realized that. … So you have to be told, even if you know you're doing well, it has to stick out to you. But I do feel like someone recognizing that I have a proficiency and them also recognizing my interest helped me recognize that. Otherwise, I wouldn't have noticed maybe. ~Julie

My chemistry teacher, originally, by the end of my senior year I was going for chemical engineering, so he had some sort of an influence for the engineering aspect. I would talk to him about different things; see what he would say about it. Like, what would a chemical engineer do? And just some of the basics. ~Michael

David decided to become an engineer when he was very young, so when he told his middle school science teachers of his interest, they agreed with him.

In the seventh grade I had a science teacher, and the eighth too for that matter, they encouraged me that "yeah engineering would be a good thing for you." After I mentioned my interest because I would tell them I wanted to be an engineer and they would say, "Hey that sounds like a good idea." They didn't so much recommend it as agree with it. ~David

Anna is pursuing her degree in Electrical and Computer Engineering, and she described encouragement and recognition from both her mathematics and programming teachers.

My math teacher that I had for Algebra II Honors … I think she knew that I was planning on going into engineering, so she encouraged that. There was senior scholarship night; she presented to me a math scholarship challenge. … It was for somebody wanting to study engineering. ~Anna

My programming teacher in high school, she really helped me. … She encouraged me a lot. She'd give us problems to code. And there was one that I actually solved that she couldn't so she used my code as an example for the rest of the class. Wrote it up on the board and said, "Thanks to Anna we now the solution to this." … She helped me realize that I was actually skilled at that area. The notes that she would write on my programs and things like that, 'I was a programming genius'. ~Anna

Mentors

Some of these STEM-based teachers invited individuals with STEM knowledge into their classrooms and school. Some of these mentors provided general information about engineering; however another presented detailed descriptions about nanotechnology which directly influenced Rob's decision to pursue Biomedical Engineering.

There was one of the faculty's daughters went into engineering, so she had an engineering Bachelor's. She came up and visited us twice; once during my sophomore and once during my junior year … and was talking about engineering in my math class. ~Michael

I know that at one point, in my physics class, a [University A] student, I think in either physics or an engineer – I think it was in engineering though, came and talked to us about … engineering at [University A]. ~Stephen

There was actually one particular speaker that we had in my high school in I think tenth grade. … He gave scientific examples of the type of technology we might have in the future involving nanotechnology. It was one of my favorite topics. So that made me even more interested [in engineering] of course. ~Rob

In other activities associated with school, Luke and Anna each enjoyed interacting with mentors who worked as degreed engineers. An electrical engineer shared his expertise in Luke's robotics club and Anna found a mentor in her friend's father who is an electrical engineer.

There was this friend who went into physics. He was also part of the robotics, and his father was a mentor in the robotics. And, through him I got a little push, he was a double E (electrical engineer) from [University A], and his wife is a double E (electrical engineer) from [University A] as well. ~Luke

My friend, I met her in eighth grade, and her dad is actually an electrical engineer. … Her dad always seemed to enjoy talking to me because he knew I was going to study something along the lines of what he did as a profession. …

> *So he has given me quite a few pointers on becoming an engineer. He's actually the one who got me the co-op with [company].* ~Anna

David described how a historical figure became something of a mentor to him. Reading about the late Serbian-American engineer, Tesla, significantly influenced David's decision to pursue Electrical and Computer Engineering.

> *Nikola Tesla, I read about him a lot. He's normally credited with the discovery of AC electricity. ... Most people actually call him an engineer, which he was. ... I'm not really sure why I felt so attracted to learning about this individual, but I did mostly because of the new form of electricity that goes hand-in-hand with his name. ... So that was pretty interesting to learn about different ways that electricity can be used.* ~David

Friends

More than half of the participants talked about their STEM-talented friends as being key influences in their decision to pursue engineering. These friends were also academically advanced and shared similar STEM career goals.

