Biosystems engineering students' experiences and perceptions of self-reflection and e-portfolios

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ABSTRACT

Biosystems engineering students at the University of Manitoba participated in a voluntary workshop series as an extracurricular professional development opportunity. The five-workshop series was designed to engage students in reflection and self-reflection as a foundation for the development of e-portfolios to document their learning over time. Following the workshop series, focus group interviews were held with voluntary participants to explore their perceptions and experiences with self-reflection relative to e-portfolios. Themes that emerged from the focus group data related to i) the value of self-reflection as an activity, ii) the value of e-portfolios for career success, iii) observations of the biosystems engineering curriculum and iv) concerns about the status of the biosystems engineering discipline in the engineering community. The motivations to consider an e-portfolio were immediately focused on job-finding, and within that, on clarifying biosystems engineering both to themselves, to other students outside of biosystems engineering, and employers.

RÉSUMÉ

Des étudiants en génie des biosystèmes de l'Université du Manitoba ont participé volontairement à une série d'ateliers dans le cadre d'une offre de développement professionnel hors programme. La série de cinq ateliers a été conçue pour inciter les étudiants à réfléchir et à faire de l'introspection en vue de développer des portfolios électroniques pour documenter leur apprentissage au fil du temps. Après la série d'ateliers, des entretiens de groupe ont été organisés avec des participants volontaires afin d'explorer leurs perceptions et leurs expériences d'introspection liées aux portfolios électroniques. Les thèmes qui sont ressortis des données recueillies lors des discussions de groupe étaient liés à i) la valeur de l'introspection en tant qu'activité, ii) la valeur des portfolios électroniques pour la réussite professionnelle, iii) les observations du programme d'études en génie des biosystèmes, et iv) les préoccupations relatives au statut de la discipline du génie des biosystèmes dans la communauté des ingénieurs. Les motivations pour envisager l'utilisation d'un portfolio électronique étaient directement axées sur la recherche d'emploi et, dans ce contexte, de clarifier ce qu'est le génie des biosystèmes tant pour les étudiants eux-mêmes, que pour les étudiants d'autres disciplines et pour les employeurs.

INTRODUCTION

The transition from an input- to an outcomes-based engineering accreditation system in Canada has caused engineering educators to focus on the outcomes of their teaching efforts (and not just their students' grades) as a profession. We have been educating ourselves about the 12 graduate attributes specified by the Canadian Engineering Accreditation Board (CEAB) and how to assess student competence in each of these attributes. Furthermore, we have committed our institutions to a continual improvement process intended to improve our engineering programs' quality. It is imperative that we not forget to consider the curriculum and/or program changes that could improve student learning. It is generally acknowledged that students will gain a better understanding of the knowledge that they have gained from an educational program through the process of self-reflecting upon those educational experiences and achievements. The portfolio (which is referred to as an e-portfolio if created and stored in a digital environment) is the tool most often used to achieve this goal of self-reflection.

Anecdotally, there is evidence that engineering employers have neither a clear nor consistent understanding of the knowledge and skill set of biosystems engineers. By default, engineering employers may hire mechanical, civil, or electrical engineers where a biosystems engineer may have been just as or more suitable. Furthermore, there is anecdotal evidence that biosystems engineering students often do not have a clear sense of their professional identity, which may lead to uncertainty in how they understand their future opportunities and market themselves to the employment sector. It was envisioned that the preparation of an e-portfolio documenting educational experiences and achievements would be a valuable tool to biosystems engineering students when applying for engineering jobs.

The objective of this project was to introduce biosystems engineering students at the University of Manitoba to self-reflection, and the preparation of an e-portfolio through an extracurricular professional development opportunity as a means of documenting their educational experiences and achievements within the context of the CEAB graduate attributes to facilitate both learning and subsequent career development.

In the 2018-2019 academic year, biosystems engineering students were invited to participate in a five-workshop series. The workshops were organized i) to introduce biosystems engineering students to the purpose and art of self-reflection, ii) to describe self-reflection in the context of the CEAB graduate attributes, iii) to introduce the e-portfolio tool, iv) to develop the skill of self-reflective writing, and v) to demonstrate the link between e-portfolio development and career success. Following the workshop series, focus group interviews were held with voluntary participants (workshop attendees) to examine their perceptions and experiences with self-reflection relative to e-portfolios.

