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Creating New Metaphors for Women Engineering Students through Qualitative Methods

Cliff Haynes
University of Florida, cliffh@coe.ufl.edu

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Abstract

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Keywords

Constuctivism, Engineering Students, Higher Education, Living Learning Programs, Metaphorical Analysis, Residence Halls, STEM Education, Women

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Cliff Haynes
University of Florida, Gainesville, Florida, USA

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The ever-changing global market increasingly requires a technologically and scientifically skilled workforce for nations to remain competitive in the global economy (Campbell, 2002). In order to provide this skilled workforce, leaders from industry and government are calling for an increase in the number of graduates in the science, technology, engineering, and mathematical (STEM) fields, yet it comes at a time when American students' interest in these majors has declined (Duderstadt, 2008). Despite efforts to encourage more students to enter STEM fields, the percentage of students intending to enroll in these majors has dropped over the last decade and remains around 20% (College Board, 2010).

Even more concerning is the enrollment rate of women in the STEM fields. Women are entering college and earning more degrees than men earn, yet male students are twice as likely as female students to enter STEM fields are and twice as likely to earn a certificate or bachelor's degree in STEM fields (Baum, Ma, & Payea, 2010). Because they represent over 50% of undergraduates but only 17.5 % of engineering students (National Science Foundation, 2011), women have been identified as the "greatest potential source of new engineering talent" (Lord et al., 2009, p. 167).

In order to address this disparity between the percentages of female undergraduate students to female engineering students, it is important to understand why women are not seeking out engineering as a major. Unlike other majors, most students cannot choose to major in engineering overnight due to the sequential and linear nature of classes (George-Jackson, 2011). Overall, engineering students typically take more math and science classes in high school than non-STEM students, and female engineering students are more likely to have had these courses than male engineering students have (Yauch, 1999). Once in college, female

engineering students earn the same GPAs as male engineering students, yet women are more likely to judge themselves as less successful in their degree programs than men are (Meinholdt & Murray, 1999).

Women chose to leave STEM fields because of experiences of being uncomfortable classroom settings and having difficult interpersonal relationships (Johnson, 2011). Models describing this phenomenon are often described as a pipeline or pathway; however, few retention models for engineering students have been developed (Veenstra, Dey, & Herrin, 2009). While the pipeline model to describe the pathway to engineering degrees is used for all students, the model for female engineering students has been characterized as a leaky pipeline (Blickenstaff, 2005). In this model, the loss of students along the pipeline is seen as naturally occurring, and few, if any, "patches" are suggested to lessen or stop these leaks.

The Pipeline Metaphor

Policy makers' efforts in the 1970s to solve national social problems elevated women (as well as racial/ethnic minorities) as a significant category to address the scientific and technological needs of the country. These efforts evolved to address economic concerns, and in the 1980s, these changes created a powerful and useful model of the U.S. educational system for STEM in the pipeline metaphor (Lucena, 2000).

Because "preparing to enter STEM majors and occupations is largely a sequential and liner process given the prerequisites that are required to advance in the sciences and remain in the STEM pipeline from year to year" (George-Jackson, 2011, p. 150), the pipeline metaphor served as a useful model to describe the STEM educational process. The pipeline metaphor explored the full educational system, starting as early as grade school through secondary school and ending with student earning their doctorate in STEM majors.

The pipeline metaphor identified behaviors of demographic subsets that interrupted the flow of engineers in the pipeline. By pinpointing these behaviors, systematic, institutional, and personal fixes could be developed to address these leaks (Lucena, 2000). For example, Kansas State University developed an early intervention program for middle school women to encourage participation in STEM by connecting school districts, university students, and corporations to the local community (Spears, Dyer, Franks, & Montelone, 2004). Assessment of the program indicated that the girls noted strongest interest in opportunities to connect with women scientists and engineers, learn about career paths, and explore the type of work these current professionals do.

Once in college, retention efforts are key to student persistence. STEM students' attrition rates, for both men and women, decrease as time in college increases (Daemple, 2003-2004). Women are more likely than men are to switch majors earlier in the college careers, and women majoring in STEM majors are more likely to graduate from a different major than their original major than women majoring in other science-based majors (i.e., agricultural/biological sciences or health sciences; George-Jackson, 2011, 2014). This decline in retention rates of women majoring in STEM fields as they progress in their college careers has implications for earlier STEM intervention programs for women.

While the pipeline metaphor has been useful in developing recruitment and retention programs, a criticism has been that it fails to address systematic concerns to assist those not in the pipeline. As Ramaley (2002) noted, "Our greatest vulnerability as a nation rests in the extent to which we limit the participation of all our young people in science and mathematics and, more importantly, fail to expect that all students can succeed" (p. 16). Beginning in the 1990s, policymakers have called for a new metaphor to be created that would address the flexibility needs for a global competitive market (Lucena, 2000). Currently, no such metaphor has been created.

The current technology age calls for an increase in college graduates, yet this is a noticeable gap in the American educational system to diversify the STEM fields, particularly for students of low economic status, for students of minority ethnic backgrounds, or for women (Campbell, 2002). When a broader definition of STEM is used to include the agricultural, biological, and health sciences in addition to the physical sciences, computer sciences, and engineering, the retention rate of women in STEM is equal to men (George-Jackson, 2011). This broader definition also changes the narrative of minority women with African-American and Hispanic women persisting in a STEM degree equal to Asian and White women. However, this broader definition does not address some underlying issues in the educational system.

