ALUMNI PERSPECTIVE ON THEIR UNDERGRADUATE ENGINEERING LEADERSHIP EXPERIENCES: DEVELOPING HUMILITY, EMPATHY, AND CURIOSITY

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Abstract –Engineering leadership is increasingly recognized as an essential attribute for engineers as they enter the dynamic and complex modern workplace. Increasingly, undergraduate institutions are offering leadership development to their engineering students. The question then follows, as these student leaders graduate and go into their career, did their student leadership experiences help to equip them to be successful in their career? This paper presents the results from a thematic analysis of twelve interviews with alumni student leaders. The results showed that the most influential factors of student leadership were: humility, empathy, and curiosity.

Keywords: engineering leadership, student leadership development, engineering alumni, career success, latent thematic analysis

1. INTRODUCTION

Newly graduated engineers are not only expected to be the technical experts with ethical values, but they are often also responsible for leading the team, meeting the budget, and completing requirements within a specified timeframe [1]. Junior engineers are finding themselves as project leaders early in their career, and there is often a gap between what industry expects and how the junior engineers actually perform [2]. Currently, leadership development can be described as “ad hoc” where engineers are expected to learn on the job, learning “soft skills the hard way” [3], [4].

The importance of leadership development has been recognized in the new student outcomes for ABET (Accreditation Board for Engineering and Technology), which will become effective in the 2019-2020 accreditation cycle. Students must be able to “function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives” [5, p. 40]. With the rise of recognition in the importance of engineering leadership, the field of research

has seen substantial growth, particularly over the past 5-10 years [6]. However, there has been limited follow-up with engineering alumni who were student leaders to better understand the influence of their leadership activities, and the attributes which were most useful as they moved through the first 5-10 years of their career. This paper aims to provide insight into this area. This research was carried out as part of a graduate degree project, and much of this paper comes from Chapter 6 of the thesis manuscript [7].

2. METHODS

2.1. Data Collection and Population

Student leaders at the Schulich School of Engineering who graduate between 2005-2012 were invited to complete a survey with questions on engineering leadership. Student leaders are classified as those who participated on the executive (president, vice-president, or equivalent) of an engineering club, team, or association.

After completing the survey, they were invited to participate in a voluntary in-person interview. The survey was distributed to 51 alumni, 23 alumni completed the survey (45% response rate), and from those 12 alumni participated in an in-person interview (52%).

Table 1 provides a summary of the demographic data on the interview participants. Additional demographic information was collected but has not been reported to maintain the anonymity of the participants. Generally, the alumni participants followed a variety of career paths, including working in technical or consulting roles within their chosen engineering field, or pursuing continuing education and a career in a different professional field (such as law or architecture), as well as a variety of environments including working in the field, the office, part-time, or remotely.

Table 1: Research participants and demographics

		n	p
Gender	Female	6	0.50
	Male	6	0.50
Graduation Year	06-07	3	0.25
	08-09	2	0.17
	10-11	5	0.42
	12-13	2	0.17
Discipline	Chemical	2	0.17
	Civil	1	0.08
	Electrical	5	0.42
	Geomatics	2	0.17
	Mechanical	2	0.17

2.2. Interview Protocol

The data analysis method (thematic analysis) is discussed in the next section, however, it is important to note that the methodologies of data collection and data analysis are tied together and should be chosen in conjunction [8]. For thematic analysis, verbal semi-structure interviews are an appropriate data collection method, with 5-7 topics that the interviewee is prompted to discuss [9]. During the semi-structured interview process, both researcher and participant are actively, reflectively, and analytically determining what should be discussed and how to generate understandings.

Sufficient sample size for interviews is based on theoretical saturation of the data. Theoretical saturation occurs when no new data is being found and when all the main concepts of the phenomenon have been identified and categorized [10]. Although an adequate sample size is difficult to standardize, research has found that generally between four [11] and twelve [12] interviews render accurate results.

The interview questions were used as guidance with the understanding that additional questions and dialogue would occur during the discussions. The interviews were audio recorded (with permission from the participant) to allow the researcher to fully engage in the discussion. An interpretive commentary was prepared immediately following each interview, with the key ideas captured. Full transcriptions were completed, however, it was important to keep in mind that the exact words were less important than recording the meaning the participant was conveying [13]. The transcripts were an interpretation by the researcher and the interviewees were not provided with an opportunity to review them.

2.3. Thematic Analysis

The data collected from the interviews was analyzed using Braun and Clarke's [14] latent thematic analysis. Generally, thematic analysis is a method for identifying, analyzing and reporting themes across an entire data. Thematic analysis is a common approach for analyzing interviews as it focuses on identifying repeated themes

and patterns of meaning [15]. Latent (or interpretive) themes were identified, which specifically seek to go beyond the explicit description of what the participant says, and interpret the features underlying the data to understand the ideas, assumptions, and conceptualizations that give the data meaning [14]. The process is not linear, and should be recursive and flexible in order to fit the needs of the research question and the data [16].