BACKGROUND

This work was built on two distinct but complementary concepts: e-portfolios and self-reflection, and their benefits in a biosystems engineering program.

E-portfolios in student learning

A portfolio can be defined as a "purposeful collection of student work that exhibits the student's efforts, progress, and achievements. The collection must include student participation in selecting content, the criteria for selection, the criteria for judging merit, and evidence of self-reflection" (Paulson et al. 1991). An e-portfolio is simply an electronic version of a portfolio. As such, an e-portfolio could contain electronic artifacts, such as videos to complement textual artifacts.

A portfolio is distinctly different from the logbook or design journal, a staple in engineering design courses and research endeavours. Logbooks are typically used to document and keep a daily record of ideas and progress in a design or research project, with a potential role as a legal document in intellectual property protection. Logbooks and design journals typically focus on processes more heavily than outcomes. By contrast, a portfolio is often more heavily focussed on end-points or outcomes, but in doing so, it requires engaged self-reflection in a way that a logbook or design journal may not. However, on a case-by-case basis, portfolios may be characterized by one of several interconnected systems: an archive of student work, documentation of outcomes achieved, and an environment for students to reflect and offer their stories of learning (Barrett 2005).

Chye et al. (2019) described three categories of portfolios, each having distinct purposes. Learning portfolios are intended to reflect upon what they have learned and document growth in their understanding of curriculum content. Credential or certification portfolios are designed to demonstrate a student's proficiency in curriculum content and readiness to contribute to their chosen profession. Employment portfolios are intended to showcase the student's abilities to prospective employers. These authors indicated that many variations in portfolios (i.e., combinations of purposes) have emerged in the discipline of teacher education depending on the pedagogical goals established by different institutions. It is likely not reasonable to expect students to complete multiple versions of a portfolio to satisfy various purposes; it is incumbent upon educators to suggest a portfolio structure that addresses all of the intended purposes.

The purposes of portfolios in post-secondary learning are numerous and varied and include acting as a place to display collected work for a permanent record, acting as a learning mechanism to foster active learning and/or self-reflection, acting as a student assessment platform, and supporting career development by consolidating evidence of knowledge and skills for a future employer (Barrett 2005; Carmean and Christie 2006; Fasina et al. 2015; Knott et al. 2004; Hartnell-Young 2006; Lam 2020). Knott et al. (2004)

described a pilot e-portfolio project at Virginia Tech. Members of Virginia Tech identified the e-portfolio as an ideal tool to support and enable student reflection. Still, it was also recognized as an excellent tool for the professional development of students (Knott et al. 2004). Fasina et al. (2015) wrote an article in *Resource* magazine that highlighted the benefits of incorporating e-portfolios into student learning. Their article described experiences using e-portfolios for biosystems engineering students at Auburn University. This experience is particularly relevant to our biosystems engineering students, given that both learning experiences and career development challenges are similar. Our literature review found an entire book entitled "*E-Portfolios in Higher Education: A Multidisciplinary Approach*" (Chaudhuri and Cabau 2017) that provides a wealth of knowledge regarding e-portfolios. This book provides a historical background of the development of e-portfolios for assessment purposes (part one), case studies of the implementation of e-portfolios for assessment at the course level (part two), and the institutional perspective of using e-portfolios (part three). A key emphasis of this book is the utilization of e-portfolios for the purpose of outcomes assessment.

While the literature identifies portfolios as a beneficial tool to support and enable student reflection, students' professional development, and students' understanding of the curriculum, it can also create more stress in already crowded curricula. Yang et al. (2016) interviewed first-year students at a university in Hong Kong who had been required to complete an e-portfolio in three core courses. These researchers reported that students exerted minimal effort in writing reflective journals and regarded e-portfolios as "unhelpful for learning." Implementation of the e-portfolios contributed to these perceptions as insufficient course credit was allocated to the e-portfolios in these core courses and students typically received feedback only after the final submission of the e-portfolios (Yang et al. 2016). Given these conditions, students tended not to see much value in the e-portfolios; they expended a minimal amount of effort, and some admitted that they could write 'acceptable' reflections even if they had not completed the learning activity. Yang et al. (2016) recommended that a strengthened formative role was necessary to foster productive learning; otherwise, the e-portfolio may simply be perceived as 'busywork' to students. Some researchers advocate that the benefit of portfolios is derived from voluntary participation in terms of the advantage students gain by choosing to maintain the portfolio (Knott et al. 2004). The workshop series used in this project was designed with this approach in mind – that is, to provide students with the tools to develop a portfolio on their own, outside of the formal curriculum.

