THE “ENGINEERS HAVE FEELINGS” PROJECT: INTEGRATING MENTAL WELLNESS AND LIFELONG LEARNING SKILLS IN FIRST-YEAR UNDERGRADUATE ENGINEERING COURSES

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Abstract – To address an identified need for programming that helps Engineering students to develop skills in coping, resilience, and lifelong learning, we designed, implemented, and reflected on the effectiveness of a curricular intervention on Engineering students’ mental wellbeing, academic engagement and achievement, and perceptions of support. This intervention has implications for the development of a model of the curricular components necessary to benefit undergraduate students’ academic engagement, success, and perceptions of student support. It may also be used to inform curriculum development across many university programs.

Keywords: Lifelong learning : Mental wellness : First-year engineering

1. INTRODUCTION

In 2018-2019, the University of Calgary conducted a survey of first-year Engineering students. The results of this survey demonstrated most respondents reported they were underperforming academically (52%) and were struggling with time management (60%). According to findings of the American College Health Association’s National College Health Assessment [1], which was completed online by a representative sample of 1004 University of [redacted] undergraduate students, 89.2% reported feeling overwhelmed by all they had to do, 60.3% reported feeling overwhelming anxiety, 52.6% reported feeling that things were hopeless, and 39.0% reported feeling so depressed that it was hard to function over the previous 12 months. These rates make it evident that there is a need for programming that helps students to develop skills in coping, resilience, and lifelong learning. Additionally, these skills, particularly lifelong learning, are skills identified by the Canadian Engineering Accreditation Board (CEAB) as essential for graduating engineering students [8].

Students want this type of programming (69.8%) and express interest in receiving information about depression, anxiety and stress (80.1%) [1]. However, our first-year

survey indicated that only 8% of respondents reported utilizing wellbeing and counselling services at the university. To address the need and demand for mental wellness and academic supports for first year Engineering students, in Fall 2019 we launched a pilot project to integrate the information into the required first-year curriculum. In this paper, we will provide an overview of the curriculum development and implementation, as well as some preliminary analyses of the feedback we have received from students.

The team of authors approached first-year engineering instructors to request 15-20 minutes of lecture time three times throughout the semester to teach strategies to support wellbeing, as well as academic and professional development. We were able to work with instructors across four courses such that most first-year students saw us at least nine times throughout their first semester. Topics we covered included: the wellness wheel, metacognitive strategies, tips for studying, problem solving strategies, exam anxiety, and career skill development. After each module, students submitted an online reflection assignment. Our biggest observation is that although it is difficult to assess levels of student engagement during module delivery, students’ reflections are deeply personal and insightful. Students have also validated this observation during one-on-one interactions with the lead author, often saying they wouldn’t admit it to their friends but the information we provided them has been extremely helpful to their transition into university. This highlights how fear of stigma may play a role in engineering students’ resistance to seeking treatment for mental health challenges [16]. Future development of this program will aim to further break down these beliefs.

Although the project has ethics board approval, we will not have consent from students until April 2020. For this reason, this paper is practice-based and describes the program development and implementation with some general themes from our reflections and some of the feedback we have received. We hope other institutions can use this information to develop or enhance their mental wellness curriculum in first-year engineering.

2. LITERATURE BACKGROUND

Many first-year engineering students leave their support network to pursue post-secondary studies. They often leave behind peer and family networks who could provide support during the transitional challenges that they face. These students take on increased financial strain, manage a household, and often learn the invisible curriculum of a new culture or city in addition to their heavy academic course load. During this time, mental health issues and psychiatric disorders like anxiety and depression are more likely to emerge [20]. These experiences can be isolating, overwhelming, and difficult to navigate even for the most resilient and well supported students, and are listed as factors in attrition rates for university students in all areas [28]. Undergraduates indicate that barriers like procrastination, poor time-management and prioritization skills, and higher levels of distraction may prevent them from achieving their long-term academic goals [15]. First-year students following a traditional access path are particularly prone to these psychological barriers because the pre-frontal cortex, which regulates planning and critical thinking is not fully developed until twenty-five years of age [9]. Programming aimed to help students work through their academic challenges has been linked with positive outcomes for students, including improved self-efficacy and self-esteem, which suggests that early interventions may facilitate student retention [23]. There is a strong relationship between students' overall mental health, the strategies for resilience or coping mechanisms they apply, and student retention rates [7]. Studies have also found a correlation between first-year GPA outcomes and both academic self-efficacy and life satisfaction, which are directly related to student mental health outcomes and students' beliefs about their academic abilities and suggests that early intervention programming could improve both academic and wellness outcomes for students entering post-secondary [14].

