”If I didn’t do engineering, I might be in a happier place:” A Comparative Longitudinal Analysis of Students Who Consider Leaving Engineering

Carlie Cooper M.Ed., University of Georgia

Carlie is a doctoral candidate in the Louise McBee Institute of Higher Education at the University of Georgia (UGA). She earned a bachelor’s degree in Psychology from UGA (2017) and a Master of Education in Higher Education Administration from Georgia Southern University (2021). She has higher education experience in business affairs and academic advising. She researches structures that contribute to underrepresentation in STEM majors and is currently a Graduate Research Assistant for the UBelong Collaborative.

Mr. Herman Ronald Clements III, Purdue University at West Lafayette (PWL) (COE)

H. Ronald Clements is a postbaccalaureate research assistant in the STRIDE lab at Purdue University and an incumbent graduate student for the 2020-2021 year. He works on the project titled â€œCAREER: Actualizing Latent Diversity: Building Innovation throu

Dr. Danielle V. Lewis, University at Buffalo

Dr. Danielle Vegas Lewis is currently the Postdoctoral Associate in Dr. Courtney Faber’s ENLITE lab in the Department of Engineering Education at the University at Buffalo. Her research agenda aims to understand and disrupt the ways in which socially constructed identities allow for the reproduction of social inequality, with a focus on understanding the ways institutions of higher education and other social structures challenge or uphold hegemonic environments in which majority populations accumulate power that harms students underrepresented in certain contexts.

Kevin Jay Kaufman-Ortiz, Purdue University/Cornell University

Kevin Jay Kaufman Ortiz holds a B.S. and M.S. in Industrial Engineering from the University of Puerto Rico Mayagüez Campus and Purdue University respectively. He is also a licensed mathematics teacher by the Department of Education in Puerto Rico. Kevin is currently a Ph.D. candidate in the School of Engineering Education at Purdue University. His interests center around national identity, engineering culture, acculturation, and inclusion of colonial migrants from the U.S. territories who are looking to pursue engineering careers in the contiguous United States.

Mr. Matthew Bahnson, Purdue University at West Lafayette (COE)

Matthew Bahnson completed his Ph.D. in the Applied Social and Community Psychology program in at North Carolina State University. His previous training includes a B.A. in Psychology from the University of Northern Iowa and an M.A. in Social Sciences from the University of Chicago. Matthew’s research focuses on sociocultural inequality in engineering graduate education with the intention of increasing diversity, equity, inclusion, and justice in STEM graduate education. He is completed a postdoctoral appointment in engineering education with the Engineering Cognitive Research Laboratory with Dr. Catherin Berdanier at Pennsylvania State University. He is currently a Research Scientist at Purdue University with the STRIDE research group directed by Dr. Allison Godwin at Cornell University.

Dr. Allison Godwin, Cornell University

Allison Godwin, Ph.D. is the Dr. G. Stephen Irwin ’67, ’68 Professor in Engineering Education Research (Associate Professor) in the Robert Frederick Smith School of Chemical and Biomolecular Engineering at Cornell University. She is also the Associate Director of the Cornell NanoScale Science and Technology Facility and a McCormick Teaching Excellence Institute Research Fellow. Her research focuses on how identity, among other affective factors, influences diverse groups of students to choose engineering and persist in engineering. She also studies how different experiences within the practice and culture of engineering foster or hinder belonging, motivation, and identity development. Dr. Godwin graduated from Clemson University with a B.S. in Chemical Engineering and Ph.D. in Engineering and Science

Education. Her research earned her a National Science Foundation CAREER Award focused on characterizing latent diversity, which includes diverse attitudes, mindsets, and approaches to learning to understand engineering students' identity development. She has won several awards for her research including the 2021 Chemical Engineering Education William H. Corcoran Award, 2022 American Educational Research Association Education in the Professions (Division I) 2021-2022 Outstanding Research Publication Award, and the 2023 AIChE Excellence in Engineering Education Research Award.

Dr. Linda DeAngelo, University of Pittsburgh

Linda DeAngelo is Associate Professor of Higher Education, and Director of Graduate Studies and secondary faculty in the Gender, Sexuality, and Women's Studies Program at the University of Pittsburgh. Dr. DeAngelo studies social stratification, investigating how social inequities are produced, maintained, and interrupted. Currently her scholarship focuses on access to and engagement in faculty mentorship, the pathway into and through graduate education, and gender and race in engineering.