In programs subject to accreditation requirements, which includes engineering programs in many parts of the world, including Canada, portfolios also offer a platform by which to demonstrate the 12 graduate attributes defined by the Canadian Engineering Accreditation Board (i.e., knowledge base for engineering, problem analysis, investigation, design, use of engineering tools, individual and teamwork, communication skills, professionalism, the impact of engineering on society and the environment, ethics and equity, economics and project management, and lifelong learning) (Canadian Engineering Accreditation Board 2020). Engineering educators are reasonably confident in their ability to assess a student's competence in the knowledge required to be an engineer through typical examinations. However, growth in attributes such as professionalism, ethics and equity, and lifelong learning are difficult to assess using typical assessment measures. Such growth arising from activities and assignments embedded into the curriculum could be documented using a portfolio. Thus, the graduate attributes offer one framework by which its author could potentially organize a portfolio.

Reflection and self-reflection

A defining feature of portfolio development is the engagement of meta-cognitive processes – i.e. thinking about thinking – and in particular, reflection and self-reflection. To contextualize reflection and self-reflection in this work, the basic premise is that any kind of learning is - by definition - active, and reflection is one proactive approach to the learning process. Reflection requires active engagement to examine one's responses and beliefs. It is often triggered by a new, unusual, or perplexing situation or experience, and it can result in the integration of new understanding into one's experience (Rogers 2001; Turns et al. 2014).

Where reflection may be directed in any direction, self-reflection is reflection intentionally turned inward onto oneself. It is introspective, with careful thinking about your feelings, behaviours or beliefs and the reasons behind them. By contrast, critical reflection is a critique or examination of the assumptions on which one's own beliefs, thoughts, and identity have been built. Critical reflection is built on a foundation of self-reflection (Turns et al. 2014).

In personal and professional life, reflection and self-reflection can be undertaken in many informal and formal ways. Informal ways may include scribbling or jotting notes or mapping project ideas as ideas emerge and talking to oneself to organize and analyze an issue and illuminate priorities and values. More formal means may include journaling for personal use and blogging and sharing with others. These and other techniques for reflection and self-reflection can help process thoughts and feelings, crystallize insights, illuminate priorities and values, examine principles and beliefs, and claim agency. Five benefits of self-reflection are personal growth, self-expression, problem-solving, stress-reduction, and critical thinking (Hiemstra 2001).

When considered more specifically toward a student's post-secondary experiences and preparation for a post-graduation career, self-reflection can help examine and break down professional stereotypes and practices and help a student craft an identity for themselves in the profession and gain confidence from it (Smith 2011). In practice, this may include: i) becoming aware of personal and social

influences that affect one's learning, ii) testing and sharing contributions, iii) envisioning new ways of doing things, iv) examining one's role in a team, class, cohort, school and profession, v) solidifying one's interests and goals, and vi) creating one's story out of one's individual post-secondary experiences as one looks toward a post-university career. These are also reflected in Schön's concept of a reflective practitioner, linking reflection and expert professional practice (Schön 1987; University of Waterloo 2020). Experience alone does not ensure learning. Instead, experience without reflection may "reinforce stereotypes, […] offer simplistic solutions to complex problems, and generalize inaccurately based on limited data" (University of Waterloo 2020). Experience coupled with reflection can act to place new experiences within existing conceptual frameworks, solidify new knowledge, and re-organize existing knowledge.

METHODOLOGY

This work consisted of two distinct phases. Phase one was a workshop series developed and delivered to biosystems engineering students at the University of Manitoba. The workshops were organized i) to introduce students to the purpose and art of self-reflection, ii) to describe self-reflection in the context of the CEAB graduate attributes, iii) to introduce the e-portfolio tool, iv) to develop the skill of self-reflective writing, and v) to demonstrate the link between e-portfolio development and career success. Phase two consisted of examining students' perceptions and experiences with self-reflection relative to e-portfolios and their broader engineering studies using a focus group methodology.