> *Well, I became friends with seniors when I was young. We all became friends, and so many of them were going into engineering. I was obviously friends with all the smart successful kids. And they were going to [Univeristy D] and [University A] and all these other schools for engineering and I thought, "Huh, so what is that about?" As they went to college, we'd talk a little bit. ... And they'd talk about the cool plant tours that they get to go on. And, the crazy things that they're learning with the circuits, and stuff that's far beyond what they've ever taught us in high school. And I just became so curious about it. ... So I found engineering on my own through my friends.* ~Diane

> *And actually I started hanging out with the smarter kids. Most of them were interested in science; all of them were good at science. So, just being surrounded by that many students, that many peers, that were good at science and were genuinely interested in becoming either a scientist, doctor, or engineer kind of pushed me forward a little bit. ... I chose engineering ... because most of my friends are in engineering or science.* ~Luke

> *Some of my other friends were going to become an engineer themselves so that helped [me decide] because you can talk about that. ... I was in a lot of honors classes so most of the kids I was with were what you would consider top of the food chain people. So it wasn't very hard to naturally become friends with people who were like, or better, students. And quite a bit of those were people who were mathematically or scientifically inclined.* ~Rob

> *I mean a lot of my friends encouraged me because they knew my strengths and the subject areas. Yeah, as I mentioned before, I watch people, and I base my*

friendship off of peoples' behaviors so that they're similar to my own. So all my friends are going into something successful. ~Anna

We were in all the same classes and we were the top 30 in our class. And that was just what you did; you took AP Bio, AP Chem, all of the weighted classes. ... So we took those together and hung out together and studied together and we were all friends. You didn't really have friends outside of that group too much. ... They were all going off to do similar-ish things. My one friend she went to [University C] for their genetics program. And my other one went for chemistry. We were all going off into things relatively scientific. So it was like, me? Oh an engineer. ... We were all pretty intelligent. ~Patty

My one friend took AP Calc. He was one that I did the academic teams with. He was also choosing to do chemical engineering at [University A]. And this could have something to do with me choosing to [study chemical engineering]. ~Tom

Guidance counselors

Guidance counselors provided further validation to four of the eleven participants. Two counselors did not provide advice but confirmed a good fit of the participant's math and science strengths to pursuing engineering, and the other two counselors actually made the connection between being good at math and science and engineering.

Guidance counselors? I mean, I said by the time I knew and had decided engineering, they were like, "Well, that's good because that fits you." ... They would help me schedule classes around that. ~Anna

And I suppose the guidance counselor. When I changed my major from political science and theater to engineering – well I knew I wanted to do something with science so I just said engineering. But we talked about it more, and she was, "Oh yep, that's probably a right fit for you." ~Diane

After talking to a [guidance] counselor he was like, "well, it looks like you're good in math and you're good in physics, you should try engineering. ... I can see you being successful in that field." ~Saraz

Senior year my guidance counselor is basically talking to people, finding out where they were choosing to go to school and I came in and I had absolutely no idea. Didn't know what I wanted to do. Didn't know where I wanted to go. ... And then she ... says "Oh, you like math and science. You should go into engineering." ~Tom

Family members

Only two participants mentioned a family member as one of the influences in their decision to pursue engineering. Stephen described many influences that his father had on Stephen's decision to pursue engineering: his natural talent to work with his hands, his machinist job where he works alongside engineers, and his knowledge of Stephen's math and science skills and [University A] engineering program.

> *My dad lives out in the country and so he would be working on stuff and I had an opportunity every once in a while to help him, and learn about tools and working with your hands a little bit here and there. And I think a lot of that also plays into the whole engineering thing because a lot of people that end up in engineering are the types of people that you think of as being very hands-on people, building things on their own in their free time, or messing around with tools and shops. And then my dad would, from time to time, he and I would end up talking about how things work.* ~Stephen

> *I think a lot of that, again, might have had a lot to do with my dad. My dad worked in factories a lot when I was growing up. He was actually a machinist, so he worked a lot in tool and die shops which naturally uses a lot of engineering principles. ... He had a lot of experience with engineers through his career. And so I think a lot of that, and the fact that I was very good at, and very interested in, math and science kind of meshed, and he realized this as, "I think I can push him toward that [engineering]."* ~Stephen

> *It gets to be mid-fall senior year, and I'm not sure what I'm going to do. I know I want to do something very math and science related. My dad starts saying, "Stephen I think you would enjoy going to [University A] and studying engineering." And I was like, "Oh, really? Why is that?" "Because you're good at math and science, and that's a field of study that* would utilize those math and science skills*"*. ~Stephen

Diane shared some of her conversations with her grandfather about her dreams of wanting to study Nuclear Engineering. She stated that he had an Aeronautical Engineering degree.