Student resiliency includes a combination of internal and external factors [4]. Internal factors include whether the student has a growth mindset, perceives they have a strong network of support, and engages in meaningful self-care. These factors are influenced by a student's early life experiences, habits, and environment. External resiliency factors include student programming initiatives, faculty and campus culture, and engagement with campus supports [4]. In addition, a critical component of resiliency is the ability to recognize emotions or situations and apply appropriate strategies or resources to work through the experience [3].

Students who were significantly less likely to engage in extracurricular activities and less likely to engage in active learning strategies while studying were also more likely to hold high levels of stigma towards help-seeking behaviour and were more likely to be at-risk academically [12]. This creates an isolating situation where students who are most

likely to need and benefit from supports are the least likely to access them outside classroom hours.

It is important to address these challenges through programming embedded directly in academic course content to help reach these students. Classroom time in post-secondary is often the largest point of involvement for students. For some students it may be the only point of engagement within the campus community and with institutional support. Integration of support programming into course content and increasing instructor buy-in is necessary for both accessibility and stigma-reduction [29]. Embedding this type of learning directly into the classroom also supports instructors' awareness of the strategies students are using to study material, and the skills that are actively being developed in this process [13].

This is particularly applicable to engineering as course content requires students to approach learning and problem-solving using strategies they may not have needed previously. Students must be able to transfer knowledge between new disciplines, work through complex and unclear problems, and apply strategies across courses. Engineering students benefit when these types of lifelong learning approaches and thought patterns are actively developed [5]. These activities and touchpoints support improved course outcomes for all engineering students. In addition, access to resources like technology and solutions manuals allow students to be successful in courses designed to build problem-solving skills while still using the retrieval-based learning strategies that students relied on in high school [17]. Without effective in-class involvement and instructor buy-in it is difficult to create lifelong learning opportunities in first year engineering curricula and adequately assess students' learning and progress towards a resilient lifelong learning model.

Short interventions that target growth mindset, higher purpose of learning, and effective learning strategies can produce results in supporting lifelong learning and resiliency outcomes [18,21,25,31]. Teaching students about neuroplasticity encourages them to seek more challenging learning opportunities and work through problems for longer periods of time [6]. When students understand that intelligence is malleable, they are more likely to find higher enjoyment and engagement in school activities [2]. The development of a first-year intervention course, Creating Opportunities for Personal Development (COPE), covering topics related to lifelong learning and resiliency like cognitive and behavioral skill building, regular emotional and mental health check-in points, nutrition, and mindset, showed a strong increase in student retention over four years compared with the control group [19]. Relative to the control group, 10.3% more students in the intervention group continued to the second year of their studies, and an additional 9.6% over the control group continued to the third year of their studies. Students in the intervention group self-reported lower levels of depression and less perceived stress throughout their program [19].

3. CURRICULUM DESIGN

The project is founded in the idea that we are *integrating* mental wellness and lifelong learning skills into first-year courses. At the University of [redacted], we have five first-year courses housed within engineering, with four sections of each course. For this reason, we had to work with over 20 instructors from across our first-year program. The goal was to work with these instructors and develop modules that would be beneficial to their specific course.

As a result, we did not plan the full curriculum in advance, but instead gathered a list of possible topics and worked with the instructors to find the best fit. We also outlined three specific learning outcomes, where we hoped to foster students' ability to:

1. Characterize personal learning strategies and reflect on their effectiveness;
2. Identify one's current state of mental wellness and list strategies for resiliency;
3. Recognize the value of skill development across courses.

In this section, we outline our teaching philosophy for the curriculum development, the course integration structures, and the module topics that were covered in the first year of the pilot program.

3.1. Curriculum Approach and Philosophy

In our approach to the curriculum development and implementation, there are three main pillars of our educational leadership philosophy that outline how we structured the curriculum.

3.1.1. Humanizing the Learning Experience. Education is not about teaching content, it is about teaching people. Engineering students report high levels of stress throughout their education and feelings of isolation and challenges with handling the workload. We believe the antidote includes creating an environment and culture where students are supported to develop their skills as lifelong learners.

