

# Investigating the Integrative Ethical Education Model in the First-Year Engineering Classroom

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**Abstract**—This Research Work-in-Progress study seeks to add empirical research to the body of literature around engineering ethics education in the United States and is motivated by the call for ethically trained engineering professionals. Organizations such as the Institute of Electrical and Electronics Engineers (IEEE) and the Accreditation Board for Engineering and Technology, Inc. (ABET) posit that ethical behavior is a fundamental professional duty for engineers. My research objective is to employ the Integrative Ethical Education (IEE) model [1], [2] to foster instructor-student relationships and student-student classroom environments that promote and inspire first-year undergraduate engineering students' ethical development. Building from the current literature on how ethics curriculum is introduced to undergraduate engineering students, I theorize that teaching ethical skills across the engineering curriculum and extra-curriculum using the IEE model could promote ethical sensitivity and foster ethical action. This paper discusses the five tenets of the IEE model in relation to current engineering education literature and highlights how the current literature supports each tenet. The main audience for this paper is engineering faculty interested in exploring how ethics could be infused into their practice. As a Work-in-Progress, I will detail potential next steps that would inform the project before moving into a study.

**Keywords**—*engineering ethics, ethics education, integrative pedagogy, novice-to-expert pedagogy*

## I. PROJECT DESCRIPTION

Several engineering organizations state that engineering professionals need to act ethically. Specifically, IEEE's first core principle commits members "to uphold the highest standards of integrity, responsible behavior, and ethical conduct in professional activities" [3, p. 1]. Moreover, ABET states that accredited engineering programs must document student outcomes related to "an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts" [4, p. 5]. Professional codes and academic standards set expectations for engineering programs and their graduates which then must be addressed by faculty and their curriculum. Engineering ethics education varies in pedagogical implementation across undergraduate engineering programs in the United States from codes of ethics to case studies to integration across the curriculum and more [5].

However, there seems to be no current consensus on a pedagogical framework for teaching engineering ethics connected with IEEE's and ABET's statements. My research objective is to answer this call by employing the Integrative Ethical Education (IEE) model to foster student-instructor relationships and student-student classroom environments in the first-year engineering classroom. This effort is inspired by promising prior results from other scholars, including an exploratory study into an application of the IEE model which found that students in an interdisciplinary university honors leadership program experienced increased ethical development during their first year of college [6]. Additionally, a study of student perceptions of how instructor behavior reflects the IEE model found that students in a single program perceived instructor-student relationships and classroom communities as central across the tenets of the IEE model [7]. Given the initial studies into its application, I believe the IEE model could be effective in the engineering classroom.

As further background, this study will focus on Narvaez and Bock's [2] five tenets of moral character development grounding Narvaez's [1] IEE model which are individually discussed below. With this model, I aim to answer the following research question: In what ways does the IEE model promote and inspire first-year undergraduate engineering students' ethical development as compared to other pedagogies? I present a theoretical framework in the following section that will guide my work. Then, a section on future project phases will describe my plan moving forward. Lastly, a section describing potential implications will frame how this work could influence engineering ethics education.

## II. THEORETICAL FRAMEWORK

My research study aims to evaluate the efficacy of the IEE model in promoting and inspiring first-year undergraduate engineering students' ethical development compared to current strategies. As described in Figure 1, the IEE model is comprised of five tenets for educators to foster that support students' ethical development. Ideally, the five tenets would be implemented simultaneously; however, tenets can be deployed sequentially for new educators [2].