The Chilly Climate Metaphor

Most of the literature about female undergraduates' experiences in engineering focuses on the negative experiences or obstacles and barriers preventing success (Goldman, 2012). Within these negative experiences is another frequently cited metaphor, that of a "chilly climate." Daemple (2003-2004) found that the chilly classroom leads to STEM attrition.

In a classroom with a chilly climate, "overtly disparaging remarks about women, as well as more subtle differential behaviors that can have a critical and lasting effect" which "puts women at a significant educational disadvantage" (Hall & Sandler, 1982, p. 3). The top three reasons for females to feel a chilly climate is difficulty with the course content, the professor's teaching style, and the personalities of classmates (Schulze & Tomal, 2006).

Course Content

In terms of course content, barrier courses, or key courses that students describe as challenging but needed to major in a field, were seen as a major obstacle for student retention (Suresh, 2006-2007). When it comes to barrier courses, students performed well when they connected with the professor's teaching style and did not view the barrier courses as intentional "weed out" classes.

Students who persisted in engineering regardless of their performance in barrier courses had one overwhelming commonality: the motivation to succeed (Suresh, 2006-2007). These students persisted because they could not see giving up or switching majors as an option. They were also more likely to adjust study habits (e.g., complete homework or do more problems than assigned) and to develop the coping strategies of not blaming themselves. Instead, they determined what they did wrong and fixed it.

The most cited personal obstacle and barrier of female engineering students is that they lack confidence in their abilities. While female engineering students earn equivalent GPAs and spend more time studying and preparing for class, they more often feel depressed about their academic performance and question their abilities more than their male counterparts do (O'Callaghan & Jerger, 2006). Compared to their male counterparts, women engineering students lack computing self-efficacy but apply greater effort to compensate (Vogt, 2003).

Professor's Teaching Style

For engineering students, chilly climates are felt due to experiences of uncomfortable classroom settings that are often male-dominated classrooms (Johnson, 2011). These classes are typically large lecture classes with little interaction with peers and faculty or smaller lab courses taught by graduate teaching assistants (Bergvall, Sorby, & Worthen, 1994). Instead, female students prefer smaller classrooms that include interaction with the professor and collaboration between classmates. While smaller classes are preferred, the benefit of larger

classes is that they allow women to fade into the background. This reflects the feeling of tokenism, which is another institutional obstacle and barrier for female engineering students.

In their qualitative study of classrooms, Salter and Persaud (2003) found that faculty are the greatest factor in creating an effective learning environment within the classroom. The impact of faculty interaction within the classroom had both positive and negative outcomes for women (Sax, Bryant, & Harper, 2005). Women who challenged a professor's ideas in class were less likely to consider gender-specific careers and hold traditional views about the roles of women; however, this interaction had women report higher rates of feeling stressed and overwhelmed. When women felt that comments to faculty within the classroom were not taken seriously, they reported declines in physical health, math ability, and degree aspirations and were more likely to consider traditional female occupations (e.g., nursing or education).

Contrary to these negative outcomes, when women received honest feedback about their abilities from faculty, they achieved higher grades, reported a higher drive to achieve, and reported an improved sense of health (Sax et al., 2005). This can begin with faculty including language on course syllabi that welcomes students to interact with them and that uses encouraging language that implies success in the class is possible (Parson, 2016). This data indicates that faculty have a large role in reducing the chilly climate of the classroom and providing a safe and equitable climate for women to succeed.

A change in the current structure for faculty research/teaching expectations, in funding opportunities, and in the experiences of all students to engage in STEM learning opportunities is necessary for educational reform to occur on a national level (Daves, 2002). In their mixed methods study, Wasburn and Miller (2004-2005) found that women in engineering called for male and female faculty to be trained on the educational needs of women in male-dominated classes. For instance, colleges could create teaching centers where faculty can learn pedagogical practices to improve education in STEM (Ramaley, 2002).

Personalities of Classmates

While women seem to have reduced the gap in behavior and environmental factors affecting retention, Vogt (2003) suggests that the cumulative effects of the differences may account for subtle and unintended discrepancies from their male counterparts. For instance, in their qualitative study of a minority engineering program, Good, Halpin, and Halpin (2001-2002) found that students reported no issues of ethnicity bias but that the females all noted gender discrimination. Similarly, Goldman (2012) found that while women are more represented in STEM majors, the role of gender is still affecting their experiences.

Landry (2002-2003) found "that the departure of women from higher education is more determined by outside social forces than academic ones" (p. 5). Female engineering students may feel like an outsider or struggle to "fit in" with the predominately male-oriented departments (Wao, Lee, & Borman, 2010). Women in STEM majors are challenged to *look the part* of a STEM major to meet expectations and *prove their worth*. This act of playing the role is done "in response to potential friendships, classmate relationships, and dating relationships" (Goldman, 2012, p. 129).

Female students are a minority in engineering departments and face stereotypes or perceptions of favoritism and gender-based advantages from their male counterparts (Heyman, Martyna, & Bhatia, 2002). Women in engineering programs noted they faced challenges with men not wanting to work with them in group projects or assigning them clerical roles (Wasburn & Miller, 2004-2005). They also felt demoralized by men's over-confidence or competitive nature in class discussions.