"If I didn't do engineering, I might be in a happier place:" A Comparative Longitudinal Analysis of Students Who Consider Leaving Engineering (WIP)

Introduction

This work-in-progress (WIP) empirical research paper uses longitudinal interview data to examine students' decision-making processes in leaving engineering majors. Previous research has presented many reasons why students may leave STEM and engineering; "chilly climates" for students from marginalized backgrounds, difficulty transitioning to college, poor teaching, curriculum design, and cost (financial and time) are among the most cited reasons for switching out of STEM majors [1]. In contrast, engineering education research indicates that engineering identity is pivotal in engineering persistence [2-5]. The process of leaving engineering is more complex than a moment in time or a list of reasons. Using engineering role identity as a conceptual framework, this study investigates the nuances of the (in)decision-making process of leaving engineering. We explore this research question: how do students describe their decision-making processes to stay in or leave engineering?

Engineering Role Identity

According to Godwin, engineering role identity can be measured based on students' beliefs about their performance/competence, recognition, and interest in engineering [3]. Recognition beliefs, students' perception of how meaningfully others view them in a particular role, affect how they see themselves. Interest in engineering is also integral in developing engineering role identity, acting as a motivator to take on the challenges of engineering. Performance/competence is tied to self-efficacy, the belief a person has about their ability to do a task. Performance/competence refers to the belief a student has about their ability to engage in the practice and material of the engineering field. According to Godwin [3], a student's beliefs about their performance/competence in math and science can shape if they view themselves as someone who can be an engineer, which is inherently tied to choosing engineering as a major/career. This study employs engineering role identity as a lens to make sense of student decision-making processes to stay in or leave engineering, considering how recognition, performance/competence, and interest in engineering play a role in those processes.

Methods

The data for this qualitative study were derived from a multi-institutional NSF-funded project that implemented a belonging intervention in first- and second-year engineering courses. The procedures for this project were IRB-approved. The original data were collected using longitudinal phenomenological interviewing with the questions focused on understanding students' experiences related to identity and belonging. The sample used in this study includes interview data over four semesters from eight participants at one of the study sites. The participants shared some similar characteristics: all participants began college in engineering and took an introductory engineering course before entering a specific engineering major or switching their major outside of engineering, they are domestic students, they attend a Public R1 Predominantly White University (PWI) in the Midwest, they have been interviewed every semester for two years, and they all discussed the possibility of changing their major (i.e.,

leaving engineering). The sample is varied in ethnic background and gender: 3 White participants, 1 Black participant, 1 Central American participant, 1 East Asian/White participant, 1 Chinese participant, and 1 Southeast Asian/Peruvian participant; 4 women, 2 men, and 1 non-binary participant. After reviewing transcripts, the authorship team chose two participants to focus on for this WIP: one who considered leaving engineering and stayed, and one who considered leaving engineering and left.

Data Analysis

The authorship team engaged in narrative analysis to compose vignettes illustrating participant decision-making processes that led to their (in)decision to leave engineering. Narrative methodology meaningfully connects events, offering insights about the world and individual lived experiences. [6, 7]. As this study is a secondary analysis of previously gathered data, data collection methods were not specific to narrative analysis [8]. Vignettes were developed from the participants' interviews and shared stories, and the results are denoted in italics with additions for smoothing in brackets.

The team began with an initial inductive review of transcripts with two reviewers for each participant to confirm interrater reliability. Following this, the team discussed the transcripts and emerging themes to determine inclusion for the WIP. The second review was deductive and applied tenants of engineering role identity to develop themes and write initial vignettes. A final review focused on writing vignettes including previously developed themes. The team met between reviews to analyze data as a group and to ensure coding consensus.

Preliminary Findings

The following vignettes illustrate the decision-making process of two engineering students in their third year who have considered leaving engineering: Maria and James. Maria decided to change her major from biomedical engineering to public health during her second semester. James is still an industrial engineering major despite numerous conversations in interviews about changing his major or even transferring to a liberal arts college.

Maria

Maria had been exposed to engineering early on in her life and chose to pursue biomedical engineering because she was interested in designing devices that could improve the lives of people like her swim coach, who experienced a major accident. Following a concussion and a period of reflection at the hospital, Maria discovered that Public Health would allow her to enjoy the content she was learning, feel included as a woman and minority in her program, and fulfill her desires to impact the lives of others holistically.

