LEGO SERIOUS PLAY AND THE GRADUATE ATTRIBUTES

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Abstract – *As part of a longitudinal project to integrate career development supports into a biosystems engineering classroom, students engaged in a LEGO® Serious Play workshop and wrote reflections on their experiences. This workshop provided opportunities for teambuilding and deliberations on what constitutes a strong team. A constructivist grounded theory analysis of students' reflections was conducted. Through this analysis, a preliminary theme of Perceptions of Engineering Skill emerged, with three subthemes of the necessity of teamwork and communication to engineering; the vulnerability in making interpersonal connection; and the explicit connection of engineering to creativity. These skills can be conceptualized within the CEAB graduate attributes and theorized within the systems theory framework (STF) of career development, which positions the students' skill development within the larger context of their career. Ultimately, the preliminary findings of this study provide a starting point for further analysis, and for the development of an interview protocol for the longitudinal study this project sits within, with the overarching goal to investigate the impact of career supports and process of career development in a professional degree program.*

Keywords: LEGO® Serious Play; biosystems engineering; CEAB graduate attributes; career pathways; experiential learning; reflections; systems theory framework; constructivist grounded theory

1. INTRODUCTION

1.1. Background and Motivation

In a rapidly changing modern world, career development opportunities integrated into engineering classrooms is one way to provide students with the tools needed to succeed in the workforce [1]. We are implementing career planning supports into a biosystems engineering program at the University of Manitoba through a three-year four-course design spine. This is a

solution-focused method to teach students how to harness their education to develop career pathways [2]. The first set of supports were implemented in the Fall 2019 in Design 1, the first-year design course in the program that employs team-based learning. One support was a LEGO® Serious Play workshop run by two certified facilitators. LEGO® Serious Play is an experiential learning method in which participants use a carefully chosen selection of LEGO® bricks and elements and a unique process that encourages participants to “think through their fingers” [3]. This experiential method [4] was chosen explicitly due to its building and design elements, and perceived affinity with the profession. The workshop was designed to stimulate students' development of investigation, communication, problem solving, design, teamwork, interpersonal and metacognitive skills within a team setting. Once the workshop was complete, students were prompted to complete a one-page written reflection. This paper will give a brief background on the longitudinal study, describe this specific career planning support, and discuss the preliminary findings from the initial analysis of students' reflections on their LEGO® Serious Play workshop experience.

1.2. Career supports and the longitudinal study

The LEGO® Serious Play workshop was one of multiple career supports in which students engaged in the first year of a four year constructivist grounded theory longitudinal study. In the first year of the project, every biosystems student registered for the required Design 1 course in Fall 2019 was exposed to career supports which were integrated into their classes and assignments. In the remaining three courses in the required, sequential biosystems “design spine,” Design 2, 3, and 4, students will be introduced to further career supports (Fall 2020, Fall 2021, and Winter 2022 respectively). Assignments and individual interviews will provide the data for each phase of the project, and students will also be interviewed one year after graduation (Summer 2023).

At this phase of the project (Phase 1), participants have completed Design 1, which included reflective letters, a workshop on embracing a career mindset, a

career planning seminar, an informational interview lesson and assignment, and a module on resumés and competency gaps, in addition to the LEGO® Serious Play workshop. The study design and methodology is further detailed in [5].

1.3. Purpose

The purpose of this larger longitudinal study is to explore the experiences of biosystems engineering students taking required design courses integrated with career development supports [5]. Specifically, the study's objectives are to examine students' experiences as they clarify their identity as professionals, identify their skills, determine their understanding of what a biosystems engineer is, and perceive their possible career futures. The purpose of the present paper is to explore these objectives in the context of students' reflections on their experiences in a LEGO® Serious Play workshop. Further, the work in this paper demonstrates training in the coding and analysis process that will be utilized in the larger longitudinal project. This work is a starting point to inform future data collection in the larger study.

1.4. Ethics

This study was granted approval by the Education/Nursing Research Ethics board at the University of Manitoba. Students whose reflections are examined here all gave their informed consent to participate in this study.

2. LITERATURE REVIEW

2.1. Reflection and Experiential Learning

Reflection has been framed as an important component of effective learning and has been utilized throughout educational settings, including career education and engineering education (e.g. [6-10]). One method of integrating reflection into the learning process, which is used regularly in engineering education, is the experiential learning cycle [4].

The experiential learning cycle is a way of conceptualizing hands-on, reflective learning. Kolb proposes that this is an impactful way to engage in learning, with many educators purposefully embedding the pieces of the cycle into their lesson plans [4]. The cycle includes:

- *concrete experience* (full involvement in the experience),
- *reflective observation* (reflecting on the experience from multiple angles),
- *abstract conceptualization* (integration of newfound understanding into theories), and
- *active experimentation* (application of these theories) [4].