In our approach, we wanted to create safe and brave space in classrooms for students and instructors where everyone can express themselves as humans with feelings. This means fostering conversations about mental health across our school, with both instructors and students. This means normalizing the experiences of students in crisis or with mental wellness concerns. This means supporting course instructors in delivering material that helps students develop necessary skills, not just presenting course content. In short, it means treating ourselves, our colleagues, and our students like individuals while remembering our shared humanity.

3.1.2. Encouraging a Growth Mindset Culture. Most students in engineering experience a time in their education where they struggle to learn a concept, get a desired grade, or otherwise perform to their expectations. Students frequently report feeling discouraged at this point, or simply 'not smart enough for engineering'.

We believe a large part of developing the resilience needed to successfully move through these challenging moments is to develop a growth mindset. To support a consistent growth mindset approach, we believe it is helpful to reinforce the ideas frequently. Therefore, we developed the modules in short sessions, delivered often (weekly or bi-weekly). Perhaps more important in encouraging this culture shift is enabling the instructors to continuously grow and improve themselves as well, so they can model a growth mindset for their students. In this project, we actively engaged with 12 instructors who teach engineering first year courses. An important goal of this project is to continually support instructors in their role as influencers of students.

3.1.3. Small Wins make a Big Difference. What defines a success? When we remember that students and instructors are people, not statistics, the answer to that question comes in the individual experience. For this reason, our intention is not to 'move the average' of the student experience. If we help even *one* instructor learn a new way of supporting the students, this is a success. If we help *one* student learn more about their approach to learning and ability to grow as a learner, this is a success. If we have *one* student reach out for help before they reach crisis mode, this is a success.

In our feedback from students we often heard opposites. For example, one student found the exam anxiety sessions extremely useful, whereas another student found the presentation repetitive and information that was not useful to them. These students' individual experiences do not negate each other. We know every piece of information will not be universally helpful, and that is okay.

3.2. Course Integration Structures

When we approached instructors, we usually requested 15-20 minutes of time three times throughout the semester; however, we were open to any format that worked best for them. There were three main structures that instructors offered to us to integrate into their courses.

First, some instructors agreed to our proposed format. These instructors gave us 15-20 minutes of class time with the students three times during the term. This structure usually involved us talking for about 5-10 minutes, doing a short activity with students, and then leaving 5 minutes for students to do a reflection. This structure was used in ENGG 225 (circuits) and ENGG 233 (computing).

Second, some instructors proposed we could come in during tutorial hours. In this format, we were given the full 75-minute tutorial, where we taught both the technical

content required for that tutorial while integrating conversations around mental wellness. For example, the students might be working on a problem, and we would stop them partway through to discuss their current state of wellness, or to consider how they could show empathy for their peers. This structure was used in ENGG 201 (fluids) and ENGG 202 (statics).

Lastly, in our first-year design course (ENGG 200), the instructors allowed us to have three of the full 50-minute seminars during the term. These seminars are specifically meant for these kind of professional development activities. We were able to use these longer times to delve deeper into some difficult topics for students.

After each module, students submitted an online reflection assignment. We believe an essential component of the curriculum is giving the students the opportunity to reflect on their learning and apply it to their own lives.

Incentivizing the self-reflections by making it worth a small proportion of students' grades helps motivate students to complete the activity. Each course gave us between 3-5% of their final grade. These grades, although they may have been perceived as 'free marks', were to the students' benefit, as taking the time to consider how often or well they use effective coping and studying strategies should increase the likelihood they will take advantage of these strategies in the future.

3.3. Module Topics

To provide a clearer overview of the structure of the pilot project, we summarized the modules covered in Table 1. We had little control over which weeks the instructors gave us time in their classes so we often waited to confirm the topic we were covering until we knew the date. For example, in Week 10 of Term 1, the students had just received their midterms back, so we covered relevant topics such as the *post-test assessment reflection*. Table 1 provides a detailed overview, and here we will highlight and describe in detail a couple of the modules.

Across multiple modules, particularly in ENGG 201 (fluids), we used the wellness wheel as a framework. The wellness wheel [10], which was first proposed by Dr. Bill Hettler, co-founder of the National Wellness Institute and former Director of the University of Wisconsin-Steven Point Health Service, is shown in Figure 1. During classes, we talked to the students about different strategies and resources within each of the facets of wellness. For example, we mentioned financial help available on campus, spiritual spaces on campus for meditation or prayer, and resources for emotional wellness such as counselling services and drop-in seminars. During the reflections, we asked students to consider their wellness in a couple of the areas. For example, for one reflection students were asked to commit to an activity in one area of wellness that they were comfortable in, and a second activity in an area in which they were less comfortable.