Engineering Living-Learning Programs (LLPs)

According to Boyer (1987), one of the major challenges in delivering undergraduate education is the divide between academic affairs and student affairs (as cited in Schussler & Fierros, 2008). To address the leaky pipeline phenomenon in engineering, institutions have developed partnerships between academic affairs and student affairs to bridge the gap between students' in-class learning and their co-curricular learning. In other words,

> Partnership programs enhance student engagement by encouraging campus involvement, academic involvement, civic engagement, and interactions with peers and faculty. …These efforts relate what one *does* while in college with what one *gains* from college. (Emphasis in original text, Nesheim et al., 2007, p. 447)

One programmatic example of higher education that bridges the gap between academic affairs and student affairs as a way to retain students is living-learning programs. These programs have students live on campus in the residence halls, interact with peers, encourage faculty interaction, and engage students in academic departments (Inkelas, 2008).

No national database exists that tracks and can provide a number for the exact number of how many engineering LLPs exist nationally, thus, an exact count of the number of engineering LLPs that exist across the country is unknown. Although no published statistics provide a description of the type of LLPs currently in place across the country, according to recent statistics, 46% of LLPs have an academic department or unit as part of the reporting structure that coordinates the LLP (Soldner & Szelenyi, 2008). Thus, little published literature exists on engineering LLPs.

A large national study found that participation in an engineering LLP increased students' likelihood to report they plan to earn a bachelor's degree in STEM (Soldner et al., 2011). LLP participation influenced the quality of students' social support systems and enhanced the quality of faculty interactions. Students who participated in LLPs report higher gains on these social-cognitive factors when compared to students living in a traditional residence hall, and these gains influence factors related to vocational choice.

Very few articles specifically mention women in engineering LLPs. Only recently has literature appeared that publishes empirical research on the benefits of women's involvement in STEM LLPs. Early assessment indicates that women in an engineering LLP do better academically than women not living in the LLP (Witucki et al., 2008). Women who participated in the engineering LLP had higher GPAs than all students in the similar majors did and higher retention rates than all first-year students (Pace et al., 2008).

Inkelas (2011) found several differences when comparing the benefits of women involved in a women-only STEM LLP to a co-ed STEM LLP. Women who participate in women-only STEM LLPs were more likely to report a successful social transition and confidence in their STEM courses; however, women who participate in co-ed STEM LLPs were more likely to report a successful academic transition to college. Additionally, Szelenyi and Inkelas (2011) found that women in single-sex STEM LLPs were more likely to report plans to attend graduate school in a STEM field; however, these results were lowered if the women visited a work setting of a STEM professional as part of their participation in the LLP.

While research indicates that women-only STEM LLPs provide support in the academic setting, Szelenyi, Denson, and Inkelas (2013) found that women reported greater gains on professional outcomes and expectations in coeducational STEM LLPs than single-sex STEM LLPs. They noted that women in coeducational halls found their residence hall environment to be more academically supportive, report higher expectations for professional/career success,

and report higher expectations of achieving balance between personal and professional life. The authors theorized that because the coed environment provides a glimpse of the future career climate in terms of gender without the consequence of the work environment, women are able to gain confidence and see themselves as professionally successful in the company of men.

Purpose of the Study

Engineering students are more likely to be involved in residence hall activities than students from other colleges (Arboleda et al., 2003), yet few published studies have explored the experiences of students in an engineering LLP (e.g., Shushok & Sriram, 2010; Thompson, Oakes, & Bodner, 2005). Even fewer published articles explore the experiences of female students in an engineering LLP and those that have been published employ quantitative methods (e.g., Pace, Witucki, & Blumreich, 2008; Szelenyi & Inkelas, 2011). The present study addresses the gap in the existing literature on LLPs by using qualitative methodology to describe the experiences of female students in an engineering LLP.

Specifically, this study addresses the following research question: How do female participants describe their experience in an engineering living-learning program?

Methodology

An epistemology is the theory of knowledge embedded in the theoretical perspective and methodology, while a theoretical perspective is the philosophical stance that informs methodology and provides a context for the research (Crotty, 1998). Epistemological awareness drives consideration for the theoretical perspective, which in turn has implications for the purpose of the study, the research question, and the data collection methods (Koro-Ljungberg, Yendol-Hoppey, Smith, & Hayes, 2009). Methods are chosen based in part on the researchers' paradigm assumptions, thus, the selection of quality criteria is determined by considering who assesses the quality of the research and the researcher's own philosophical position (Creswell & Miller, 2000). Using Koro-Ljungberg, Yendol-Hoppey, Smith, and Hayes (2009) as a guide,

Utilizing Crotty's (1998) categorization of these elements of qualitative work, I selected constructionism as the epistemological foundation for this study, while constructivism is the theoretical perspective to ground the research. Since a constructivist study is designed to explore how individuals experience their own world through their vantage points (Hatch, 2002), the current study of female participants' experiences in an engineering LLP fits the constructivist theoretical perspective.

Constructionism is an epistemology that views knowledge as being constructed by human beings through interactions. Because this framework views knowledge as a construction of interactions, constructionism is a fitting epistemology to study how female engineering students describe their interactions within the LLP. Constructionism will shape and inform my study through the selection of interview questions that ask participants to describe and reflect upon different interactions that they have had through participation in the LLP.

