

## THE MINDFUL ENGINEER: CONTEMPLATIVE EDUCATION AS A STRATEGY FOR SUSTAINABLE LIFELONG PROFESSIONAL DEVELOPMENT

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**Abstract:** This paper explores and assesses the contribution that mindfulness practice can have as a bridge to professional self-reflection in undergraduate engineering education. The use of mindfulness practices in higher education is part of the emerging field of contemplative education. In engineering education, contemplative pedagogies remain largely unexplored, but one rationale behind contemplative education and mindful awareness is that they can help support the type of lifelong reflective practice increasingly expected of engineering professionals. In this context, the notion of sustainable development is extended to include the personal sustainability of one's own professional development. The main research questions that inform this paper are: What does contemplative pedagogy look like? What attitudes do engineering students have towards the contemplative practice of mindful awareness? How can contemplative practices contribute positively to the professional self-awareness of the 21st Century engineer? I will sketch my own attempts to introduce contemplative pedagogy in the engineering classroom and describe a session in mindful awareness that was offered to a second-year multidisciplinary engineering class. Based on classroom observation and written responses to open-ended questions, reaction to the exercise is encouraging but there are also distinct challenges to introducing students to a largely unfamiliar and unconventional practice for the engineering context. I will provide examples of student responses to mindful awareness and then discuss the possibilities of and justifications for developing and expanding upon these initial classroom forays.

### 1 INTRODUCTION

Engineering education has been undergoing a transformation. Industry, government, and professional associations now challenge universities to educate "T-shaped" engineers: people who not only possess deep theoretical and technical knowledge, but who also have the breadth to understand the social, economic, environmental, and global impacts of engineering. In North America, organizations such as the Canadian Engineering Accreditation Board (CEAB) and the Accreditation Board for Engineering and Technology (ABET) in the United States now formally recognize the need for engineering programs to promote the development of a broader spectrum of skills and attributes. These qualities include the ability to collaborate on multidisciplinary teams, to show effective leadership, to communicate well with a variety of stakeholders and audiences, and to understand the social, ethical and environmental dimensions of engineering. These types of transferable skills undergird the sustainability of one's professional career, particularly amidst conditions of continual and rapid technological change where engineers are now expected to be versatile, creative, and resilient lifelong learners. These attributes nevertheless remain difficult to quantify, measure, and assess in the conventional engineering curriculum. In response, some engineering educators have been exploring ways to help their students develop non-technical but

essential “soft skills,” which often require a different approach to instruction than traditional technical courses.

### **1.1 Reflective Practice in Engineering**

One approach for developing non-technical skills is to provide students with opportunities for reflective practice. Reflective practices are any activities that allow students to learn from experience by critically analyzing their strengths, weaknesses, thoughts, feelings, and values (see Schön 1983 on the “reflective practitioner”). Reflective practice usually involves a cycle of questioning that allows a person to examine their experience in order to derive meaning from it (Amulya 2004, Gibbs 1988). Reflective practices can include things like introspective journal writing, project debriefs, and team retrospectives. Reflective practices have long been built into post-secondary training for careers traditionally considered among the people-oriented, “helping” professions, such as medicine, nursing, and social work (Mann, Gordon, and MacLeod 2009, Gould and Taylor 1996, Schön 1987). By contrast, it is only relatively recently that attempts have been taken to integrate reflective practice into engineering programs (see for example Davis et al. 2009, Prudhomme, Boujut, and Brissaud 2003). The engineering profession now strives to count itself explicitly as a “helping” profession (Grasso and Burkins 2010), particularly when it focuses on areas such as human factors engineering, biomedicine, and issues in sustainability. From the standpoint of reflective practice, the ability to inwardly reflect on one’s professional practice and self-identity is just as important as the outward application of design theories and principles, when it comes to asking the right questions and formulating sustainable solutions.

Goldberg and Somerville provide a useful context for reflective skill-building when they speak of three fundamental skills they believe that 21<sup>st</sup> Century engineering education should foster: the ability to notice, to listen, and to question (Goldberg and Somerville 2014, 2012). Reflective practice helps build these skills: to notice and listen to the workings of one’s inner and outer world, and to ask deep and incisive questions in order to explore the meaning of one’s experience and to learn from it.

### **1.2 Contemplative Pedagogy as a Bridge to Reflective Practice**

My exploration of reflective practice in engineering seeks to help students gain an integrated understanding of the profession’s roles and responsibilities and of their own professional identity. In designing reflective practices for students, I have drawn upon developments in the field of contemplative education. “Contemplation” in this context means to observe or attend with nonjudgmental awareness in the present moment (Brady 2007, Haynes 2005). Contemplative practices commonly include meditation, breath awareness, yoga, walking, writing, and art, but there is no prescriptive list of practices that facilitate contemplative awareness. Contemplative education uses these awareness-focusing practices to cultivate attention and emotional balance and to help develop an individual’s capacity for insight and creativity (Zajonc 2008). From this position, the goal of teaching and learning is not simply to transfer information, but to help develop modes of attention that will empower students to engage deeply with the world (see for example the Association for Contemplative Mind in Higher Education (ACMHE)). Goldberg and Somerville’s “noticing, listening and questioning” (NLQ) framework for engineering education has provided a useful entry point to explore contemplative practices in the engineering classroom.

