

Promoting Professional Identity Formation in the First-year Engineering Classroom Using Metacognitive and Reflective Pedagogical Practices

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Introduction

The first-year engineering education curriculum at the Wentworth Institute of Technology is currently being reimaged to meet the demands of a rapidly changing world. In addition to analytical skills, emerging engineers need to develop competencies like innovative thinking, creative problem solving, and the ability to compellingly communicate and meaningfully collaborate with a diverse range of partners. These skills are essential professional attributes which set up young engineers for success in the modern interdisciplinary workplace.

“Introduction to Engineering Design” is a required first-year course that empowers novice engineers with such future-oriented and broadly transferable skills. “Introduction to Engineering Design” also aims to transform professional identity formation in first-year engineering students from a process of subconscious introjection to an intentional and explicit part of the curriculum. To address these educational objectives, we are piloting a novel pedagogical strategy employing a series of writing assignments collectively called the Engineering Notebook.

Methodology

The Engineering Notebook is a constructivist learning strategy which employs metacognition and reflection to help first-year students actively make connections between what they learn in the classroom and real-world scenarios from an engineer’s perspective. The Engineering Notebook’s thoughtfully composed writing prompts are designed to deepen student engagement with essential questions aligned to the course’s learning objectives. Additionally, the six writing prompts aim to spark student curiosity about the multifarious ways that engineering impacts our modern lives. To develop their professional skills as systems thinkers and designers, novice engineers must begin by being keen observers, asking critical questions, and formulating novel approaches to solve complex problems. The Engineering Notebook is an exercise in metacognition integrated into the course to promote effective learning and to encourage students to take ownership over their own learning. To be successful engineers, students need to understand their own thought processes, becoming conscious of the ways that they take in information, synthesize it, and make decisions. As part of this pedagogical initiative, first-year engineering students are provided with metacognitive tools to help them measure their current thinking and reach for deeper levels of insight, including explicit instruction about metacognition and metacognitive learning strategies. These strategies include study skills, active learning methodologies, and theoretical lenses like learning taxonomies and the impact of mindset on innovative thinking. Reflecting on the assigned prompts, students make their development as design thinkers visible to themselves, empowering them to enunciate their evolving skills as creative problem solvers. In the process, they develop both essential professional writing skills

and the ability to recognize and eloquently communicate their thought processes. Both steps—the awareness of one's cognitive processes and the ability to eloquently explain one's thinking to others—are skills that will serve our students well as they start their professional career paths. Another fundamental skill that the engineering notebook reinforces is systems thinking. Through reflective writing, first-year students draw explicit connections between their lived experiences and the fundamentals of engineering, reinforcing the training in systems thinking that the course provides. Elevating genuine curiosity in our students is essential, as both innovation and lasting learning depend on intrinsic motivation. It is also important for students to understand the essential role of failure in the iterative design processes. This advances a growth mindset in students, allowing them to reframe failure as necessary for progress, and leading students to become more resilient professionals. Ultimately, meeting these educational goals will help support retention efforts in the first-year engineering program.

Engineering Notebook Prompts

Three samples of several developed prompts are shown below:

Prompt 1– Your Vision: Please take this entry to write a bit about yourself so that I can get to know you better. Tell me about your previous experiences with engineering. What made you want to become an engineer? What does engineering mean to you? How do you hope to use your engineering to improve the society around you? Please use the image that you chose in the visioning exercise as inspiration—what does the picture mean to you? Why did you choose it, and how do you see yourself making your vision become reality in your engineering career?

Prompt 2– Design a Better Semester for Yourself: We just designed tangible items personalized to meet a user's unique needs. Now you get to design something intangible— a system, a process, an experience. Ask yourself: What would make an ideal semester for me? What changes could I make to increase what I value (e.g., time, happiness, health, learning, grades, success, satisfaction, community, et al.) and decrease what I want less of? How can I design a semester of maximum value to me? What would I need to change, and how would I do so?

Prompt 3– Metacognition and You: Part A) *Theory* - How can metacognition help you become a more innovative thinker? Part B) *Application* - Describe a scenario in which your ability to better understand your own thought processes helps you to solve a problem creatively. Give a specific example of metacognition applied to your life!

Future Direction

The Engineering Notebook exists to help novice engineers to take ownership over their newly forming professional identities. Throughout the semester, the efficacy of the project at meeting its stated goals is reassessed and upcoming prompts are modified to meet student learning needs. In future semesters, we intend to design qualitative and quantitative instruments to measure the effectiveness of this pedagogical intervention. We aim to develop the Engineering Notebook into an impactful reflective tool for metacognition and professional identity formation to be integrated into the transforming first-year engineering curriculum at our institution.

References

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