Using constructionism as my guiding epistemology, the theoretical perspective of this study is constructivism. Constructivism is a theoretical perspective that explores how individuals experience their own world through their vantage points and how their interactions with the world creates understanding and meaning (Hatch, 2002). For constructivists, knowledge is not discovered. Instead, constructivists view knowledge as being created or made through experiences (Schwandt, 1994). Individual versions of knowledge are created by

interactions between the interpretable (the existing world in a specific time and location) and our system for interpreting it (symbols, cultural meanings, and language systems).

Methods

Before the research process began, I sought and gained approval for research of human subjects by the university's Institutional Review Board (IRB). Each participant provided written consent in order to digitally record the interviews. To provide confidentiality, I gave participants pseudonyms and masked identifying experiences.

Description of Participants

To study individuals' experiences and meaning making process, I used purposeful criterion sampling to identify my participants (Hatch, 2002). I selected eligible participants based on the following criteria: (a) be a female student, (b) have lived at least one semester in the engineering LLP, and (c) be currently enrolled as a student in the college of engineering. As a financial incentive for participating, participants received a $20 gift card to either the bookstore or dining services upon completion of the first interview

All eligible students (n= 77) were invited by an email to participate in the study. To assist with the recruitment of participants, I elicited the assistance of administrators from the housing department to contact the prospective students, and interested participants responded directly to me. In communication with the students, I acknowledged my role as a doctoral student and as a staff member within the housing department. Confidentiality of responses was assured in the initial email invitation and in any subsequent communication with participants.

Given the scarcity of this sample in the larger student population on campus and/or due to lack of interest in the sample population, the final number of participants included seven female students who were each given pseudonyms. When fewer participants are involved in the study, more time should be spent with each one in order to sufficiently answer the research question (Hatch, 2002). Upon analysis of the data collected in the 13 interviews (7 initial interviews and 6 follow-up interviews), I concluded that enough data had been collected to adequately answer the research question. Data saturation in qualitative research occurs when no new information appears or no new categories emerge (Morse, 1995). Because the final number of participants fits within the original goal range of 6-15 participants and because data saturation occurred, I determined that no more additional participant recruitment was necessary.

Data Collection

I collected the data for this study through semi-structured interviews. The use of interviews allows the researcher to describe the experience of participants using their own words and experiences, while the semi-structured interviews allow the researcher to begin with guiding questions yet follow leads and probe areas that arise during the interview (Hatch, 2002).

I designed the interview questions to gather the participants' description of their experiences in the engineering LLP and their interactions with peers, faculty, and their coursework. Some of the questions posed were as follows:

- How would you describe life in the engineering LLP?
- Because of your participation in the LLP, how connected do you feel to the college of engineering?

- Describe an experience you have had with a faculty member because of your participation in the LLP, and
- Describe an experience you have had with other students because of your participation in the LLP.

Prior to the end of the interview, I gave the participants the opportunity to add any additional comments that they felt were helpful and relevant.

I conducted interviews in locations that were mutually agreed upon by the researcher and participant, such as residence hall lounges or library study rooms on the university campus. These locations provided quiet places to meet and freedom from distractions and interruptions. I obtained written consent in order to digitally record the interviews. Interviews lasted approximately 60 minutes and were transcribed in verbatim within one week of the interview. Following transcription, I verified all transcripts for accuracy.

After I completed all of the first interviews, I performed my initial data analysis. I then contacted each of the participants for a second interview. During this follow-up interview, I asked some follow-up questions and asked each of the participants if there was anything from the first interview upon which they would like to expand or if there was anything they would like to add. I also presented my initial findings to each of the participants and allowed them to provide input on the findings and note if and how they agreed or disagreed with each of the initial metaphors. Only six of the participants completed a second interview. The last participant was away from the institution for the spring semester at an internship.

Data Analysis

In order for people to help make sense of complex information, they develop connections to mental models, or schemas, based on experiences that are familiar to them (Bernard & Ryan, 2010). Schemas come in three levels. The most pervasive schemas are universal, or those reflective of experiences common to all humanity. The mid-range level is cultural schemas, or those held by a particular culture, population, or group. The last level is idiosyncratic, or those schemas held by individuals based on their unique life experiences.

Schemas may take the shape of folk stories, life scripts, abbreviations, and metaphors (Bernard & Ryan, 2010). For purposes of this study, I focused on metaphorical schemas. The study of metaphors is concerned with how people understand their experiences. It views language as a way to provide data that develops concepts and systems of understanding (Lakoff & Johnson, 2003). In short, metaphors communicate the unknown in terms of the known (Moring, 2001) or the complex or abstract in terms of the ordinary (Kochis & Gillespie, 2006).

Lakoff and Johnson (1980) found that because "the metaphor is pervasive in everyday life, . . . the way we think, what we experience, and what we do every day is very much a matter of metaphor" (p. 3). As a research tool, metaphors can provide a creative method to understand an experience. However, metaphors may only provide a partial and personal view of truth/experience (Koro-Ljungberg, 2001).

To gain a description of female students' experiences in an engineering LLP, I employed a modified version of Systematic Metaphorical Analysis. This method was developed by Schmitt (2005) based on the work on Lakoff and Johnson (2003) by adding a step-by-step reconstruction of metaphorical models. I will describe each of the steps here and provide an example of that step from the current study.