Of particular interest to this study is reflective observation, which is a tool found throughout career development theory and practice (e.g., [11-13]).

Experiential learning in engineering has been linked to positive outcomes in engineering classrooms [6], achievement of learning outcomes [7], positive feedback of students, and increased students' reports of their perceived learning [8]. Extensive research has also connected experiential learning with academic success [9], better understanding of engineering topics [6], [7], [8], and the development of skills sought by employers [10]. It is clear that the experiential learning cycle [4] is useful for higher education and can improve the student experience.

Experiential learning can also be used to conceptualize the processes employed by career educators. This is demonstrated by the LEGO® Serious Play workshop utilized in Phase 1 of this study and central to this paper, where students engaged in facilitated experiences and were then asked to reflect on those experiences. Numerous career theories, though not explicitly linked by their authors, utilize experiential learning techniques to support career development. These include career construction theory [11], constructivism [12], and happenstance [13]. These theories position career development as a process of gaining experiences, then reflecting on these experiences. Ultimately, career development can be understood as a learning process, as the individual learns about who they are and what they want from their career [e.g., 11-13].

3. THEORETICAL FRAMEWORK

Systems theory framework (STF) of career development [14] is the theoretical framework for this study. This is a meta-theory created by Patton and McMahon that pulls together numerous existing career theories into one super system. It emphasizes the interrelationships of all the elements with the complex system influencing an individual's career development, and the iterative interactions within and between all the parts in the system [14]. It provides a framework which conceptualizes the various components of career development, from work to education to individual career identity [15].

The theory is represented as a series of concentric circles (see [14]), situating the individual as central to the system, with personal characteristics such as gender, health, skills, disability, values, and interests that influence the individual's career development surrounding them [14]. A contextual system then surrounds the individual and their factors, which includes the social system (e.g. peers, family, educational institution) and the environmental-societal system (e.g. labour market, location, politics). All of these systems, constantly interacting and changing, impact the

individual's career journey, occur within the context of time, and are influenced by chance events. This is an apropos theory in the context of engineering, reflective of engineering systems thinking [16].

4. METHODOLOGY

The longitudinal study is designed using Charmaz's constructivist grounded theory methodology [17]. Data collection methods will include open-ended qualitative interviews and a series of reflections on career support activities integrated into student coursework, analyzed using the grounded theory constant comparative analysis method [17]. Constructivist grounded theory was chosen because there is little research conducted on the integration of career supports into area disciplines, and the process of students' career development [5]. This methodology provides the opportunity for identifying a low-level theory to illustrate this process [17]. The LEGO© reflection was one of five reflections students were asked to complete in response to the integrated career supports during Phase 1 of the study, all for which students received course credit. For this paper, the constant comparative grounded theory analysis method [17] will be used to analyze and code students' LEGO© Serious Play reflections.

4.1. Research Site

The longitudinal research site is the Design Spine in the biosystems engineering program in the Faculty of Engineering at the University of Manitoba. These are four required courses offered over three years in the biosystems engineering program, an engineering discipline that incorporates biology into engineering [18]. The program has specializations in bioresources, biomedical, and environmental engineering [18]. For this paper, the research site was the Design 1 course offered in Fall 2019. This is a 4-credit hour course that runs for 16 weeks with 3 hours of lectures and 3 hours of labs per week, with emphasis on design, teamwork and communication skills. Career supports were integrated into 10 lectures and one lab in the course.

4.2. Research Participants

Thirty-two students were registered in Design 1 in Fall 2019 and are studying biosystems engineering. They all participated in the career development activities and reflections, including the LEGO© Serious Play workshop and corresponding reflections, as part of their coursework. Eighteen students volunteered to participate in the longitudinal study by sharing their coursework. These students' LEGO© reflections are analyzed here.

4.3. LEGO© Serious Play Workshop

The LEGO© Serious Play workshop was offered in the first month of the course, during one consecutive

lecture and lab. The instructors had applied for and were awarded monies from a faculty endowment fund, which enabled them to purchase 30 LEGO© kits and hire two certified facilitators to orchestrate the workshop. The facilitators, who own a company called Brickstorming, provided an interactive platform for students to get to know their design team members, whom they would collaborate with throughout the term.

The class was divided into two, with half of the students remaining in the course classroom, and the other half moving to an adjacent classroom. Small clusters of tables and chairs were arranged in advance, and students sat in these clusters in their design teams of four. Each student was given one LEGO© kit to use for the workshop. The facilitators instructed students to individually build a number of different physical metaphors out of LEGO©, which were then used to facilitate team discussions on students' personal values of teamwork, perspectives on what makes a strong or weak team member, and considerations of diverse perspectives, ultimately facilitating team members getting to know one another [3]. At times, students were asked to present their ideas to the larger group in their classroom. The workshop lasted 2 ½ hours.