Table 1: Module Topics and Schedule from Pilot Project.

Term 1 – Fall 2019			
Week	Course	Time (min)	Topic
1	Design	50	Introduction and Lifelong Learning
2	Computing	15	Learning strategies for problem solving
3	Fluids	75 ¹	Wellness wheel
5	Design	50	Exam Anxiety
6	Computing	15	Review and feedback
8	Fluids	75 ¹	Wellness wheel
8	Design	50	Career Planning
10	Computing	15	Receiving feedback and post-test assessment
11	Fluids	75 ¹	Wellness wheel
Term 2 – Winter 2020			
3	Circuits	15	Difficult convos and bystander effect
4	Statics	75 ¹	Emotions and learning
5	Fluids	75 ¹	Wellness wheel
7	Statics	75 ¹	Exam Prep
9	Statics	75 ¹	Resiliency
10	Fluids	75 ¹	Academic integrity
11	Statics	75 ¹	Circle of Influence

¹The 75 minutes included the tutorial problems.

Fig 1. Wellness wheel [10]

Another example comes from the second week of classes in the first term. Students are just starting to get accustomed to university life, so we felt it was important to have a discussion around learning strategies. We talked about *three strategies for getting unstuck on a problem* that were routed in the literature. First, we talked about the

brain dump of thoughts, which comes from work in psychology that found when students write their emotional experiences down, they show improved GPA, lower stress levels, improved working memory and more [26,30]. Next, we talked about the importance of taking *creative recharge breaks*. We discussed at a high level how the brain moves between a focused state and a diffuse state, and how it is important to move between these two states for productive studying [24]. Lastly, we talked about the idea of *reframing stress*. Increased stress is helpful during difficult situations and can actually help one's performance; however, we need to reframe this stress for it to be supportive of our learning [11].

After reviewing these three learning strategies, we asked the students to reflect on one strategy and describe how they would integrate it into their study habits. Even though this module was early in the semester, we found it was one of the most well-liked topics that students frequently refer back to.

As is well known, in March 2020 we faced a world pandemic and our classes moved to remote learning. In the days following this transition, we had a module planned for the statics course. By some stroke of luck, this module was on *resiliency*. The students had written their midterm the week prior, and the first statics midterm is known to be challenging for students. The plan was to discuss how to be resilient after receiving a difficult midterm mark. We were able to use the same resiliency content, and we simply pivoted the reflections to get students thinking about resiliency in their current context. For example, we included the following questions:

- *Doing your classes fully through remote learning will be a new experience for you. What is your biggest area of concern right now for your own learning?*
- *What is your biggest opportunity for learning and developing your skills in the next two months due to the remote learning?*

During the transition to remote learning we also cancelled a few of our planned modules. In fluids, we had initially planned to do three modules and were only able to complete two. We changed the topic for the second module to be on *academic integrity* as students were being expected to complete exams independently at home. We asked them what academic integrity meant to them and how they planned to maintain their own academic integrity. Lastly, for the circuits course, our second module was cancelled as it was closely tied to their final operational amplifier soldering lab, which was not able to go forward.

4. FEEDBACK AND REFLECTIONS

4.1 Student Feedback

There is a wealth of data that we are excited to delve into from the students' reflections and feedback comments throughout the project. Although we have ethics board approval, we will not receive consent from students until

April 2020. For this reason, we are only sharing student feedback at a high-level with general themes.

Across the feedback received from students, the biggest general theme is that they appreciate the program. Students feel through this program that the faculty truly cares for their wellbeing and wants to support their success. We have also seen increased help-seeking behaviour, with more students going to our Engineering Student Centre earlier in the semester. For example, we usually only see students asking for help after their first midterm. This year, we had over 20 students make appointments *before* the first midterm. This is a true indication of students proactively asking for help, rather than reactively asking for help when they have already started slipping behind.

In terms of the different formats, we found students prefer the shorter sessions (15-20 minutes) over the longer seminars (50-minutes). However, this could also be related to the fact that the seminars are scheduled for 5pm and 6pm in the evening, and students are often done their other classes much earlier in the day. Additionally, they really appreciate the 75-minute tutorial format, as it is good to see how different people approach teaching the technical material and have different ways of explaining the same concepts.