The first step is to identify metaphors and perform deconstructive segmentation of the text. This step is performed after the data collection process. More specifically, I reviewed the texts of data and search for metaphorical phrases that are present in the data (Cameron et al.,

2009). I identified metaphors in text using the concept created by Schmitt (2005) that includes if:

> A word or phrase, strictly speaking, can be understood beyond the literal meaning in the context; and the literal meaning stems from an area of sensoric or cultural experience, (subject area), which, however, is transferred to a second, often abstract, area (target area). (p. 371)

In practice, this is done by looking for words or phrases that compare two dissimilar things, for simile comparisons which start with words such as *like* or *as* (Carpenter, 2008), or for colloquial phrases that are used in their connotative sense instead of their denotative sense (Pitcher, 2013).

In the present study, in my review of the interview transcripts I found 251 metaphorical phrases including *opens up doors*, *rocky course*, and *like your sisters* used by the participants. Some participants used more metaphors than others did, and this created fluctuations in the data and in the frequency of metaphors per participant.

The next step was to synthesize any present metaphorical phrases into metaphorical categories. This step reduced the large number of metaphorical phrases into a smaller number of metaphorical categories that are created by grouping models that describe the same target (Schmitt, 2005). I assigned each of the concepts with a metaphorical category labels.

In the present study, I created 21 metaphorical category labels. For instance, I grouped the metaphorical phrases of *extended family, home away from home*, and *like your sisters* into the metaphorical category label "LLC as family." Because not all identified metaphorical phrases will help answer the research question or describe the same target as other identified metaphors, not all of the indicating data points were grouped into metaphorical categories.

The final step was to combine the metaphorical categories into reconstructed interpretive metaphors that can be used to describe the research topic. The researcher can use conventional metaphors, metaphors used routinely by the participants, or a creative metaphor that fits the cultural aspects of the participants to create this interpretive metaphor (Schmitt, 2005).

In the present study, I grouped the categories "LLC as community," "LLC as family," and "hall as building" into the interpretive metaphor "LLP as Neighborhood." While fluctuations in the data occurred, each interpretive metaphor has at least one indicating text from at least 5 of the participants, and most of the interpretive metaphors have at least one indicating text from each participant.

Goodness and Trustworthiness

Because of my theoretical perspective of constructivism, I subscribe to the language of *goodness* for determining quality (Arminio & Hultgren, 2002; Lincoln & Guba, 2000). Within this language is the concern for trustworthiness and authenticity that focuses on the processes and outcomes of qualitative inquiry and not on the application of methods. During the analysis process, I took steps to maximize goodness so that the research is credible and representative of the participants (Arminio & Hultgreen, 2002).

First, I ensured that there was consistency of epistemology between the research question, data collection, and data analysis (Howe & Eisenhart, 1990, as cited in Jones, Torres, & Arminio, 2006). I first accomplish this by stating my epistemological assumptions and theoretical stances in the study (Jones, Torres, & Arminio, 2006). Following the discussion of my assumptions and stances, I provided evidence and a description of how the epistemology is

maintained consistent throughout the study (Arminio & Hultgren, 2002; Koro-Ljungberg et al., 2009).

Next, I engaged in peer review, which enabled me to strengthen my interpretations based on the comments that my peers provided about my preliminary findings. Peers who were not associated with the data collection process in any way were presented with the data. These peers were qualitative research colleagues and fellow graduate students who have taken qualitative research courses and have experience in conducting qualitative research and analysis. This peer review allowed me to consider alternative interpretations and to determine if my interpretations were the most probable and reasonable conclusions to make (Golafshani, 2003).

Additionally, I used respondent debriefing or member checking. I provided participants the opportunity to check interview data for accuracy and to comment on emerging interpretations that I identified from the interviews. If my interpretations have goodness, participants will be able to recognize their experience in my interpretations (Merriam, 2009). For metaphorical analysis, this process is known as metaphor checking and serves as a form of triangulation (Armstrong, Davis, & Paulson, 2011). During the first interview, I asked participants to clarify the meaning of a metaphor if the meaning seemed unclear to me during the interview. During the follow-up interview, I presented the participants with my interpretive metaphors and allowed them to provide additional insight in relation to the metaphors and to comment on whether they agreed with the interpretation of the text and with the wording of the metaphor.

Finally, I incorporated the strategy of providing thick, rich descriptions to integrate goodness into research. Thick descriptions allow the reader to understand the context and use this context in understanding the researcher's interpretations (Cho & Trent, 2006). With enough vivid detail, readers can understand the experience to make decisions about the applicability of the findings (Creswell & Miller, 2000).

Role of the Researcher

In qualitative research, the role of the researcher is that of the instrument of inquiry and the tool of analysis (Stewart, 2010). One way to assist the readers in understanding the relevance of the findings is to acknowledge the researcher subjectivity, including his personal beliefs, values, and possible biases that may shape the inquiry (Creswell & Miller, 2000). This section will acknowledge my biases and situate my own background in regards to this study.