> *I sat down with my grandpa and we're talking about what I want to be. And he graduated from [University B] with an aeronautical degree in engineering. ... He actually helped work on one of the first planes to reach Mach speed. And telling me about that, how his work was secret, it was oh so interesting*. ~Diane

Discussion and Conclusion

Whereas the literature indicates that low-SES first-generation students are less likely to find support from helpful people, all of these low-SES first-generation engineering students found various people in their lives who encouraged, validated, and supported their decision to go to college and enroll in engineering.

These low-SES first-generation students were influenced in their decision to pursue engineering by a variety of helpful people with whom they interact often. STEM-knowledgeable helpful people included teachers, mentors, high school friends, guidance counselors, and family members who are familiar with STEM topics and who offered encouragement, support, and perspective to these students. Despite being low-SES, it is clear that these students have social capital and are able to make use of it as they proceed with their decision to pursue engineering.

Limitations of the Paper

This paper discusses only one of the four assertions. The collective set of assertions will provide a more comprehensive picture of these students' lived experience, but the scope of this paper does not permit addressing those other assertions. A further limitation is that the first author used a purposive, criterion-based sample taken from an undergraduate engineering program at a Midwest research-intensive university. Typical of such qualitative studies, the results are not intended to be generalizable. The sample should not be expected to be representative of the larger U.S. undergraduate engineering population of low-SES first-generation students and is certainly not representative of the lived experience of low-SES first-generation students who do not enroll in college engineering programs.

Future Research

This research will continue by sharing evidence for the other three assertions and drawing inferences based on how those assertions are related. Further interviews with more low-SES first-generation engineering students, particularly at other engineering universities would help determine if these assertions are unique to an institution, a region, or more common to the lived experience of low-SES first-generation students across the United States.

References

1 Blue, C. E., Blevins, L. G., Carriere, P., Gabriele, G., Kemnitzer, S., Rao, V., & Ulsoy, G. (2005, May). *The engineering workforce: Current state, issues and recommendations: Final report to the Assistant Director of Engineering*. National Science Foundation.

2 Stanley, D. L., Sterkenburg, R., & Dillman, B. (2003). *Diversity: The challenges for engineering and technical education*. Proceedings of the American Society for Engineering Education 2003 IL/IN Sectional Conference, Valparaiso University, Valparaiso, IN, April 4-5, 2003.

3 Geller, M. B. (2003, January 26). Boeing puts more behind minority efforts. *Journal & Courier*, p. C8.

4 Wulf, W. (2007). *Engineering education in the 21st century* [Video file]. Retrieved December 20, 2011, from http://www.youtube.com/watch?v=_oaIhzlpENY

5 Wallace, S. A., & Lewis, M. D. (1998). *Becoming a professional counselor: Preparing for certification and comprehensive exams* (2nd ed.). Thousand Oaks, CA: Sage Publications.

6 Brown, D., & Brooks, L. (Eds.). (1990). *Career choice and development: Applying contemporary theories to practice* (2nd ed.). San Francisco: Jossey-Bass.

7 Super, D. E. (1980). A life span, life space approach to career development. *Journal of Vocational Behavior, 16*(3), 282-296.

8 Schultheiss, D. E. P., Palma, T. V., & Manzi, A. J. (2005). Career development in middle childhood: A qualitative inquiry. *The Career Development Quarterly*, *53*(3), 246-262.

9 Swail, W. S., & Hosford, S. (2007). *Missouri students and the pathways to college*. Educational Policy Institute: Virginia Beach, VA. Retrieved December 20, 2011,

http://www.educationalpolicy.org/pdf/Missouri_Pathways.pdf

10 Trusty, J., & Watts, R. E. (1996). Parents' perceptions of career information resources. *Career Development Quarterly, 44*(3), 242-249.

11 Birk, J. M., & Blimline, C. A. (1984). Parents as career development facilitators: An untapped resource for the counselor. *The School Counselor, 31*(4), 310-317.