Lastly, across the feedback, although the students appreciate the material, there is an acknowledgement that it is not their first priority, and they don't put as much value on listening or learning the module content. Particularly when we were invited into classes at inopportune times (e.g., right before a lab or assignment was due), students really felt we were taking away from the 'important' material. Part of this requires a culture shift, as it has been shown that engineering culture values 'soft' skills lower than 'hard' skills, and this mentality is hard to shift [27]. However, we believe this pilot project is a small step toward deconstructing this way of thinking in engineering.

4.1. Our Reflections

Throughout the first semester of the pilot project, Robyn, Kim, and Destiny did approximately bi-weekly reflections, answering the questions: "what, so what, now what". Additionally, everyone, including Melissa, provided an end-of-term reflection in early January. Through reviewing these reflections, we observed some relevant themes of our experiences and approach to the project.

Firstly, this project was a **big dream**, something that felt impossible at the beginning. For example, "There was a part of me that felt like we were more so having fun dreaming up fantasies together than actually planning a project that might happen." We really felt like we were trying to accomplish the impossible, "As a goal it felt a little insurmountable and bit like an idealist pipe dream."

However, as we were implementing the project we were able to have extremely **rewarding experiences**. It was something that we accomplished together, as a team. For

example, “I have such amazing pride for the group that ended up coming together and making this happen. What was just a crazy hallway idea [...] turned into this absolutely amazing project that is just incredible.” We really felt we were making a difference, “I believe that these small steps go a long way in helping to destigmatize self-care and support seeking.” And although we prepared ourselves for significant pushback, we were delightfully surprised. For example, “I was mentally prepared to receive pretty harsh feedback as this was our first draft and I anticipated lots of pushback. But the feedback was largely positive.”

As with any project, however, we are always considering areas for *continuous improvement*. Whether we were thinking of giving “more discussion time” to increase engagement, or improving our approach, “I think my examples have been too simple”. We were always adjusting for the benefit of student learning, for example, “I think there are certain ways we can [change how we] approach the topic that will land for students.” And sometimes we were able to implement feedback after these reflections, and we noticed a difference. For example, “I just really need to make sure I set up a safe space, and always give students time to speak with a table partner before calling on anyone. And then it works such magic.”

These reflections show how the project was successful, but also has room to grow and improve. Some more reflections are added into the “Next Steps,” section below as we were also always thinking about how we can extend the program and make it more sustainable.

4.2. Institutional Feedback

Although this project was initiated as a passion project for the authors, we have received significant institutional support for the project. The fact that the instructors from all of our first year courses allowed us to come in and use course time is a strong indication of the institutional support.

Additionally, we have been tasked to expand the program next year. Students who choose to add a minor to their degree have a very high course load, with, at minimum, six courses per semester each term across their entire degree. Both within the School of Engineering, and at the University-level, we have been asked to provide students with minors with wellness support.

5. CONCLUSIONS AND NEXT STEPS

In conclusion, this pilot project has highlighted a number of benefits of incorporating concepts of student wellness and lifelong learning into the engineering curriculum. Importantly, it has also helped us to identify a number of directions for ongoing and future curriculum development.

As mentioned, we have research ethics for this project and we will be reaching out to students for their consent to

use their reflection assignments, as well as to complete an end-of-year survey in April 2020. This survey matches a similar survey given out to first-year students in April 2019, and we will be looking for changes in students’ perceptions of mental wellness and awareness of supports available.

We have also received institutional funding to conduct a scholarship of teaching and learning (SoTL) research study. This summer, we have hired four first-year engineering students and one psychology graduate student to parse through the data and support the planning of the program expansion for next year. Next year, we will continue the program in first-year and we will expand the program for students who are taking a minor in their second-year.

In our reflections, we also have lots of other ideas about how we can further expand this program and ensure its sustainability. One of the big next steps is engaging students to help run the program, “I’d like the program to somehow be self-sustaining. Engaging upper-year students would also keep it raw and authentic, and normalize help-seeking behaviour even more.” We would also like to continue to engage more of our colleagues from across campus, “I’d also love to see more integration with services on campus.”

Our stretch goal would be to make this a 4-year program, we would really like to “explore ways to continue to build supports and community throughout the 4-year program – I would love to see a real cultural shift towards less stigma and more inclusiveness.”

Overall, this pilot project has lots of room to grow and we are excited for our next steps, both in terms of practical implementation and research.

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