As I interact with the participants and the data, I bring my lens of an American white male who received a bachelor's degree in a liberal arts field. During college, I completed and passed my required three science courses, three science labs, and two math courses. These general education requirement courses were the extent of my STEM involvement. As a first-year student, I was a member of a learning community but not an LLP. I lived on-campus in residence halls for all four years and was an active member of the community. During graduate school, I served as a hall director for an all-male hall at a technical university, which housed a large percentage of engineering students.

During data collection and analysis, I worked for the housing department in the office that is responsible for the coordination of the LLPs. Through my experience and role, I have an interest in LLPs, student involvement in the programs, and the outcomes of participation within these programs. Additionally, I view LLPs as a positive experience for students and a worthwhile endeavor for universities to fund and provide.

As a housing professional and student affairs researcher, my research often focuses on the students living in the residence hall communities on my campus. As a researcher/practitioner, both benefits and complications of *insider research* exist that can

influence my research of my campus' residence hall communities. The benefits of insider research include ease of access to participants, ease of rapport building, and ease of understanding the research field (Chavez, 2008). Participants may also have a higher level of trust with insider researchers and be willing to discuss more openly topics that they may not discuss with outside researchers (Corbin Dwyer & Buckle, 2009). Finally, the flexibility provided to insider researchers based on their knowledge and enmeshment in the community can aid the researcher in research settings that are changing, unstable, or unsafe (Kacen & Chaitin, 2006).

Researchers who take an insider position are able to use background knowledge to best interpret their findings. As Chavez (2008) put it, insider status provides "knowledge of the historical and practical happenings of the field" (p. 479). For inside researchers, the level of their involvement is one of understanding of subject matter while also using the participants' experiences to provide context and setting.

Some of the complications of insider researcher include assumptions in entering the research field, bias in selecting participants, and potential power conflicts/relationships between researcher and participant (Chavez, 2008). Ethical dilemmas arise that may influence protocol choice when information becomes available that conflicts with the dual role of researcher and practitioner. This is particularly challenging when the researcher responds to participants or analyzes data from a perspective other than that of researcher (Corbin Dwyer & Buckle, 2009; Jones, 2003). Inside researchers also lose objectivity if the participants only provide information that they think the researcher wants to be told or do not discuss certain topics due to close relationships (Padilla-Goodman, 2010).

As a language tool, metaphors allow for communication of ideas across cultural differences (Lakoff & Johnson, 2003). However, this communication is only effective if the metaphor is relevant in historical references of both cultures. When conducting schema analysis, an important methodological skill is having an understanding of both the language and the culture of the people one is studying (Bernard & Ryan, 2010). Not only is it necessary for researchers to have background knowledge based on relevant literature, but the researcher also needs to understand any current metaphorical models that might exist surrounding the topic (Schmitt, 2005). In this sense, the researcher serves as the interpretative force between the language of the participants and the language of the reader. Therefore, I believe the benefits of insider research outweigh the complications in order to perform a schematic metaphorical analysis of the experiences of female students in an engineering LLP.

Findings

After conducting metaphorical analysis, I found five interpretive metaphors emerging: LLP as a Starting Point, LLP as a Neighborhood, Engineering Classes as Challenges, Different as Normal, and Female Engineers as a Support System. Conceptually speaking, metaphors related to Starting Point and Neighborhood focused on the LLP itself. Meanwhile, the metaphors related to Engineering Classes as Challenges and Different as Normal focused of the experiences of the women both inside the LLP and outside the LLP. While the final metaphor of Female Engineers as a Support System reflects the experiences of the women both inside and outside the LLP, the participants felt it was present in all aspects of their experience and served as the "common thread" connecting the other metaphors or one that "melded" their other experiences together. Figure 1 represents a detailed illustration of how the interpretive metaphors interact with one another.

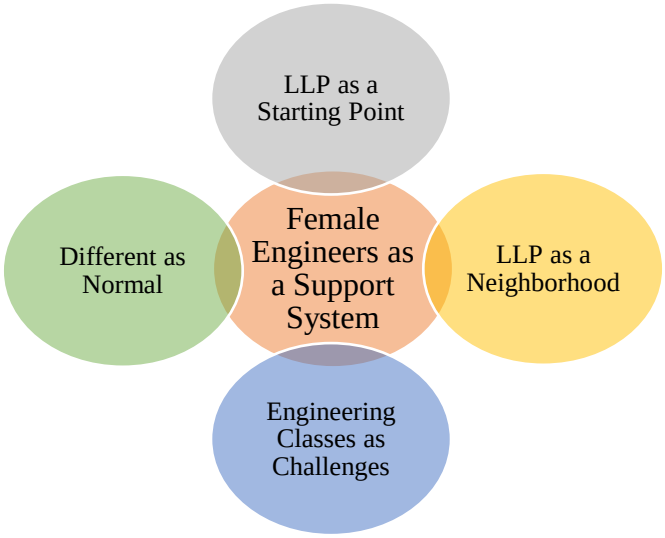

Figure 1. Illustration of how the interpretive metaphors interact with one another.

The first metaphor in the data provides a description of the students' experiences in the engineering LLP through the concept of a starting point. This interpretive metaphor LLP as a Starting Point includes the categories of a threshold, a point of origin, or a lead off point. Metaphors used in this group reflect that the women saw the engineering LLP as one of the first places they first met some of their classmates and where they learned about involvement opportunities. In describing her experience, Sharon noticed that "living in [the engineering] hall is not as different as living in another hall, but it gives you more--it maybe has an edge to it."