4.4. Student Reflections

In the lecture immediately following the workshop (i.e., two days later), course co-instructors gave a mini-lecture on reflection and on the CEAB graduate attributes. Then students were asked to write a one-page typed reflection responding to the following prompts:

- What surprised you?
- What did you enjoy?
- What didn't you enjoy?
- What does this tell you about yourself?
- What did you learn?
- How can you apply this to working on a team? To designing?
- What did you learn about your values in regards to teamwork?
- How did you feel?
- What will you take with you as you move through this course? This program?
- What is the relevance to engineering? [19]

The reflections were due the following week. For this study, only the reflections of students who provided their informed consent to participate were analysed (n=18).

4.5. Data Analysis

Constructivist grounded theory constant comparative analysis [17] was used to analyse student reflections on the LEGO© Serious Play workshop. The first two authors began by independently coding the first five reflections, progressing from initial coding to focused coding. They both memoed throughout [5], tracking perceptions, feelings, ideas, and noting biases that could influence the

analysis, as practiced in constructivist grounded theory [17]. Initial coding included in vivo codes, which are quotes taken directly from participants' reflections, and gerunds, which are "ing" words capturing actions present in the data [17]. As the researchers continued their analysis, focused codes emerged from initial codes. Focused codes are more abstract than initial codes, and are initial thematic connections between ideas found amongst participants [17]. The first two authors then met to discuss our initial processes and findings, and compare the preliminary themes that were beginning to emerge. Following this meeting, we continued to code the remaining 13 reflections, using constant comparative methods and memoing. We then met for a second time, this time with support of the third author, to continue our discussion on the theoretical categories emerging from the data. During that meeting, one of the strongest emerging themes as agreed upon by all three authors was selected as the focus for this paper. However, further analysis on these reflections will continue in the future within the context of the larger longitudinal study.

5. FINDINGS

Multiple themes emerged from students' LEGO© reflections. This paper will focus on the theme *Perceptions of Engineering Skill*. This was a major theme amongst participants, both connected to and beyond the explicit CEAB graduate attributes. Specifically, within this theme, emerged the subthemes of the importance of teamwork and communication to engineering; the vulnerability in making interpersonal connections; and the explicit link of creativity to engineering.

5.1. Teamwork and Communication

In students' written reflections, the notion of teamwork and communication as essential skills to engineering were found in the majority of reflections, and are demonstrated in the following quotes:

[Participant 14] I learned that I really value cooperation and communication in a team. Even if everyone works hard, if they are not telling each other what they are doing, and helping each other to cover each task, it is extremely difficult to organize and push the project forwards. Using open communication as a base allows the team to flourish and work together successfully towards their goals.

This theme is also captured in the following quote:

[Participant 15] The lessons I learnt from the workshop addressed competencies that I would need to possess to remain relevant in an ever-changing world like the need for effective communication, the need for trust in teams and the need to keep an open-mind to the suggestions of others.

5.2. The Vulnerability of Interpersonal Connection

Students wrote about the importance of open communication to achieve effective teamwork, while at the same time noting that they struggled with interpersonal connections and feared sharing their ideas. As one student explained:

[Participant 3] I tried to be as open as possible during the workshop, but sometimes I hesitate in moments I'm not really comfortable with. I can't help it as I realize that I take it slow in making new friends and that means I open myself bit by bit, even though the situation is a bit awkward at times.

Another student shared:

[Participant 16] I learnt that I can work on a team so long as we communicate early on and through the task/project. Naturally I'm largely imperceptive to social cues, so I will have to make sure to pay attention to my teammates and their feelings.

Students used words like "awkward" and "struggle," demonstrating their vulnerability, and in conjunction, used the word "improve." They identified their current skill-level, or lack therein, and noted a need for improvement for success in school and in their profession. Many looked forward and identified effective communication and interpersonal skills as determinants for success in their futures:

[Participant 8] Throughout this course, I will learn to communicate my ideas more effectively. Oftentimes I am afraid of sharing my opinion as I feel like I will get shut down or my ideas are rejected. Hopefully, I will learn a more efficient way to express my words when speaking to others in order to get my point across. This skill will be useful throughout the rest of my studies in university and will be especially beneficial in a career-based setting.

5.3. Creativity

Finally, creativity emerged as an additional and important engineering skill in one third of student reflections. Students made statements directly connecting engineering to creativity:

[Participant 2] The foundation of engineering is to utilize creativity and knowledge to help a society.

Or, as another student wrote:

[Participant 6] I believe this workshop had a great relevance to engineering, since both creativity and teamwork are essential parts of being a successful engineer.

Students explicitly connected creativity to the engineering profession, using strong language, such as "foundation," "essential," "functional," and "succeed" to underscore the importance of creativity. Creativity was positioned as a necessary skill that facilitated success in engineering.

