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The WISER Experience: Supports and Opportunities for Improvement Perceived by Female Engineering Students in a Living-Learning Community

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The WISER Experience: Perceived Supports Embedded in a Living-Learning Community

Background

The need for STEM graduates in the United States is growing at an alarming rate. A 2012 President's Council of Advisors on Science and Technology (PCAST) report predicted that there will be a 1 million college student deficit in science, technology, engineering, and mathematics over the next 10 years (Olson & Riordan, 2012). For years now, there has been a call for more underrepresented groups in STEM fields. According to the National Center for Education Statistics (NCES), only 18.4% of the students earning engineering degrees in the year 2014 were females (Digest of Education Statistics, 2015). Given this underrepresentation of women, it is important to determine why so few earn engineering degrees. Studies have shown that one possible explanation for the lack of women who persist in engineering is the in-class and out-of-class dissatisfaction of the college experience (Watson & Froyd, 2007). Another study confirms this statement with findings that show a significant correlation between overall college experience and intent to pursue a major (Amelink & Creamer, 2010). Other studies have also found that the "lack of belonging" is a significant factor in the reason students leave engineering, and students' initial confidence level for completing their engineering degree significantly predicted the lack of belonging factor (Marra, Rodgers, Shen, & Bogue, 2012). Thanks to the abundance of prior research, we know some of the reasons that female engineering students do not persist. So, what can we do to increase persistence?

Living-learning communities (LLCs) may provide a solution to this problem. These LLCs, sometimes referred to as residential learning communities (RLC), are defined by Zhao and Kuh (Zhao & Kuh, 2004) as a "organized on-campus living arrangements so that students taking two or more common courses live in close physical proximity." Living-learning communities bring students of similar academic interests together to create a community of students that have strong social and academic support systems.

Tinto (1996) states that the integration of academic and social experiences is necessary for retention. Zhao and Kuh (2004) found that learning communities were strongly linked with active and collaborative learning and interaction with faculty members. A recent study found that students in engineering living-learning communities felt more connected to their University, had better peer relationships, and had higher levels of overall satisfaction than their peers in engineering that were not a part of a living learning community (Flynn, Everett, & Whittinghill, 2016). Pike found that students in the residential learning community had higher levels of interaction, integration, and involvement than the students in traditional learning communities (Pike, 1999). For our study, we focus on one of the female engineering LLCs at Clemson University and determine its essential elements that contribute to the students' academic and professional development.

The purpose of this study was to identify the resources that female engineering sophomores find most beneficial for their academic and career development in an LLC at Clemson University. About 26% of the students in the general engineering classes are females (CECAS Mini Fact

Book, 2016). The participants in this study are students who are currently in the Women in Engineering and Science Residence (WISER) program. WISER is a living-learning community exclusively for sophomore women majoring in engineering and science. Since its inception in 1999, the WISER program's purpose has been to bring women together so they do not feel as isolated in their male dominated disciplines and provide professional development that will assist in the advancement of their professional STEM careers. These students all live in the same residence hall and are afforded opportunities such as peer mentoring, on-site tutoring, professional certification opportunities, and social and community activities. Through this study, we attempt to answer the following questions: What are the essential elements of WISER that contribute to student academic and career development? What learning experiences embedded in WISER directly or indirectly increase student self-efficacy and positive outcome expectations in engineering?

Literature Review

The theoretical framework for this study will be the social cognitive career theory (SCCT). SCCT is grounded in Bandura's social cognitive theory and is used to explain how academic interest along with career interest and choices are developed and turned into actions (Lent, Brown, Hackett, & Brown, 2002). Prior research has applied the SCCT to explain the variables that promote or impede the career development process (Flores & O'brien, 2002; Lent, Brown, & Hackett, 1994). However, it has also been used to understand and meet the needs of adolescents and prospective, first generation college students (Flores & O'brien, 2002; Gibbons & Shoffner, 2004). This study adds to the existing literature by viewing SCCT in relation to an LLC. We used this theory as a lens to study the essence of the WISER experience contributes to the students' career choices by becoming a source of high engineering self-efficacy and positive outcome expectations.

The social cognitive career theory (SCCT) has been used to explain several factors that influence career choice. Specifically, it has been used to determine how academic and career interest are developed, how career choices are developed, and how these choices are turned into action. This model begins with the Sources of Self-Efficacy and Outcome Expectations that determine the Self-Efficacy and Outcome Expectations. Self-efficacy is one's perceived ability to succeed in a task or situation, and the outcome expectation is what one would expect as the result of a task or situation. As children, we have many different observations and influences that guide our sense of self-efficacy and outcome expectations. For example, parent's occupation may affect their child's self-efficacy in that field. Bandura et al conducted a study that found that a parent's perceived self-efficacy and career aspiration affects the child's self-efficacy (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001). If a child feels like they can succeed at something, such as their parent's occupation, they are likely to expect to do well. The opposite is also true. If you have low self-efficacy in a subject area, you are likely to believe you will perform poorly. This highlights the relationship between self-efficacy and outcome expectations. These two elements then determine interest in an occupation, intentions to pursue a career in an occupation, and finally selecting that occupation. This selection, along with self-efficacy determines the level of performance in the occupation.