Another prominent metaphor in the data, LLP as a Neighborhood, connects unknown to known through the concept of a neighborhood. The first two categories of community and family reflected a positive interactive nature between the women living in the engineering LLP. Billie described this feeling further when she said, "it can be like home, just like I said because of that openness. You feel more comfortable, and I like that." The third category of building reflected a less interactive nature and saw the neighborhood as living quarters and refuge.

The third interpretive metaphor from the data, Engineering Classes as Challenges, provides a description of the students' experiences in the engineering LLP through the concept of various challenges. This metaphor reflects the difficulty level of the classes the women are taking. Carrie explained what made these classes so challenging. She noted that "if you're not gonna sit down and do it every night and work on it, then you're not gonna make it. That's what call a weed out class." This interpretive metaphor includes the four categories of engineering as a path, classes as obstacles, engineering as business, and engineering/classes as competition. The first two themes of path and obstacles reflect how the women viewed the coursework, while the other two themes of business and competition reflect how the women view their interactions with the coursework and the skills in which they use to overcome the challenges.

The fourth interpretive metaphor from the data, Different as Normal, reflects the acknowledgement that women engineers are different from the male student majority in engineering classes, but the metaphor also represents how the women respond to this difference. This interpretive metaphor includes the three categories of outsiders, being equal, and difference as unifying. The first theme is the awareness of being an outsider or being different. The other two themes represent the women's reactions to that awareness. For instance, Sharon realized what the difference allowed her to bring to engineering, to her classes, and to any group or team in which she played a part. Her description of being a female

engineering student is "like being a marker in a crayon box. It gives you the opportunity to do something that nobody else has necessary thought of before or thought you could do before."

The final interpretive metaphor, Female Engineers as Support System, reflects the way in which each of the women shows support and encouragement to one another. This interpretive metaphor includes the two categories of role models as encouragement and women as community. Carrie felt "like there is definitely a support system in the engineering hall." Lizzie also found that she easily related with the other residents. "Actually, that's the cool thing about [the engineering] hall. These girls were just like that, so you click with them, too." This support extends beyond the walls of the residence hall and extends to other female engineers as well including graduate students, faculty members, and industry leaders.

Significance of the Findings

A significant finding of this research is the creation of advantage-based metaphors that use a positive description of women in engineering. The current literature uses metaphors like the leaky pipeline (Blickenstaff, 2005; Lucena, 2000) and chilly climate (Hall & Sandler, 1982) to describe the experiences of female undergraduates in engineering from a negative viewpoint or a deficit model, but the findings of the present study describe the experience in a positive viewpoint or an advantage model. While the deficit model looks at students as underprepared or at-risk and develops programs and initiatives to fix these shortcomings, the advantage model looks at the "knowledges, histories, and experiences students bring with them" in order to design "more effective and responsive programming" (Castro, 2012, p. 6).

Although participants described their experience within the engineering LLP in mostly favorable terms, it seems unlikely that their comments were positive simply because they were interviewing with an administrator. The findings of the present study should be seen as a step in the direction of research using the advantage model to describe the experiences of this population. Advantage-based models provide insight into the unique role women can play in engineering and allows us to better understand what creates a positive, welcoming environment for the women. Further exploration of advantage-based models will assist in meeting the goal of changing "the status quo in STEM fields by increasing representation of traditionally underrepresented groups" (Castro, 2012, p. 6).

A second significant finding is that metaphorical analysis is an appropriate method for conducting research under the constructivist theoretical perspective. Constructivists view individual versions of knowledge as created by interactions between the interpretable (the existing world in a specific time and location) and our system for interpreting it (symbols, cultural meanings, and language systems) (Schwandt, 1994). Similarly, metaphors help the participant and the researcher connect a known concept to an unknown concept in order to explore, understand, and describe the unknown (Moring, 2001).

Constructivism focuses on the "meaning-making activity of the individual mind" (Crotty, 1998, p. 58). When metaphors are used in qualitative data, they "become illustrations of the way the person thinks and the images in her or his mind in relation to the conception being discussed" (Pitcher, 2013, p. 4). As a constructivist research tool, metaphors allow the researcher to understand the concept being explored from the viewpoint of the participant while using an illustrative description that has shared meaning between the participant and the researcher. Constructivists also acknowledge that multiple realities exist that are unique to the individual experience (Hatch, 2002). Because "students' meaning-making of their own experience is the source of understanding their development and the multiple realities within it" (Torres & Baxter Magolda, 2002, p. 478), metaphors provide a creative way to "illuminate the meanings of experiences" (Carpenter, 2008, p. 274).

While constructivists understand the subjective nature of the individual meaning making process, they also acknowledge that personal and cultural identities can be understood among individuals who interact with the same surroundings (Lincoln & Guba, 2013). Thus, college students at the same institution may have similar mental constructs based on their interactions with each other and the same physical surroundings. Metaphors have been used in some research to understand the college student experience (e.g., Kochis & Gillespie, 2006; Longwell-Grice & Kerr, 2013), and the findings of the present study support the continued use of metaphors as a constructivist research tool to explore the experiences of students in higher education.