6. DISCUSSION

6.1. Connections to the CEAB Graduate Attributes

Students made explicit links between their own skills utilized in the workshop and the CEAB graduate attributes, and they also identified additional skills they believed were essential to practicing engineers. As a teambuilding exercise, it is no surprise that students shared their thoughts related to the individual and teamwork CEAB graduate attribute. There was also explicit discussion of communication skills, often in the context of effective teamwork. At the same time, students positioned themselves as needing to develop their interpersonal skills in the context of demonstrating effective communication skills and thus, teamwork. They disclosed vulnerability, expressed as feelings of awkwardness, fears of connecting with others, and the challenges associated with working with other people. While participants aligned themselves with skills they perceived as essential to their profession, they also positioned themselves as not fully skilled in the attributes they perceived as required to be successful in the field. This gap between what is perceived as required to be an engineer and participants' existing skills will be explored further in the larger study.

Students also expanded on the competencies they felt were necessary to engineering, writing about the value of creativity. Though not an explicit CEAB graduate attribute, educators have argued creativity is a meta-attribute [20], an overarching competency that is inherent in, and comprised of multiple attributes. This sub-theme in students' reflections emerged out of the reflection prompts, but was not explicitly mentioned in them. As creativity is not one of the CEAB graduate attributes, it was also not mentioned in the mini-lecture preceding students' LEGO© reflection assignment. Still, one third of participants expressed a strong and clear notion that creativity was fundamental to their skillset as engineers. This sub-theme will be explored with participants further through the open-ended qualitative interviews that will be conducted for Phase 1.

6.2. Connections to Systems Theory Framework

Systems theory framework (STF) for career development can be used to understand and conceptualize students' perceptions of their own skills and the skills they perceive necessary for engineering. Most obviously, skills are one of the influences related to the self at the centre of STF. Within this framework, skills, specifically creativity and the communication and teamwork skills identified by participants, influence all other areas of the system [14]. Identifying one's skills and then connecting these skills to occupations is considered an important

piece of the career planning process [21]. This is reflected in students' reflections, where they connect their own skills, and the skills they need to develop to becoming and being an engineer.

Additionally, in STF, individuals are situated within the social system of their peers. This is seen in this LEGO© workshop where students exercised their skills with, and through collaboration and communication with their peers. Peers were also the source of students' vulnerability, fears, and discomfort as they recognized their developing – or the gaps in their – interpersonal abilities.

Finally, students located themselves within the broader context of the engineering profession, the social system of colleagues, recognizing the skills they felt the broader community of engineers require. As students explicitly stated the skills required for career “success,” they also positioned their skill development within the environmental-societal context of the labour market, where these skills are seen as essential for future employment. This future-oriented perspective on what is needed for career success also situates participants' career journeys within the context of time as proposed by STF. Ultimately, students' perceptions of the future influenced their reflections on their current skills.

6.3. Informing Further Research

The preliminary theme, *Perceptions of Engineering Skill*, provides initial insight into the ways in which students' conceptualize their skill development within the larger engineering profession. The preliminary findings of this analysis will be used to inform the open-ended qualitative interview protocol which will be used to interview participants for Phase 1, and after each phase in the larger longitudinal study. In particular, the contrast between existing competencies of the students and the skills students deem essential to engineering merits further exploration. As students, the participants are by definition learning to be engineers and not yet official members of their profession. They appear to be undergoing the development of their engineering identities [22]. This study will provide the opportunity to learn more about how students experience this process, particularly noticing engineering skills they perceive they lack, identifying skills they perceive as required for the profession, and connecting their existing competencies and identities to their perceived understanding of the engineering profession.

7. CONCLUSIONS/IMPORTANCE FOR MEMBERSHIP

This paper explored students' reflections on their experiences with an experiential learning method, LEGO© Serious Play, and focused on one initial theme emerging in the data, *Perceptions of Engineering Skill*.

Preliminary findings show subthemes of students' perceptions of engineering skills, with students noting the importance of effective communication skills for effective teamwork; their vulnerability in making interpersonal connections; and the connection between engineering and creativity. These subthemes can be conceptualized through, and provide insight into students' understanding of the CEAB graduate attributes. Further, these preliminary findings can be theorized within STF, positioning students' skill development within their overall career development and the wider social and environmental-societal contexts of their peers, engineering colleagues, and the wider labour market. The overall conclusions from this preliminary work can be used to inform the development of the interview protocol that will be designed to conduct open-ended qualitative interviews with Phase 1 participants. It is the first step in analysis for the larger longitudinal study this project sits within.

Through the implementation of career supports in a biosystems engineering program, we aim to promote understanding of the self and the establishment of a career direction for engineering students. Through awareness of one's skills it is anticipated that students will develop the ability to communicate the knowledge, skills and attributes needed to successfully secure and maintain a career, and grow professionally in a complex, and rapidly changing world.

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