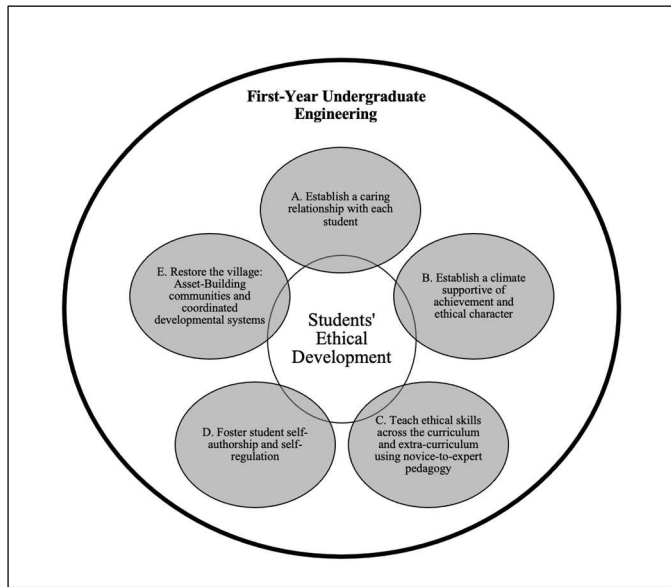


Fig. 1. Theoretical Framework of the Integrative Ethical Education Model. *Note: The outside, shaded ovals represent actions by the educator that support students' ethical development. This diagram is adapted from the concepts in [2] and is placed in the context of engineering education.*

Narvaez and Bock [2] more specifically introduce the elements of the IEE model as: 1) establishing a caring relationship with each student which allows educators to invite students into a welcoming learning environment where they feel safe and can openly communicate; 2) a climate that is supportive of achievement and ethical character combined with a caring relationship with each student, forming the foundation from which the following tenets can promote moral character development; 3) the novice-to-expert pedagogy used for teaching ethical skills which has four progressively more difficult levels (i.e., immersion in examples and opportunities, attention to facts and skills, practice procedures, and integrate knowledge and procedures); 4) self-authorship and self-regulation are fundamental to student success and persistence and foster intrapersonal and metacognitive skills; and 5) the IEE model is designed specifically with a community in mind rather than just individuals, including in terms of coordinated developmental systems where educators, community members, and students work together to build ethical skills, serving as the pinnacle of engaged and active ethical development.

For first-year undergraduate engineering students, the IEE model provides a comprehensive and integrated method for preparing students for current and future ethical challenges. The IEE model also supports students' holistic character development as they make the transition from high school into the ill-structured and less-defined college arena. The college experience will place new demands on students such as intense time management, financial obligations, and pressure to participate in an array of new activities. The IEE model is a step-by-step process for educators to build an in-class and out-of-class environment where students can succeed and flourish.

The following paragraphs detail the current literature that collectively supports the five tenets of the IEE model and its implementation in the first-year engineering classroom.

#### *A. Establish a Caring Relationship with each Student*

As Narvaez and Bock [2] stated, establishing a caring instructor-student relationship is imperative to implementing the rest of the IEE model. A caring instructor-student relationship represents an active and engaged involvement in the student's life as a student and as a person. Caring is the responsibility of individuals to one another and this responsibility creates a space to foster ethical discussions [8]. Through this lens, a caring instructor-student relationship is both a responsibility to be upheld and a foundation for discussing ethics – a sentiment echoed by its place in the IEE model. When instructors invest in building a relationship with their students, students feel increased enjoyment for the instructor as well as the course content [9]. Specifically for first-year undergraduate engineering students, feeling a sense of enjoyment can lead to feeling like they belong in engineering [10]. Care is the starting point of instructor-student relationships. If students feel cared for by the instructor, it can have tremendous benefits for the student as a person and for implementing subsequent tenets of the model.

#### *B. Establish a Climate Supportive of Achievement and Ethical Character*

An environment supportive of achievement and ethical character encourages students to meet or exceed specific goals or outcomes [11] while also developing their moral character [12]. An environment that supports achievement could be seen to support students' self-efficacy. Self-efficacy for first-year engineering students refers to a student's judgment of their ability to complete tasks that achieve the desired result [13]. Using Bandura's social cognitive theory, several categories of factors that can support student achievement have been revealed including feeling able to understand and learn the material; effective teaming and the opportunity to seek help; and enjoyment, interest, and satisfaction associated with the course [14]. In addition to achievement, supporting ethical character could include a focus on character education virtues such as critical thinking, empathy, service, and teamwork [15]. Supporting achievement and ethical character together creates the bridge for the instructor to connect the individual relationships they have formed with the students to the greater class community. This web of connection and support provides the safety net for students to engage with difficult content and concepts without the consequences associated with making high-risk mistakes.