First, the interviews were transcribed, and although scholars describe this process as sometimes feeling frustrating, boring, and time-consuming, it is an important first step in becoming familiar with the data and starting to form interpretations [17]. Next, the data was systematically coded by reviewing the transcripts, identifying interesting aspects of the data [14]. Third, the codes were collated for review, and to consider how they may combine to form overarching themes and a cohesive narrative [18]. Themes should consider both manifest content, directly observable, and latent content, implicitly observed [9]. The fourth step of the process included refining the themes to ensure codes within themes are coherent and each of the themes are distinct. Lastly, the themes were named in order to capture their essence, and reporting on with sufficient evidence from the data that compellingly illustrate their meaning (i.e. interview extracts).

3. RESULTS

The alumni participants were asked a variety of questions about their undergraduate experience and their subsequent early career experiences. The interviews ranged in length from about 20 minutes to 45 minutes, with an average length of just under 33 minutes. The 6 hours and 30 minutes of audio was transcribed to 88 pages of text, just under 52,700 words.

Adhering to the latent thematic analysis methodology, the interviews were analyzed to observe codes and themes across the data. In exploring the influence of engineering leadership and career success, three main themes were observed: humility, empathy, and curiosity (visualized along with sub-themes in Figure 1). Each of these themes are reported below with evidence from the data to illustrate their meaning.

Fig. 1. Themes and sub-themes of engineering leadership and career success observed from the alumni interviews.

3.1. Humility

Within the interviews, the importance of humility as a success factor for engineers came up as three sub-themes: *vulnerability*, *confidence and courage*, and *self-awareness*.

The sub-theme *vulnerability* was prevalent across all interviews, particularly when asked questions about the most important skills they valued in themselves or in other engineers they have worked with. Comments included, “don’t be afraid to look stupid,” “leave pride at the door,” “willingness to be wrong,” and “don’t pretend to know things.” Additional comments within this sub-theme also emphasized a willingness to take on new things, “because you are able to start when you have no clue what you are doing.”

Alumni also talked about how their activities as a student leader helped them to gain *confidence and courage*, specifically in speaking with people who were perceived to be their senior or more knowledgeable. “Lower sense of intimidation talking to higher ups. Confidence. Understanding everyone is a person.” These experiences also helped them to know how to make the most of opportunities and put themselves out there. “Recognize opportunities to stand out. Confidence to make yourself well-known.”

Self-awareness was about the ability to authentically reflect on one’s actions and one’s own personality, including personal development, stress management, and self-motivation. “Being aware that you can’t change other people, but understand how you can change your own skills.” And also understanding one’s impact on others, “awareness that as a leader I can impact others both positively and negatively.”

3.2. Empathy

The three sub-themes within empathy included, *perspective taking*, *clear communication*, and *service to others*.

The most commonly coded concept, mentioned by all interviewees, was the importance of *perspective taking*, or understanding multiple viewpoints. This sub-theme included “understanding where others are coming from to be able to interact better,” “being open to other perspectives,” and “dealing with different personalities.” Simply put, this sub-theme emphasized respecting varied approaches and learning to work with people who are “perfectly lovely but don’t have the same style as you.”

Communication was mentioned frequently as an important skillset in engineering, however specifically the *clear communication* sub-theme emphasized the ability to speak to diverse audiences, and to understand how to communicate one’s ideas. “Communicating effectively to make sure everyone gets on the same page,” and “learning to explain complex technical topics to others” at the appropriate level. Some also mentioned the lack of communication skills observed in new graduates, specifically that they struggled in relating with operators and other non-technical employees.

In being able to empathize, it follows that one typically has a desire to help, or to provide *service to others*. “Give people tasks they will be motivated to accomplish. Understanding what people are passionate about and that it’s different for everyone.” The alumni talked about how their positive undergraduate experience and strong support system helped them, and that they wanted everyone to have this because “everyone struggles and [University] is hard.”

3.3. Curiosity

The sub-themes included in curiosity were *ask questions*, *get a mentor*, and *network*. All of these are rooted in the belief that engineers need to be continuously learning and developing their skills.

The second most commonly coded concept (after *perspective taking*) was *ask questions*, the “ability to listen and question thoughtfully.” This came up often in discussions around the most valuable career skills the alumni saw in themselves or that they observed in others. However, it’s important to note, that it was not just about asking questions, rather it was often a combination of all three themes, being humbly and empathetically curious. For example, “not being too shy to ask questions” highlights the humility and vulnerability required, and “being good at knowing which questions are most important to get answered” highlights the importance of being empathetic towards others and knowing when to struggle alone, and when to ask for help.

Along with asking questions, comes the importance of *mentorship*. For example, “willing to seek out resources

and ongoing education. Seek out more experienced mentor.”

Lastly, *networking* was said to be a critical skill for success in engineering. “Network. It’s all who you know in industry. Networking should be your biggest goal.” The purpose of networking was really to “show you are eager and interested.”

4. DISCUSSION

The three themes, humility, empathy, and curiosity, emerged from the analysis and thus were not known at the beginning of the research to be included in the introduction. This section will provide brief overview of the literature framework for each within leadership and engineering contexts.