For this study, we view interest as the desire to learn more about engineering. At Clemson University, all students begin in the same general engineering class before they can declare their majors. We will call this the interest stage. Keep in mind, all the students in WISER are sophomores so many, if not all of them, will have already been through the interest stage. After this stage, we have the intentions stage. At this point, students declare their majors with the intention of becoming engineers. The Activity, Selection, and Practice stage involves purposeful actions taken to become an engineer. This might include passing upper level engineering classes, joining professional engineering organizations, applying for internships and coops, or attending professional development workshops. Performance Attainment is the next stage. Here we define it as identifying as an engineer.

Godwin (2016) found that a combination of recognition, interest, and performance/competence measure engineering identity for early post-secondary engineering students. Earlier researchers had similar ideas about what it takes to be an engineer. Svarovsk and Shaffer (2006) states that feeling like an engineer takes combination of skills, knowledge, values, identity, and epistemology that characterizes the profession. Participants in this study developed engineering identities by interacting with clients or external experts in a digital zoo. Another study found a difference in the way men and women view their engineering identities; men saw engineering as primarily "building" while women saw engineering as primarily "seeking information." The authors also point out that the culture of the school is an essential part of engineering identity formation (Chachra, Kilgore, Loshbaugh, McCain, & Chen, 2008). Yet another study states that access to engineers and engineering experiences are critical for engineering identity formation (Pierrakos, Beam, Constantz, Johri, & Anderson, 2009). Because forming one's engineering identity is unique to each person, there is no right or wrong time to feel like an engineer. However, many female students who start in engineering fields never graduate with engineering degrees. Therefore, they likely never make it to the performance attainment stage where they identify as an engineer. We believe that the essential elements of the WISER program will serve as a source of high self-efficacy and positive outcome expectations in engineering. These factors will then lead to goal fulfillment and a strong engineering identity in their chosen engineering occupations.

Procedure

Sampling

Unique sampling was used to recruit participants for this study. It was important that we have a diverse sample to increase the probability that the factors that contribute to the similarities that emerge from data are due to the WISER experience as opposed to external factors. For example, if we only interviewed students within the mechanical engineering department, the similarities in their views may be due to their experiences in mechanical engineering as opposed to their experiences in WISER or Clemson University. For this reason, we recruited five students with a variety of majors and ethnicities.

Study Design

This qualitative study consisted of one interview with three parts for each participant. Questions were centered around the best and worst experiences the students have had thus far, availability and use of resources within and outside of WISER, feelings about being female in science and engineering fields, and future career plans. The interviews lasted for about 30 minutes each. The interviews were semi structured, which allowed for impromptu probing questions when necessary.

Analysis

After each interview had been recorded, they were transcribed verbatim. Once the transcription was complete, the coding took place in three stages. During the first phase, we open coded by reading through an entire transcript, and looking for significant statements that may help to answer the research question. The second phase, consisted of focused coding. We looked through the significant statements to determine if there were any keywords and phrases with similar meanings that could be grouped together. Next, we organized these groupings into subcategories with similar meanings. These categories and subcategories helped reveal our emergent themes.

Results and Discussion

Interviews with WISER students revealed many diverse perspectives on life as a female engineering student at Clemson University. However, within the participants' responses, four common themes emerged and these themes revealed the essential elements of WISER. These themes were Social Engagement, Mentoring, Professional Development, and Sense of Belonging.

Social Engagement

The social engagement theme consisted of any statements made by the students that involved social activities that bring engineering students together. Many of the students interviewed expressed the desire for more social engagement with peers in engineering. They acknowledged their awareness of WISER events, but they still feel the need to come together more often. While some students mentioned the desire to have events specifically for female engineering majors, others stated that they would like to have events where all engineering majors could come together because this would give them the opportunity to meet new people. One student stated,

> "As for WISER, I don't think we do enough just to kind of get together… Like maybe if it was like a once a month thing or we just all kind of got together and did something like maybe a movie night with food."

When another student was asked which college experience she would re-live, she also mentioned social engagement, saying,

> "…just I guess meeting other girls and connecting with other girls that were in engineering was like what I would want."

Mentoring

Amelink and Creamer (2010) reported that female engineering students expressed the importance of having visible female role models because it helped to reduce the feeling of isolation in a male dominated field. The findings from our interviews support this statement. The

mentoring theme consisted of words and phrases that mentioned mentoring, teaching, advice, and guidance. This theme was consistent among all the students. Specifically, the students mentioned the impact that the WISER graduate student, WISE coordinator, and WISER director have had on them. The details of their academic journeys and words of encouragement have inspired them to accomplish their goals. One student said

> "I definitely enjoy hearing [the graduate assistant's] experience and other people's experience. [The WISE coordinator]. I talk to her sometimes. She actually got me into more Creative Inquiries. Just the idea of it or maybe like an independent study in the future. But I'll talk to her about her past and how she got here so I definitely like having those two just to bounce ideas off of and talk to."