#### *C. Teach Ethical Skills across the Curriculum and Extra-Curriculum Using Novice-to-Expert Pedagogy*

Teaching ethical skills centers on both the ethical decision-making and ethical behavior of individuals [16]. A potential advantage of the IEE model is the emphasis placed on curriculum *and* extra-curriculum content taught over progressively difficult steps. There are different curricular pedagogies already used in engineering to teach ethical skills

including student-created ethics proposals/designs, student-led discussions, case studies, moral theories, and codes/standards [17], [18], [5]. The IEE model could be coupled with these curricular applications to teach ethical skills across the curriculum and extra-curriculum. For example, the IEE model could be combined with a service-learning initiative already present at the University/College/School level. At Purdue University, the Engineering Projects in Community Service (EPICS) design program promotes student-community partnerships to address local and global needs. Using the IEE model, instructors could highlight the role of engineering ethics throughout the community-based projects such as stakeholder perspective(s), environmental impact, and product lifecycles. With a specific emphasis on a novice-to-expert approach, the IEE model gives increasing independence to the student as they progress through the experience. This independence allows students to sustain themselves and each other while requiring progressively less hands-on guidance from the instructor – developing self-authorship, self-regulation, and a caring, supportive environment.

#### D. Foster Student Self-Authorship and Self-Regulation

This fourth tenet continues the trajectory of students becoming practitioners by fostering intrapersonal and metacognitive skills for them to support and maintain themselves as aspiring professionals. Self-authorship and self-regulation are fundamental to student success and persistence such as self-monitoring and self-cheerleading [2]. Self-authorship means trusting one's judgment, using that judgment to form a foundation for action, and supporting that foundation with intentional, committed actions [19]. Undergraduate students utilize self-authorship techniques to engage in meaningful roles and experiences [20] as well as to develop a sense of direction [21]. Specifically, first-year undergraduate engineering students have indicated increased confidence, awareness of growth, and passion for engineering through a self-authorship pedagogical practice [22]. Self-regulation is attaining goals through monitoring one's behavior, judging if that behavior aligns with anticipated goals, and reacting to that judgment of behavior consistent with one's desires [23]. Students use self-regulation techniques to persist through difficulties [24] and to work effectively in teams [25]. First-year undergraduate engineering students, through mindfulness activities, describe enhanced self-regulation habits that lead to feeling less stressed, anxious, and overwhelmed [26]. Therefore, self-authorship and self-regulation competencies may provide the cognitive tools for first-year undergraduate engineering students to meaningfully consider ethics within their curricular, extracurricular, and personal experiences.

#### E. Restore the Village: Asset-Building Communities and Coordinated Developmental Systems

Coordinated developmental systems, where educators, community members, and students work together to build a purposeful and positive social experience, are the pinnacle of engaged and active ethical development [2]. An asset-building community uses these coordinated developmental systems to invest in its members and empower them to live a good life in

*the community* [2, p. 18, emphasis in original] Relationships and community are two themes that show up as central to shifting toward an asset-based approach to engineering education [27]. Although [27] focuses on pre-college settings, the IEE model supports all education levels and lessons could be learned and potentially applied from engineering education settings other than the undergraduate level. For the relationships and community to flourish, the culture of engineering education must evolve to include diverse perspectives that can address the challenges faced by their communities [28]. The final tenet is aimed at creating the net around which the other four tenets operate. In this system, education would be woven into the fabric of the community and students would be able to apply insight from class to the community and vice versa.

### III. FUTURE PROJECT PHASES

The IEE model's five tenets capture many features of a rich academic experience and may promote the characteristics of professional engineers called for by IEEE and ABET. A caring relationship and supportive environment combined with ethical and intrapersonal skill development and an asset-building community could help prepare engineering students to address the ethical challenges of today and tomorrow. The goal of this project is to promote ethical character in first-year undergraduate engineering students so that they have the tools to address the grand challenges of engineering [29] while considering the global, economic, environmental, and societal consequences of engineering solutions.