## **2 AN EXPLORATION OF MINDFULNESS IN ENGINEERING**

### **2.1 Course Context**

I teach two mandatory courses for all second- and fourth-year engineering students at Memorial University, in St. John’s, NL, Canada. The courses cover areas such as communication, ethics, and professionalism, and directly address six of the twelve professional attributes that the CEAB has identified as most important to the success of the engineering graduate. Several of my course outcomes focus on building students’ professional self-awareness, which necessitates a certain amount of introspection. Some assignments require students to keep a regular written log that reflects on their experience with the course material. I have used Goldberg and Somerville’s NLQ framework as a rationale for the extensive amount of reflective work that we do, but last year I decided to pilot a session in contemplative practice to further explore how reflection can support professional self-awareness.

I chose to use a mindfulness-based approach to help students explore their noticing, listening, and questioning. Like contemplation, mindfulness refers to the state of awareness that emerges when one pays purposeful attention to the present moment with an attitude of non-judgement (see for example Segal et al. 2007, Bishop et al. 2004). Mindfulness practices are any practices that facilitate this state of open, non-judgmental attention, and commonly include focusing on one's breath, on a sound (such as a bell or repeated phrase), on an object (such as a candle), or on a movement (such as walking). One of my intentions for introducing mindfulness in this course was to focus student attention on attention itself. In other words, what are the effects when students begin to notice their noticing?

## **2.2 The Mindfulness Exercise**

I invited an experienced mindfulness instructor to lead a 75 minute introductory session with my second-year engineering course. This course, "The Engineering Workplace," is intended to cultivate an understanding of and appreciation for the roles and obligations of the engineer in upholding the health, safety and wellbeing of the public. We examined mindfulness from the perspective of what it means to hone one's noticing, listening, and questioning skills, skills that are easily understood as fundamental to any workplace. The facilitator introduced the class to a brief history of mindfulness and used modern examples of engineering failures to illustrate how diminished attention can impact one's work, especially in an environment of high stress and tight deadlines. He then introduced a basic mindfulness practice: students were asked to sit in silence and observe their breath, to notice when their attention wandered, and to gently draw their attention back to their breath. He led the class in a five minute silent meditation, followed by a short discussion of what the students noticed. Having introduced the students to "noticing their noticing," he then paired students off for a brief listening exercise: one student was to speak on a given topic for two to three minutes, while the other was meant to listen attentively without speaking, questioning, or interrupting. The students then switched roles. Throughout the listening exercise the students were to notice what was happening and what they were feeling. The final part of the exercise was for each partner in turn to ask a "powerful" question of the speaker that would enable a deeper understanding of the speaker's position.

Throughout the exercise, the facilitator would pause for short verbal debriefs and to gauge student reactions. At the end of the session all students were asked for an impromptu response to their experience, which they submitted in writing on index cards. The question was "What is the most important or surprising thing you are taking from this session?" I chose the index card method and this question in order to collect brief and immediate feedback from all participants (participation credit was given for completing a response card) and in order to find out what was foremost on their minds from the experience.

Students then had the option to provide a longer written response to the session, which they submitted at the end of the course. They were asked to reflect upon: "What is the most a) important, and b) surprising thing that you gained from the session? Why did you choose these to comment on? How might the session influence your future academic and professional experiences?" I chose this method and these questions in order to solicit longer, more detailed reflections, which would help the students make sense of the experience in a broader context of their education.

In order to analyze the responses from both the short index cards and the longer reflections, submissions were scored according to major themes. Contemplative pedagogy in general and mindfulness-based practices in particular have been used to decrease student stress, to improve student concentration and focus, to help clear the mind, to open awareness, to deepen understanding and insight, and to cultivate compassion (Barbezat and Bush 2013, Shapiro, Brown, and Astin 2011), and so these themes informed our scoring process. We also scored responses according to themes that were relevant to our primary research questions, such as those that describe student attitudes towards the mindfulness exercise and towards the relevance of the NLQ framework.

## 2.3 Results

The results of this exercise provide a snapshot of the range of student expectations and reactions upon encountering mindfulness in engineering. In total, 120 students were present for the mindfulness sessions, 51 of whom consented to have their responses used for research purposes. Most students were prepared to follow the exercise as directed, and did so accordingly. A small number of students appeared self-conscious and embarrassed during the exercise, needing to check periodically on their neighbours and around the room to see how seriously their peers were taking the exercise. Still others, despite the request to minimize distractions by turning off and putting away all electronic devices, either kept theirs close at hand and followed the exercise reluctantly, or continued to use their devices and did not participate at all.