4.1. Humility in Literature

Humility can be defined as “a desirable personal quality reflecting the willingness to understand the self (identities, strengths, limitations), combined with perspective in the self’s relationships with others (i.e., perspective that one is not the center of the universe)” [19].

Humility and leadership initially may seem to be two dichotomous terms. Being a passionate leader is often associated with being decisive, powerful, driven, self-assured, and fearless, whereas at the heart of humility is fallibility, vulnerability, transparency, inadequacy and interdependency [20]. Humility is often believed to be a display of weakness, when in reality a quieter, humbler leader has been shown to have a many positive effects on the organization, including organizational sustainability [21] and employee engagement [22].

Vulnerability, an important sub-theme of humility, is described by Brené Brown as “the birthplace of innovation, creativity and change” [23]. The ability to be vulnerable is therefore essential for engineering innovation and change. To be vulnerable, is really just when “we slap ourselves into reality and acknowledge that we are all just people making our way through the murky waters of change.” [24].

Although humility is often defined by self-awareness, it is possible to exhibit accurate self-awareness while still lacking humility by considering others as inferior to oneself [21]. Humility requires both an accurate self-awareness as well as a belief that everyone has worth and should be respected, which leads to the importance of the next theme, empathy.

4.2. Empathy in Literature

Although empathy is sometimes viewed in literature to be a component of humility, here it has been distinguished as a unique theme. Empathy can be defined as the “ability to understand people by perceiving their life situations” and that this increased understanding can “lead to actions

that effect positive change, social and economic justice, and general well being” [25, p. 267].

From as early as 1954 (Bell & Hall), the importance of empathy has been found to have a positive effect on leadership. Goleman, who popularized the concept of emotional intelligence, said that “empathy is particularly important today as a component of leadership for at least three reasons: the increasing use of teams, the rapid pace of globalization, and the growing need to retain talent” [26, p. 100]. An empirical study reviewing empathy and leadership concluded that empathy is an essential aspect of leadership and “can no longer be ignored if we want to prevent continuation of ethical disasters in the business world” [27]. When considering leadership in engineering specifically, there is evidence showing that mathematical and logical intelligence have no correlation with good leadership, but rather emotional availability is one of the most strongly correlated factors for engineering leadership [28].

There is also a recognized need for empathy to prepare engineers for the globalized nature of the twenty-first century challenges (as described in [29], [30]). Human-centered and empathetic design have become increasingly prevalent in literature, which can be defined as an “approach that is directed towards building creative understanding of users and their everyday lives for new product development” [31]. Engineers who engage in empathetic communication can address the challenges of the future through genuine and participatory collaboration with partners and stakeholders [32]. Although empathy is observed as intrinsic to the engineering profession [33], there is lack of explicit instruction in empathetic ways of thinking and a disconnect with the traditional focus on analytical thinking in engineering undergraduate programs [29].

4.3. Curiosity in Literature

Alberta Einstein once said, “I have no special talents, I am only passionately curious.” Curiosity can be viewed as a strong desire to know or learn something. One definition of curiosity is “the threshold of desired uncertainty in the environment that leads to exploratory behavior” [34]. Curiosity is prompted in response to stimuli or activities which are novel, complex, uncertain, or conflicting. Curiosity can be *divergent*, actively seeking out sources of novelty and challenge, or *specific*, actively seeking depth of knowledge in a particular stimulus or activity [35].

Although technical foundational knowledge is important in engineering and science, perhaps even more important is using this knowledge to engage the brain in curiosity through problem solving. It has even been shown that major scientific discoveries are influenced more by a curiosity than by a desire for economic gain [36]. Curiosity is often the motivator for innovation, and most people would agree that good engineers are

inherently curious [37]. This is reflected in the Boeing's list of *Desired Attributes of an Engineer*, which includes as one of the ten attributes "curiosity and a desire to learn for life" [38]. The CDIO syllabus also emphasizes that when teaching students about the process of developing new products, processes, and systems (design-implement experiences), the learning experiences should be designed to generate curiosity and stimulate reflection [39].

5. CONCLUSIONS

An analysis of the reflections from engineering alumni who were student leaders found the most influential aspects in their careers have been: humility, empathy and curiosity. Humility included the ability to be vulnerable, the confidence and courage to stand up, and self-awareness of one's strengths and weaknesses. Empathy emphasized the ability to take others' perspectives, to clearly communicate, and to have a desire to help others. Curiosity underscored the importance of asking questions, seeking mentorship, and networking. Overall, the findings from this research will be beneficial to education institutions and industry organizations looking to develop or refine their engineering leadership programs and workshops.

5.1. Future Work

The themes of humility, empathy, and curiosity came from anecdotal research from engineering student leaders. To test these results, future research could measure these skills in engineering students and engineering alumni, and compare the results with academic and career success. This would provide an understanding if there is a correlation between strength in these skills and success.

Additional future work could look into designing programming to explicitly foster humility, empathy, and curiosity in engineering students. Specifically, it would be important to consider how to effectively foster the skills in larger groups and workshop-style activities.

This research was conducted with participants who were involved in extracurricular engineering leadership activities. Future studies could consider how to integrate leadership training, specifically the development of humility, empathy, and curiosity, into the core engineering curriculum.

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