More specifically, I propose introducing the IEE model into a section of a current first-year undergraduate engineering course such as *Transforming Ideas to Innovation I* at Purdue University which enrolls approximately 120 students per section. I will utilize an explanatory sequential mixed-methods research design [30] that collects and analyzes both quantitative data and qualitative data focusing on Narvaez and Bock's five tenets of moral character development [2]. The study will be carried out on one random course section with another section acting as the control. In the control condition, students will not receive the IEE-model content. The experimental section will employ IEE-model content using novice-to-expert pedagogy where students cultivate their character through apprenticeship and guided reflections relative to the ethical implications of their assignments. For example, students may be given an assignment at the beginning of the semester that asks them to identify ethical issues associated with the Soap Box Derby scenario presented in [31]. During the lecture, the instructor would guide students through a discussion about the implications of the decisions made or not made. Extending the example to the end of the semester, students may be asked to complete an introductory design project. Utilizing the novice-to-expert pedagogy built into the IEE model, students should be readily available to address ethical issues that arise during the scoping, design, and future application phases of the project. A caring instructor-student relationship and supportive environment should allow students to embrace conflicting views inherent in ethical scenarios. As self-regulated and self-

authored learners, students should also feel empowered to make their best judgment. Finally, an asset-building community should provide the support network for students to relate in-class content to their environments and offer opportunities to further explore the ideas present in these ethical scenarios outside of class.

To measure changes in the students' ethical development, I will utilize the Engineering Ethical Reasoning Instrument (EERI) [31], [32]. The EERI offers insight into how students understand and conceptualize ethical scenarios through Yes/No questions and response alternatives of great, much, some, little, and no. These choices aim to capture the nuanced ethical considerations associated with the scenario that each participant experiences. I theorize that the IEE model and interventions will support students' personal and professional ethical development as measured by the EERI because of the interpersonal, intrapersonal, and community relationships fostered in the model. I will administer these instruments through pre/post-course surveys with qualitative interviews of approximately 12 students from each section conducted to further enrich the quantitative data. I will compare the survey data between the pre/post-course assessments to identify shifts in responses, and then I will gather qualitative data to better understand what those shifts may represent. This work will hopefully expand the pedagogical practices available for engineering faculty to use in their classrooms and increase undergraduate engineering students' ethical development through intentional ethics education.

The next steps for this project will be to apply for Institutional Review Board (IRB) approval and collaborate with a course instructor to carry out this study. After finding both a test and control section, I will implement the IEE-model content and begin the sequential mixed-methods research design. Using the EERI, I will administer pre/post-course surveys for both study groups, each containing approximately 120 participants. Once I determine the appropriate statistical method (i.e., ANOVA), I will quantitatively analyze the data produced from the surveys. I theorize that the IEE-model content will show statistically significant shifts in student responses; however, I will collect qualitative data from approximately 12 participants in each condition regardless of whether the survey data shows differences in responses. The qualitative data should illuminate student perceptions of the IEE-model content not captured in the quantitative surveys. I will host semi-structured interviews using a pre-determined interview protocol to collect student responses. I theorize that themes will develop from the student interviews about the perceptions of the IEE model and its ability to promote and inspire ethical development.

#### IV. POTENTIAL IMPLICATIONS

With the sustained calls for professional and academic institutions to produce ethically trained engineering graduates, this work will hopefully add to the available pedagogical strategies for engineering faculty. I theorize that the integrative nature of the IEE model will capture the breadth and depth of ethical considerations faced by engineering professionals. Because of its relational approach to ethics education, the IEE

model excels at creating a caring and supportive environment for students. A caring and supportive environment creates a firm foundation for educators and students to then work towards cultivating ethical character through teaching ethical skills, fostering self-authorship and self-regulation, and establishing asset-building communities and coordinated developmental systems.

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