### 2.3.1 Initial Student Feedback

The initial, immediate feedback collected on index cards at the end of the session revealed several recurring themes that students considered the most surprising or important. Some students listed more than one aspect that stuck with them, and so the list that follows is a compilation of the number of individual references made to certain common themes.

Of the 51 responses collected, students reported:

- feeling **calm or relaxed** by the end of the session (10 references)
- having **difficulty concentrating** at various points in the exercise (10 references)
- noticing how much the individual's **mind wandered** during the session or how it wanders generally (9 references)
- how the exercise allowed **clearing of the mind** (7 references)
- experiencing **improved focus or attention**, or a **greater sense of self-awareness**, during and after the exercise (7 references)
- learning to **suspend one's judgment** and to **simply listen** to their partner during the listening part of the exercise (7 references)
- **finding the session helpful**, or to thinking that the **mindfulness technique would be helpful in the future** (6 references)

### 2.3.2 End-of-term Student Feedback

The longer reflective piece submitted at the end of the course again asked for the most surprising and important aspects of the session, as well as for students' impressions of what contributions the session might make to their academic and professional lives. Twenty-six log entries were collected with consent for this study; the responses below therefore represent a sub-sample of the group of 51 described above. Some of the same individuals reported on the same themes, but developed their ideas further. Other themes were also introduced.

Students reported:

- experiencing **increased attention and focus** in the session (13 references)
- finding the session helpful in **illustrating the concepts of noticing, listening and questioning** (13 references)
- experiencing **relaxation** in the session (12 references)
- feeling as if they had gained a **greater understanding of others** or that the techniques introduced would lead to a greater understanding of others (9 references)
- beginning the session with **skepticism or negative presumptions** (8 references)
- noticing how much the individual's **mind wandered** (5 references)
- **difficulty concentrating** at various points in the exercise (5 references)
- having an experience of **being in the present** during the session (4 references)

### 3 DISCUSSION

I have described the most common themes that arose in terms of what students report experiencing both during the mindfulness exercise and subsequent to it. Given what previous research reports about the benefits of mindfulness practice, I did expect student responses to include references to feeling relaxed, to noticing an increase in attention and concentration, and to having achieved a clearer mind. It is also not surprising that students noticed and commented on how much their minds tended to wander, and how difficult it was to focus on something as basic as one's breath for a prolonged period of time.

#### 3.1 Student Attitudes

I was interested in what attitudes engineering students would have towards the mindfulness exercise, both before and after the session. While reflective practices are not unknown in engineering, the specific study of mindfulness might be perceived as an unconventional area for engineering education, and I therefore wanted to capture some student perceptions about this.

Eight of the 26 extended reflections conveyed a distinct note of either skepticism or outright negative presumption about the value and effectiveness of the exercise. For example, one student's comment highlighted an initial worry that meditation would be a waste of time:

"At the beginning of the session, I immediately thought that I was wasting my time being present in the class since on that particular day I had what felt like a million other things to do. I didn't think that something silly like meditation would ever help me be more mindful of the things that are going on around me..." (A1)

This attitude was echoed by others:

"Initially, I suspected that the idea of maintaining a specific posture, breathing techniques, and monitoring my thoughts ...was absurd." (A2)

"I thought that the suggestion to stop work briefly to meditate seemed counterproductive..." (A3)

"...I tend to be very skeptical of abstract practices like meditation..." (A4)

However, despite initially conveying skepticism or a negative presumption, seven of the eight respondents acknowledged a change from their attitude, and subsequently reported that they felt relaxed, focused and/or present by the end of the session.

According to accounts elsewhere in contemplative education scholarship, it is not surprising to encounter skepticism when introducing contemplative practices in the classroom (Barbezat and Bush 2013, Grace 2011, Simmer-Brown 2011). This is why managing student expectations should be a high priority for educators who are interested in trying out similar experiences with their students. In our case students were familiar with the rationale for the importance we placed on noticing, listening and questioning, and had been briefed on the variety of ways that we would be exploring those concepts.

A few students nevertheless found the experience stressful, and reported feeling stressed in the silence of the breath meditation; they were unaccustomed to the stillness of the room and found it difficult to focus on the task at hand. The point of mindfulness practice is to acknowledge those thoughts and feelings in a nonjudgmental manner and to continually guide one's attention back to the breath, but the fact remains that an introductory experience in mindfulness can certainly cause discomfort. One student who did feel uncomfortable still acknowledged some value of the exercise:

"I have had meditation experience before....while not a fan of meditation, I do understand focusing is important and [the facilitator's] particular brand of mindfulness is useful in trying to figure out what I actually enjoy." (A5)

Overall, however, the majority of responses conveyed an impression that most students got a lot from the topic and found it to be a positive experience; one comment even framed mindfulness as “an unexpected tool to take home” and considered the session to be “interesting and powerful”.