12 Hoyt, K. B. (1984). Helping parents understand career education. *Journal of Career Education, 10*(4), 216-224.

13 McDaniels, C., & Hummel, D. (1984). Parents and career education. *Journal of Career Education, 10*(4), 225-233.

14 Otto, L. B., & Call, V. R. A. (1985). Parental influence on young people's career development. *Journal of Career Development, 12*(1), 65-69.

15 Herren, C. D., Cartmell II, D. D., & Robertson, J. T. (2007). *Perceptions of influence on college choice by students enrolled in a college of agricultural sciences and natural resources*. December 20, 2011, from http://agnews.tamu.edu/saas/2007/Herren.pdf

16 Peterson, K., & Stroh, H. (2004). *Thinking about college: Results of the college awareness survey among Achievers High School in Washington*. Retrieved December 20, 2011, from http://www.spu.edu/orgs/research/College%20Awareness%20Survey%20Final%20Report%20No%208.pdf

17 Donaldson, K. M., Lichtenstein, G., & Sheppard, S. D. (2008). *Socioeconomic status and the undergraduate engineering experience: Preliminary findings from four American universities*. Proceedings of the American Society for Engineering Education 2008 Annual Conference, Pittsburgh, PA, June 22-25, 2008.

18 Walpole, M. B. (2003). Socioeconomic status and college: How SES affects college experiences and outcomes. *Review of Higher Education*, *27*(1), 45-73.

19 Cabrera, A. F., Burkum, K. R., & La Nasa, S. M. (2005). Pathways to a four-year degree: Determinants of transfer and degree completion. In A. Seidman (Ed.), *College student retention: A formula for student success* (pp. 155–214). Westport, CT: ACE/Prager.

20 Terenzini, P. T., Springer, L., Yaeger, P. M., Pascarella, E. T., & Nora, A. (1996). First-generation college students: Characteristics, experiences and cognitive development. *Research in Higher Education, 37*(1), 1-22.

21 York-Anderson, D. C., & Bowman, S. L. (1991). Assessing the college knowledge of first-generation and second-generation college students. *Journal of College Student Development 32*(2): 116-122.

22 Billson, J. M., & Terry, M. B. (1982). In search of the silken purse: Factors in attrition among first-generation students. *College and University, 58*(1), 57–75.

23 Choy, S. P. (2001). *Students whose parents did not go to college: Postsecondary access, persistence, and attainment* (NCES 2001-126). U.S. Department of Education, National Center for Education Statistics. Retrieved December 20, 2011, from http://nces.ed.gov/pubs2001/2001126.pdf

24 Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

25 van Manen, M. (1990). *Researching lived experience: Human science for an action sensitive pedagogy*. Abany, NY: State University of New York Press.

26 Säljö, R. (1997). Talk as data and practice – A critical look at phenomenographic inquiry and the appeal to experience. *Higher Education Research and Development*, *16*(2), 173-190.

27 Creswell, J. W. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, CA: Sage Publications.

28 Patton, M. Q. (1990). *Qualitative evaluation and research methods*. Thousand Oaks, CA: Sage Publications.

29 Guba, E. G. (1981). Criteria for assessing the trustworthiness of naturalistic inquiries. *Educational Communication and Technology Journal, 29*(2), 75-91.

30 Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage.

31 Graneheim, U. H., & Lundman, B. (2004). Qualitative content analysis in nursing research: Concepts, procedures and measures to achieve trustworthiness. *Nurse Education Today, 24*(2), 105-112.

32 Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for*

Information 22(2), 63-75.

33 Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis* (2nd ed.). Newbury Park, CA: Sage.

34 Moustakas, C. (1994). *Phenomenological research methods*. Thousand Oaks, CA: Sage Publications.

35 Creswell, J. W. (2008). *Educational research* (3rd ed.). Upper Saddle River, NJ: Pearson Education, Inc.

36 Seidman, I. (1998). *Interviewing as qualitative research: A guide for researchers in education and the social sciences*. New York: Teachers College Press.

37 Merriam, S. B. (1998). *Qualitative research and case study applications in education* (Rev. ed.). San Francisco: Jossey-Bass Publishers.

38 Arksey, H., & Knight, P. (1999). *Interviewing for social scientists*. London: Sage Publications.

39 Bailey, C. A. (1996). *A guide to field research*. Thousand Oaks, CA: Pine Forge.

40 Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Thousand Oaks, CA: Sage Publications.