One student also mentioned that hearing about her professor's experience, made her more excited about engineering. When asked if she could re-live any college experience she's had thus far, another student said

> "[I would re-live] the first semester engineering class … our professor was just really awesome about explaining um… things in real life. He just had crazy experiences so I think like that really sparked my interest… it was just encouraging to know we can do cool things with [engineering]."

Professional Development

Undergraduate research and professional development opportunities are important for the formation of professional identity and personal growth (Hunter, Laursen, & Seymour, 2007). This theme includes any statements about the professional development workshops and opportunities as well as Creative Inquiry (CI). Creative Inquiry is a mandatory aspect of WISER. Every student must participate in a research experience with a professor at least once. Professional development is also mandatory. All students are required to attend at least three professional meetings during the semester.

The mandatory Creative Inquiry came up in every student's interview without any prompting. This is a crucial part of the WISER experience, and the students see the value in getting this research experience while they are in their undergraduate programs. One student was eager to discuss her summer research opportunity, and she credits her CI for preparing her. She said

> "I don't know if I would have gotten the research position I have now because [WISER] like got us to do a CI…Like literally just once every two weeks just going through how to research. That was just so helpful so the CI helped so much."

The only negative comment was that the Creative Inquiry could have been more structured. One student commented about the seemingly unorganized scheduling that took place after the semester had already begun. She mentioned the hassle of having to fit the CI into their weekly routines after class and work schedules had already been determined. As mentioned in the introduction, WISER students are afforded the opportunity to attend workshops and professional development events. Students expressed their appreciation for these events, and it was evident that they take full advantage of these chances to learn new life skills. One student said,

> "… like this past Monday there was a financial class talking about finances and Savings in your 20s is better than like 30s because you'll have a better 401k. Just to name a few."

The professional development element seems to be the greatest contribution to the academic and career development of the students. All the students appreciated the workshops and professional development activities that WISER provides. Students were particularly pleased with their CI experiences and personal finance workshop. One student suggested that these opportunities be better advertised to freshman because she had a hard time finding these resources her first year.

Sense of Belonging

The most expected theme was Sense of Belonging. This theme consists of any statements related to the negative feeling associated with being a gender minority in an engineering classroom or major. One student recognizes that she is treated differently than her male peers and that her dedication is not as appreciated.

> "So it's like I wish it was almost socially acceptable to be as dedicated… You know, but I've just been really surprised that my student organizations assume I could commit more time than a male engineer would."

This same student talked about the responses she gets when she tells people that she is majoring in engineering. She describes the amount of shock in their voices and faces as "insulting." When asked about her ideal college experience she said,

> "I just want it to be normal as opposed to all like WOW! People shouldn't have to react like that when I say my major. You know they should just be like okay. Just like they do for a guy."

Inside of the classroom things are not much different for female students. Even in a class full of people, they still feel very much alone. There were many comments made about being the only female at the table, and feeling left out. If the male students in these classrooms do not make a conscious effort to treat the female students as equals, there can be dire consequences. One student described how she feels when she is in a group with only male students. She said

> "I've been the only girl there so when you discuss things sometimes you feel like … no one's actively listening to you like when you're setting up … it's not like you're isolated but you can tell when… it's just you can tell they're not engaging with you...like your input isn't really being heard and over time you just don't speak up anymore."

Contributions to self-efficacy and positive outcome expectations

Having a sense of community is not only important for the social aspect of college, but prior research has also shown that good contacts with peers has a positive influence on the degree of a student's academic integration which is also an important factor for persistence (Kamphorst et al., 2015). After speaking with these students, it was evident that they value the opportunity to meet other students majoring in engineering outside of the classroom. Social engagement plays a large role in the students' perceptions of their abilities.

All the students also mentioned the impact that WISER team have had on them. They go to these mentors for professional advice, academic guidance, and general life tips. They have played a vital role in the success of the students interviewed. The fact that all the students feel supported by the women in WISER shows this is an apparent strength of the program. Some of the students have even begun to consider graduate school and careers in research because of interactions with the WISER staff members.

Many of the students expressed that they felt as though their voices were not being heard in their engineering classes. They also talked about the negative effects of having so few females in their classes. Most of the students spoke of these instances as "something you just have to get used to." However, these same students also mentioned that WISER was a place where they felt as though they belonged. WISER has provided a great support system and social network for female engineering students at Clemson.

Limitations

There are apparent limitations to this study. Because the sample used for this study is so unique, the results many not be generalizable for all female engineering students. Another limitation is the researcher bias. Since the researcher was once a female engineering major, it is difficult to keep personal feelings and opinions out of the research. The questions that were asked and the interpretations of those questions were likely influenced by the researcher's experiences. Lastly, there may be response bias. Students may have felt obligated to tell the researcher what they believe is the "right answer." The students were interviewed by a doctoral student in the Engineering and Science Education program at Clemson University so they might have been hesitant to speak openly about their academic challenges. They may also have been hesitant to say anything negative about the WISER program or Clemson University.

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