I took [Project Lead the Way (PLTW) courses] in high school, and I just really liked that [engineering] classes [gave us] the flexibility to create solutions in our own ways. [And] growing up too, I always liked knowing how the things worked. My swim coach was in an accident and was paralyzed from the waist down. And watching him go through all the stuff that he had to change and the different engineers that came in to [help him adapt] was really fascinating. So I was like, I want to do that. [Plus] my parents definitely from a young age pushed that I could explore [STEM] pathways. So coming [to college], I felt like, 'yeah, women

can be engineers, minorities can be engineers', and I also was a part of preview for minority and engineering program, [and wanted to go to a school with a] very highly ranked swim team and highly ranked engineering program. [These were] the big reasons that I chose to do engineering at [institution].

My [first] semester, [I] was just learning how to study [because] the first round of exams was a huge wake up call, [but I got help and used resources,] and after that my exam scores increased significantly. [At the end of my first semester], I [was] just excited to continue to be challenged. [Instead], I got a concussion [in my second semester] and was out for two weeks [which] was a good reflection period. I realized that [in] engineering, I just really was not enjoying the content [and] was more in it for the biomedical side versus engineering. So I switched to public health so I could focus a little bit more on the biology and medical side. I think I [want] my career to incorporate some work with minority groups or improving some of our health disparities that we face. And I do think that is because I am part of a minority group and I like to see and experience that, whereas in engineering last year, I didn't think to even tap into that [part of myself]. [But] one of the reasons I was hesitant to switch [out of] engineering [was] the idea that I could just keep my bachelor's and be very marketable after I graduated, being a female, a minority, [I'd] get a decent job just from that with a pretty decent salary. I just wanted to get my bachelor's and then go into the workforce. But with epidemiology, if I made the switch, I knew I'd have to get my master's as well and possibly my PhD. [So] my plan right now [is] doing the four plus one program to get my MPH.

[Now that I'm in public health], it doesn't feel isolating. I feel like you see a lot more women of color. There's a lot more groups that I have found and a little bit bigger of a community. So I just feel like there's more support going up through the ranks in my new major. I would've just been so much happier if I chose public health in the beginning [of my collegiate career] just because I'm really excited to show up for class and it really excites me.

James

Despite his reservations, James initially chose to pursue engineering due to perceived alignment with his hobbies and interests following input from a high school engineering teacher and mentor. James also felt a high level of expectation from his parents to pursue a prestigious profession like engineering. As he progressed through his degree program, James began to struggle with coursework and social isolation, leading him to consider leaving engineering.

Growing up I always liked to design things and just kind of tinker, see how I could improve and change the world around me. I guess engineering was what came up as a way I could do that. My high school teacher taught engineering through Project Lead the Way, and I'd say he had one of the largest impacts [on me]. I mean, I hung out in his classroom a lot, talked to him a lot. I guess there was always a little bit of pressure or influence from [my] parents. If I would talk about engineering, "Ooh, engineering," they would kind of reinforce it. They just [kept] kind of pushing for that. Maybe it was a little bit of they were trying to live through me kind of thing. But I think that was a major influence honestly. I got into college for engineering. I can't say I was like, I don't know, overly joyful about the entire experience. That's it. I didn't really have high expectations for what I wanted.

I just kind of floated through [last semester]. I didn't do great in math again, I actually got a D. I just don't feel rewarded from going to school at this point. It's just another thing to do. I was diagnosed with ADHD. And the diagnosis kind of made everything make sense, but didn't really help in a way to move forward. It's been hard to find a group that I actually feel very comfortable with. [I'm a first-generation immigrant Chinese American from the Midwest], and I feel like I'm in a very weird middle spot between, I'm not international, so I can't really fit in too well with them, and the [other first-generation immigrant Asian students] come from backgrounds like Bay Area, lots of Bay Area, like band kids. I was never in band. I never had a robotics program at my school or in the area even. Am I really the same as the people that I'm talking to? I can't say I am. But yeah, just trying to not stay secluded, and that is hard.

Maybe it's made me a better person, persevering through hardship or something. But yeah, overall just feel like maybe if I didn't do engineering, I might probably be in a happier, better place. Second semester last year, [I really thought about leaving]. I applied and everything. Small, liberal arts kind of school. [I considered majoring in] some sort of international relations or something related. [But], yeah, I'll finish [engineering]. Sunken cost, might as well. I mean, it would be, I guess, disappointing if I just decided to drop out or change my major at this late into it. I went to college because my parents told me they were setting it up for me to go to college for basically since I was born. It's halfway through, a little more, so I might as well finish it just to say, "Hey, engineering degree."