Additionally, constructivism explores how individuals experience their own world through their vantage points and how their interactions with the world creates understanding and meaning (Hatch, 2002). Using metaphors as a constructivist research tool provides the opportunity to view the data as a whole and appreciate the experience from a different perspective (Carpenter, 2008). Because the current literature uses metaphors like the leaky pipeline and chilly climate to describe the experiences of female undergraduates in engineering from a negative viewpoint or a deficit model, the findings of the present study support the use of metaphors as a constructivist research tool to explore the experiences of female undergraduates in engineering using a different perspective and describe them in a positive viewpoint or an advantage model.

Limitations of the Study

As with all research, the present study had limitations. The first dealt with the sample. This study focused on the experiences of students at one institution; thus, the findings may not be transferrable to all such students within four-year institutions nationwide. The findings provide snapshots of the aspects inherent to this group of students at the time during which this study was conducted.

The second limitation also dealt with the sample. This study focused solely on the experiences of women who participated in the engineering LLP. It is likely that men who participated in the engineering LLP may have different experiences. Additionally, members of ethnic or racial minority backgrounds who participated in the engineering LLP may have different experiences when viewed as a demographic subset. Because only participants were interviewed, non-LLP participants' experiences were not be reflected in this study.

Another limitation comes from the difference in gender between me as the researcher and the gender of the participants. Reinharz and Chase (2003) note that

> when men study women, then, the same general methodological principle applies as when women study women: It is crucial that the researcher take account of his or her own and the interviewee's social locations and how they might affect the relationship. (p. 85)

To address this limitation, I took steps to build rapport with the participants; however, it is unclear as to whether the fact that I am a man interviewing women participants had any effect on the participants' willingness to discuss freely and talk openly about their experiences. If this gender difference had an effect on the relationship, then the findings of this study might have provided different results had there not been a gender difference between interviewer and participant.

A fourth limitation dealt with the data collection method. The use of semi-structured interviews allows the participants to describe their experience in their own words. Because this method relies on memory recall and because "the meanings of life events are not fixed or

constant; rather, they evolve, influenced by subsequent life events" (p. 341), the interviews provide truths of personal positionality and subjectivity (Reissman, 2003). For instance, if participants only provided positive accounts of their experience, then the findings of this study might have provided different results if they had also included negative accounts. In an effort to address this limitation, I asked participants about both positive and negative experiences within the LLP.

Another limitation comes from the structure of the LLP involved in the study. Although LLPs exist in European countries and within Islamic educational systems in the form of residential colleges where faculty are more integrated into the LLP (Penven et al., 2013), the present study explored an LLP with an Americanized learning community structure (Soldner & Szelenyi, 2008). Within this context, faculty members have a limited role within the community in the form of infrequent presentations or when 1-2 faculty members serve on the LLP advisory board. The use of a LLP with a more residential college structure might have provided different findings related to faculty involvement. Additionally, an LLP with a residential college structure might have made the findings more transferable to non-American institutions.

The final limitation dealt with the data analysis method. The combining of the metaphorical into reconstructed interpretive metaphors is a complex process. As Cameron et al. (2009) noted,

> the grouping process involves imagination and creativity in describing how metaphors best fit together. Because of this and because of the dynamic nature of language in use, the groupings that we construct will inevitably have blurred boundaries and a degree of overlap. (p. 76)

To answer the research question, I used conventional metaphors, metaphors used routinely by the participants, or creative metaphors to create the interpretive metaphors; however, a multiplicity of possible interpretations could exist when metaphors are viewed as linguistic devices to connect unknown to known and the researcher's and readers' experiences with the research topic to shape interactions with the findings and research texts. To address this limitation, I incorporated metaphors used by the participants as much as possible for the interepretive metaphors in order to represent the culture of the participants (Bernard & Ryan, 2010; Schmitt, 2005).

By addressing the limitations of this study, I am attempting to ensure that this study is not interpreted beyond the bounds of the seven participants; however, the limitations are only a very small part of the overall study. Although the present study had several limitations, the study was worthwhile in spite of them. The results of the study expanded the body of literature on the engineering LLPs and the body of literature on women's involvement in engineering LLPs.

Conclusions

Women in engineering LLPs are a population that has not been widely studied. Because there is underrepresentation of women in STEM majors and because participation in a LLP appears to be related to success in the first year, it is important to understand what experiences students are having while a part of the LLP. The present study addresses the gap in the existing literature on LLPs by using qualitative methodology to describe the experiences of female students in an engineering LLP.

The findings of the present study provide an example of how metaphors can suggest appropriate interventions (Carpenter, 2008). The advantage-based metaphors can be seen as

the first step in creating a new metaphor to describe recruitment and retention programs in STEM (Lucena, 2000). While the findings of the current research do not provide an overarching metaphor like the pipeline, the findings should be seen as a step in the right direction.

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Author Note

Dr. Cliff Haynes is a Clinical Assistant Professor of Higher Education Administration/Student Personnel in Higher Education at the University of Florida. He teaches courses related to student affairs administration, student development theory, and qualitative research methods. His research agenda focuses on student learning outside of the classroom, including living-learning programs, the graduate student experience, and community college student affairs. He may be contacted at University of Florida, College of Education, School of Human Development & Organizational Studies in Education, PO Box 117049, Gainesville, FL 32611. Correspondence regarding this article can be addressed directly to: cliffh@coe.ufl.edu.

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