The study site was the biosystems engineering program at the University of Manitoba, a large, research-intensive university in western Canada. The University of Manitoba enrolls approximately 1850 undergraduate and 500 graduate students per year across five departmental engineering programs (biosystems, civil, computer, electrical and mechanical) and a common preliminary year. The discipline of biosystems engineering emphasizes applying engineering principles to biologically-based systems. The biosystems engineering program is designed to give students knowledge of the fundamental principles of engineering. It introduces biological concepts to enable these engineers to successfully interact with relevant professionals when solving engineering problems involving biological systems. The department offers three specializations (biomedical, bioresource, and environmental), and the program is offered in both traditional and cooperative education formats. Approximately 160 undergraduate students were enrolled in the biosystems engineering program as of September 2020, with a cap of 48 new students admitted each year.

Workshop series

Five workshops were delivered to biosystems engineering undergraduate students in the fall of 2018. These workshops were designed to introduce students to self-reflection and creating an academic e-portfolio. The workshops were held during the weekday when most students would not have classes or labs. All biosystems engineering undergraduate students were invited to participate in the workshops as a professional development activity. No inducement nor reward was offered for participation, and no penalty was levied for not participating. A light meal was served (pizza or sandwiches) given the time of day.

The series was designed by a graduate student and faculty member and delivered by the graduate student, three faculty members, and a co-op/internship program staff member in various combinations. Each workshop was approximately 60 min long. The content of each of the five workshops was detailed in previous work (Soriano et al. 2019) and is summarized below. Attendance at the workshops ranged from 22 to 24 students, which correlates to approximately 15% of the biosystems engineering student population.

- Workshop #1: The Purpose & Art of Self-Reflection. The workshop addressed the importance, forms, and benefits of critical self-reflection with an emphasis on personal growth, development, and self-expression.
- Workshop #2: Self-Reflection in the Context of Graduate Attributes. The workshop introduced students to the 12 graduate attributes and provided an overview of where each of these attributes is being developed within the biosystems engineering program.
- Workshop #3: Introduction to e-Portfolios. The workshop introduced students to e-portfolios and discussed the benefits associated with developing an e-portfolio. Four e-portfolio software platforms (i.e., Seelio, Google Sites, Weebly, Wix) were reviewed and compared using the unranked paired-comparison technique (Soriano et al. 2017).
- Workshop #4: Development of an e-Portfolio. This workshop linked e-portfolios with reflective writing. Students were provided with several examples of self-reflection writing assignments related to the 12 graduate attributes. In the workshop, they were given an opportunity to practice writing a self-reflection for their e-portfolio to link learning with practice.
- Workshop #5: Demonstrating and Articulating your Skills and Experience for Career Success using an e-Portfolio. This workshop discussed potential content and the mechanics of developing an e-portfolio as an undergraduate biosystems engineering student. Further, e-portfolios were presented as a powerful tool in a job search, including interviews, networking events, or developing a resume. Students were provided with strategies for connecting their e-portfolio with their resume/CV through story-telling.

Focus group research

Qualitative methodology is an inquiry of understanding a social or human experience or phenomenon, with the purpose to understand and relate actors' perspectives and experiences as they live and feel them, and they generate deep meaning. The focus group is a typical strategy to

collect qualitative data (Morgan 1996, Krueger 1988, McCracken 1988). A focus group is a "carefully planned discussion designed to obtain perceptions on a defined area of interest in a permissive, non-threatening environment. […] Group members influence each other by responding to ideas and comments in the discussion" (Krueger 1988, p. 18). Essentially, the researcher facilitates discussion within a group interview comprising a small number of demographically similar people in a natural setting. Within the discussion, the topics are carefully predetermined, sequenced, contextualized, and framed within open-ended questions and probes (Krueger 1988). The data produced is qualitative, in which participants provide insights into their attitudes, perceptions, and opinions. Direct quotes of participants are sampled to indicate the rich description in the data (Creswell 1994; Bogdan and Biklen 1998). It is considered an appropriate technique in evaluating programs and initiatives (Taylor and Bogdan 1998; Krueger 1988).

Qualitative research is not often applied in engineering research, yet this relative absence does not make it an inappropriate approach. Engineering research tends to be grounded in a contrasting methodology, namely quantitative methodology, which is (in very broad strokes) an inquiry into a social, human, or technical problem, based on testing a theory composed of variables to establish verifications and generalizations. Frequently, quantitative inquiry goals and outcomes are to establish a fact, show statistical relationships, or determine whether predictive inferences of a theory hold (Creswell 1994; Bogdan and Biklen 1998).