Discussion

These preliminary findings indicate that while engineering role identity is tied to students' decision-making processes to stay in/leave engineering, it does not *directly* lead to (in)decision. However, weakness in one or more components of engineering identity may lead to insecurity about major choice, triggering the (in)decision-making process. During this process, participants considered multiple factors to decide whether to finish their engineering degree or switch to a different major. For example, despite a lack of interest in engineering content, not feeling competent, and not seeing himself as an engineer, James weighed factors such as sunken cost, time to complete a new degree, and feelings of failure/quitting as more important. Similarly, Maria shared that while she initially thought she was interested in engineering, she discovered she was not that interested in the content. Gendered experiences in the engineering space challenged her perception of being recognized as an engineer. James and Maria have similar beginnings to their stories: both had initial recognition and interest in engineering from high school mentors and experiences; both considered leaving engineering in their first year; both considered the prestige of engineering degrees. Unlike James, Maria decided to leave engineering to pursue her interests.

This study challenges the narrative that leaving engineering is a "failure" or negative process or that staying in engineering is a "win." In this analysis, Maria viewed her decision to leave as a positive. Conversely, James feels forced to stay despite a lack of engineering identity and aspirations outside of engineering: "An engineering degree is better than whatever else."

Conclusion

An analysis revealed that challenges to engineering identity trigger the leaving/staying decision-making process. Future analysis will include reviewing transcripts of additional participants and construction of composite narratives. The goal of this future work is to provide a deeper understanding of not only why students leave engineering but how they make meaning of the decision-making process along the way, contributing rich and nuanced findings to current literature. The stories of these two students begin to provide a rich account of the complex decision-making process that accompanies the decision to leave engineering. Understanding this decision-making process will add to engineering retention literature and is vital to designing support systems to help students reach the right choice for them earlier in the process, easing their path through choice/change to career.

Acknowledgments

Thank you to our team members that contributed to this project: Kelly Tatone, Charlie Diaz, and Kelsey Scalaro.

This study is based upon work supported by the National Science Foundation under Grant No. (2111114/2111513). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

References

[1] E. Seymour and A.-B. Hunter, *Talking about Leaving Revisited: Persistence, Relocation, and Loss in Undergraduate STEM Education*, Springer International Publishing, 2019.

[2] K. L. Tonso, "Teams that work: Campus culture, engineer identity, and social interactions," *Journal of Engineering Education*, vol. 95, no. 1, pp. 25–38, Jan. 2006. [Online]. Available: https://research.ebsco.com/linkprocessor/plink?id=2063a875-0cb9-3a42-9217-4c8cf581ce71.

[3] A. Godwin, "The development of a measure of engineering identity," in *2016 ASEE Annual Conference & Exposition Proceedings*, New Orleans, Louisiana, [Online]. Available: 10.18260/p.26122.

[4] B. M. Capobianco, B. F. French, and H. A. Diefes-Dux, "Engineering identity development among pre-adolescent learners,", *Journal of Engineering Education,* vol. 101, no. 4, pp. 698-716, 2012, [Online]. Available:10.1002/j.2168-9830.2012.tb01125.x.

[5] *D. Chachra, D. Kilgore, and H. Loshbaugh,* "Being and becoming: Gender and identity formation of engineering students," Research Brief, 2008. Available: https://research.ebsco.com/linkprocessor/plink?id=ff42c92d-7364-3628-bdb9-b4cf150bd1e3

[6] J. M. Case and G. Light, "Emerging Methodologies in Engineering Education Research," , *Journal of Engineering Education,* vol. 100, no. 1, pp. 186-210, 2011, [Online]. Available: 10.1002/j.2168-9830.2011.tb00008.x.

[7] L. P. Hinchman and S. K. Hinchman, *Memory, Identity, Community: The Idea of Narrative in the Human Sciences*. Albany, NY: State University of New York Press, 1997.

[8] N. N. Kellam, K. Sweeney Gerow, and J. Walther, "Narrative analysis in engineering education research: Exploring ways of constructing narratives to have resonance with the reader and critical research implications," *2015 ASEE Annual Conference & Exposition,* pp. 1-20. [Online]. Available: https://research.ebsco.com/linkprocessor/plink?id=afd455cb-9c8b-32f5-b9ab-cb10303e051b.