### **3.2 Contribution to Professional Self-awareness**

This exploration of mindfulness also asks: *How can contemplative practices contribute positively to the professional self-awareness of the 21st Century engineer?* The mindfulness exercise was intended to bring students’ attention to how they notice, listen to, and question themselves and the world around them. In asking them to reflect upon how the session might influence their future academic and professional experiences, they were therefore provided an opportunity to demonstrate a level of professional self-awareness. According to one student:

“Mindfulness meditation is an opportunity to reflect and learn about yourself. Using what I learned today, I can continue to practice this skill ...in order to gain greater knowledge of myself.” (A6)

The mindful listening exercise also held some professional relevance; one student described the power of the listening exercise:

“[the listening exercise] will impact my future professional experience so that when a mistake is made, either by myself or someone else, the resulting conversation will be thorough and equal in a way such that all facts and emotions from both parties will be out in the open for consideration and judgment can and will be dealt fairly and accordingly.” (A7)

Thus, combined with the mindful listening and questioning exercises that followed the mindful breathing exercise, students could elaborate upon the real-world, interpersonal relevance of mindfulness practice:

“The tools and skills described by [the facilitator]...are not only essential for engineering, but for all aspects of education. If people are not able to notice details and exercise mindfulness, they will not be able to learn or develop effectively.... In future endeavours, I will remember the importance of noticing, listening, and questioning attentively. I understand its importance and the dangers involved in the loss of attentiveness.” (A8)

It would therefore appear that the mindfulness exercise did provide an opportunity for students to arrive at some constructive insights about their professional identities. Reflective insights can come in a variety of ways, but in this case mindfulness practice offered access to both the inner and outer life of the student through an immediate and direct experience.

### **3.3 Areas for Future Development**

#### **3.3.1 Shortcomings of the Session**

This paper describes just one experience in one engineering course and one session was not enough time to explore the NLQ experientially in a sustained and deep manner. Ideally, the mindfulness practice would be introduced early on in the course and continued throughout the term. Students would then be asked to track their noticing, listening, and questioning abilities for the duration of the term, whereupon they could write a longer, more thorough reflection. They could be asked to reflect on how their abilities to notice, listen, and question might have changed over time, what influence they thought the mindfulness technique might have played, and what relevance their practice might have had in their lives—academically, professionally, and personally.

In gauging student attitudes towards the mindfulness exercise, it would be helpful to administer a mandatory pre-session survey to determine whether students had particular positive or negative expectations or impressions of contemplative practice, and whether they have had previous experience with mindfulness practice. A post-session survey would be useful to compare initial attitudes and expectations with actual experience. The index card responses at the end of the session did not ask for either specifically positive or negative impressions, and the results from the optional longer reflection are

biased towards those students who were interested in answering the question. An exit survey may therefore have captured a wider spectrum of responses, including those who left the session with a negative impression.

### **3.3.2 Considerations for Educators**

For educators who are interested in trying out contemplative practices in their courses, the following are some key issues that would need consideration:

- **Facilitation:** Some instructors lead the practice, while others invite a facilitator. There are ongoing discussions in contemplative education scholarship over whether contemplative pedagogy can be led by anyone or whether it is necessary to have an experienced practitioner introduce the techniques (Simmer-Brown 2011, Kabat-Zinn 2003). At the very least, instructors should familiarize themselves with contemplative education literature before attempting any techniques.
- **Course context:** The instructor should be clear about both their intended purposes for using contemplative practices in the classroom and how the contemplative practice relates to the course subject (Gunnlaugson et al. 2014, Coburn et al. 2011). Contemplative practices do not appeal to everyone and the instructor should not assume that the practice will be beneficial for all students. Instructors should make informed judgments about whether the exercise is appropriate and advisable in the context of their course (Grace 2011).
- **Classroom environment:** While contemplative practices and mindfulness awareness can be conducted almost anywhere, it is important to consider both the physical and social environment in which the techniques are tried. Most importantly this refers to having established a classroom atmosphere of trust and respect, beyond the more mundane matters of comfortable seating and lighting.

## **4 CONCLUSIONS**

Can mindfulness make for a better engineer? It is difficult to evaluate whether mindfulness practices on their own would contribute significantly to one's professional self-awareness, but when used as an experience to reflect upon, mindfulness presents a potentially powerful tool for learning. Using a contemplative practice such as mindfulness to explore and develop skills in noticing, listening, and questioning may present an unexpected and challenging experience for engineering students, but ultimately can provide valuable self-knowledge that is essential to the lifelong learner and the reflective practitioner.

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