The qualitative inquiry may have an overarching concern with process, while the quantitative inquiry has an overriding concern with outcome or product (Hittleman and Simon 1997; Glesne and Peshkin 1992). Quantitative work is well-suited to determine *what* is happening, whereas qualitative work is well-suited to determine *how and why* it is happening from the participants' perspectives. The qualitative tradition has established its own set of norms that govern how research is carried out to ensure that the researcher engages in a systematic, rigorous inquiry of sufficient depth and commitment into the subject matter. This ensures that the researcher can extract real meaning from the participants and develop credible interpretations and theory (Creswell 1994; Taylor and Bogdan 1998).

Students were recruited from the workshop attendees to participate in focus groups held in early 2019 voluntarily after the workshop series. The researcher recruited participants to the focus group session via an email written in a jargon-free language which outlined the nature and purpose of the research. The researcher invited those interested in participating in a focus group to contact them. The researcher followed up with full information on the research and solicited informed consent for those who expressed further interest. The wording of all recruitment materials complied with University of Manitoba Research Ethics Board approval. All participation was entirely voluntary, and no compensation was offered for participation. Five of the 22-24 students who attended the workshops participated in three focus group sessions.

Each focus group was 45-90 minutes duration and took place in a meeting room in the Price Faculty of Engineering at the University of Manitoba. The focus groups were open-ended long interview format. They were used to collect data on participants' perceptions and experiences with e-portfolios and self-reflection on their engineering studies more broadly.

The researcher moderated the focus group. This role entailed presenting the focus group questions, following up with probing strategies, guiding the discussion and transitions, and maintaining a relaxed and open atmosphere that invited positive and negative perspectives. The focus group interviews were audio-recorded, and the researcher created notes during and after each event. The audio recordings were professionally transcribed by a third-party service and returned to the focus group participants for member checking. A coded system was employed to maintain the anonymity of the participants. Data analysis relied on the transcripts and the researcher's notes.

FINDINGS

In keeping with the qualitative approach used in this work, findings are presented thematically, with extensive quotes from the participants to demonstrate the range and fullness of the data. The results have been grouped into four sub-sections reflecting four themes that emerged from the focus group transcripts: i) value of self-reflection, ii) value of e-portfolios for career success, iii) observations of the biosystems engineering curriculum and iv) concerns about the status of the biosystems engineering discipline in the engineering community. The first two sub-sections align with the themes anticipated based on the focus group script that had been developed. Not surprisingly, the discussion within the focus group sessions extended to topics beyond the scripted questions – leading to unanticipated information regarding student perceptions of the biosystems engineering curriculum and student fears about how the discipline of biosystems engineering is perceived within the larger engineering community.

Value of self-reflection

Participants discussed the value of self-reflection and discussed e-portfolios as a way to engage in and demonstrate self-reflection. Several participants' responses centred on a personal goal of increased self-awareness, to "*help clarify what my goals should be and what I should try to be noticing about my learning. It definitely helps understand what I'm being taught in the big picture*" (P3).

Other participants concurred, saying, "*I realized you can actually sit down and think about it for a while, thinking about experiences and things that you've learned and how you grew from that, or knowing either how you're feeling or why you're doing something a certain way, or what the reason is for your difficulties*" (P3) and "*thinking what you've been through in classes and at your work, and how you overcame those obstacles and learning from it, it's important to stop and think, gather yourself and organize*

your thoughts, the lessons you've learned, if you need them again, it's important to have them organized" (P4).

This awareness also extended to the CEAB graduate attributes and having a context within which to understand them. One participant commented, "*if I don't have a big picture, I can get caught up in the details*" (P3), while another stated, "*when you read it, you're like 'oh, this should be something I get out of this' [...], and it's important to be able to take certain skills that you've learned and not necessarily need a title for yourself*" (P5).

Value of e-portfolios for career success
E-portfolios were seen as valuable for their ability "*to put a lot of information on here that you would not put on your resume*" (P2). Yet, the participants echoed the comment that the most significant barrier to completing an e-portfolio is that "*it sounds like a lot of work* (P2)*,*" particularly when it was not a required element of the curriculum and had to be scheduled into free time. Participants' comments also showed them considering how an e-portfolio would differentiate itself from other forms of self-reflection and demonstration of one's academic competencies, such as a personal website, or a social media presence such as LinkedIn, and other forms of personal self-reflection including journaling, design and sketch journals, writing, and creative expressions like music.

Yet, the motivations for considering an e-portfolio were immediately focused on job-finding for the participants. Within that, on clarifying biosystems engineering both to themselves, to other students outside of biosystems engineering, and employers. One participant commented that the workshop series "*helped me think about how to market myself*" (P3). At the same time, another observed that "*I'm starting to look for summer jobs, and I was thinking of a different way to advertise myself*" (P4). Another remarked that "*the general idea of having your work recorded somewhere that someone can look at, it's a good idea*" (P2), and "*it's really good practice for me to express myself in a different way. Being able to explain biosystems engineering with the environmental specialization in it is a little bit different than something that a specific environmental engineering student would take, but I tried to look at it as an advantage and value that perspective*" (P5).

Observations of the biosystems engineering curriculum
Participants perceived a curriculum focused on theoretical knowledge over specific skills. Therefore, they expressed uncertainty in what specific and practical skills they have to offer employers, and they said they lacked confidence in asserting skills to an employer. One participant remarked, "*engineering courses can be very theoretical, but I feel like in the past year, I've taken a lot of courses that I was able to then extract a skill to be able to put it on my resume and talk about it, like SolidWorks in our CAD course or taking our computer science course and learning Python*" (P5). Another noted that "*I find our department doesn't do as much hands-on stuff as I was expecting. When I was younger, when I thought of engineering, I definitely thought*

more building and actually making things, and I've found we've done a lot more theoretical work" (P3). At the same time, another added, "*I think the design stuff starts in the 4000 level classes. The third-year classes feel theoretical and lab-based*" (P4).

Concerns about the status of the biosystems engineering discipline in the engineering community
Further, participants expressed uncertainty and lack of confidence in marketing themselves as a biosystems engineering student or graduate to an employer. These uncertainties included a heavy comparison of their program to mechanical engineering students they see as their primary competitors for jobs and perceive as receiving more advanced design content in their degree than biosystems engineering students. Participants also expressed a perceived lack of understanding among employers of what sets biosystems engineers apart from other disciplines.

One participant noted, "*one of my biggest challenges is selling biosystems to employers*" (P1), while another observed, "*I'd like to see a change in the way people think about biosystems. Employers still don't understand what we're doing*" (P4). A third participant stated, "*I'm applying for a lot of summer jobs, and I think being able to articulate biosystems engineering is a little bit different than somebody in civil engineering because everyone knows what civil engineering is*" (P5).

Students also wondered whether employers perceived them as less qualified than other disciplines. One mentioned, "*employers don't think of us as real engineers. I don't know if they even know what our curriculum is, but they compare the kind of work that we do with the kind of work that mechanical students do*" (P3) and "*they would prefer the mechanical student instead of someone who is a mix of all, [...] this jack-of-all field*" (P2).

Yet, participants also spoke of receiving reassurance from biosystems engineers working in the industry they had met at career fairs. One participant appreciated the perceived ambiguity, saying that "*I think there are strengths with having the vaguer concept because I can say whatever I want about it and I can take what I need from it and minimize other aspects*" (P5).

DISCUSSION
The participants' comments on the value and benefits of e-portfolios are well-aligned with the benefits cited in the literature. However, students did not identify nor advocate for e-portfolios as an assessment method in the curriculum. Given the focus of the workshops that took place before the focus groups, it is not surprising that students tied e-portfolios to self-reflection and identified e-portfolios as an outcome and demonstration of the self-reflection process. Given that co-op/internship experience is a strong emphasis at the University of Manitoba. For students at the senior stages of their degree, it is also not surprising that their motivation in developing an e-portfolio was focused on career development and, more specifically, marketing themselves for employment.

The participants also expressed perceptions of the curriculum that could be interpreted as curriculum weaknesses, such as an excessive emphasis on theory over practise, too few design experiences, and design experiences that begin too late in the program. These were also contextualized by participants as weaknesses both on their own and relative to their perceptions of the mechanical engineering program, which they implied as their main competitor in employment searches. While the participants' perceptions are valid on face – that is, the students perceive what they say they perceive – it is also possible and likely that this perception could be shifted if participants had a larger context and more information on their program and other engineering programs. For example, one participant referred to pre-university expectations of what an engineer's work would entail. This highlights the need and opportunity to showcase the profession, particularly biosystems engineering, in the K-12 school system and in popular culture to meet children and youth in the places and times they form impressions.

Similarly, for students who feel that their program is not adequately preparing them for future employment, a deeper understanding of the graduate attributes and accreditation and a comparison of programs may be helpful to understand why the curriculum is designed as it is. Further, learning happens in the cognitive (knowledge) domain, the psychomotor (skill) domain, and the affective (values) domain and the graduate attributes are designed to address all domains. It is, however, incumbent upon faculty members (rather than students) to draw this big-picture mental map for students on an ongoing basis within courses and a program.

Participants expressed uncertainty in marketing themselves as biosystems engineers, and this uncertainty seemed to be directed both outward and inward. Looking outward, participants expressed frustration with a perceived lack of understanding of biosystems engineering among employers. Looking inward, participants expressed uncertainty in their own professional identity and what being a biosystems engineer means. Those close to graduation described a lack of trust in themselves as having the adequate skill set to do the job of a graduate biosystems engineer, which is a common uncertainty among soon-to-be graduates. These findings are not necessarily unusual or unexpected and could even be interpreted as the appropriate posture, indicating an openness to learning and understanding the limitations of one's scope.

The participants' anxieties could further be interpreted as evidence for the value and need for self-reflection to solidify a strong understanding of one's identity as a biosystems engineer. Participants' uncertainties and lack of confidence could be barriers to creating an e-portfolio in not knowing where and how to begin. At the same time, the process of creating an e-portfolio could be an active strategy to evaluate and clarify for oneself the knowledge, skills, and values that a biosystems engineering degree and all its accompanying curricular and extracurricular experiences have fostered, thereby leading its author to a clearer sense of purpose and identity.

LIMITATIONS AND CONCLUSION

The study has several limitations that should be noted. First, the intention was to hold focus groups with workshop participants who had completed an e-portfolio due to the workshop series. Although several participants were at the beginning stages of developing an e-portfolio, none of the participants had completed one in the past or as part of this study. This changed the line of inquiry in the focus groups to become speculative on the e-portfolios and expand the discussion to the curriculum more broadly. Second, the number of participants in the focus groups was smaller than hoped, given that 24 students attended the workshop series. As with all qualitative studies, the findings are specific to this setting and these participants. Although they may shed light on other similar settings, they do not claim to be generalizable.

This study highlights, as many others also do, those young adults in engineering programs are not only there to acquire the knowledge and skills needed for a profession but also to understand and steer the identity they are building for themselves. In doing so, they display openness and interest in approaches like self-reflection that help make sense of their world. This is likely true of most post-secondary students. Still, this reality is perhaps overlooked or less often considered in engineering programs where pragmatism and objectiveness toward externalities (engineering theories and problems) are often foregrounded. The study reminds faculty members of the opportunities to engage students in the self-expression of their values, interests, and goals through their engineering program.

Remembering that the objective of this project was to introduce biosystems engineering students to self-reflection and e-portfolios as a means of documenting their educational experiences and achievements to facilitate learning and subsequent career development, we must step back to reflect upon what has been learned through this study. A fundamental premise behind this work was that students would perceive the potential value of e-portfolios as a tool to market themselves and set aside a portion of their free time to prepare an e-portfolio. Although the subset of the biosystems engineering student population who participated in the workshop series and the subsequent focus groups seemed to recognize the potential benefits of an e-portfolio, preparation of the e-portfolio was perceived to be a significant undertaking. Although several months had elapsed between the workshops and the focus groups, there was no indication that students had invested time into preparing an e-portfolio. From this perspective, this project was a failure. At best, this strategy of introducing self-reflection and e-portfolios using an extracurricular professional development workshop made a small proportion of the biosystems engineering student population aware of these topics. To achieve a more significant impact, it will likely be necessary to formally

integrate e-portfolios into the biosystems engineering curriculum to ensure that all students are exposed to these topics and provide both time and incentive for students to develop an e-portfolio. As indicated by some of the sources referenced earlier in this paper, there are also challenges associated with the formal integration of e-portfolios into courses. There is still much work ahead to get to the point where our biosystems engineering students will i) gain the benefits of a deeper understanding of their engineering program through self-reflection and ii) be able to more effectively market themselves and their unique attributes as biosystems engineers using a well-constructed e-portfolio.

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