



An Introduction to the Integrated Community-Engaged Learning and Ethical Reflection Framework (I-CELER)

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Pronouns: she, her, her's

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Abstract

Cultivating ethical Science, Technology, Engineering, and Mathematics researchers and practitioners requires movement beyond reducing ethical instruction to the rational exploration of moral quandaries via case studies and into the complexity of the ethical issues that students will encounter within their careers. We designed the Integrated Community-Engaged Learning and Ethical Reflection (I-CELER) framework as a means to promote the ethical becoming of future STEM practitioners. This paper provides a synthesis of and rationale for I-CELER for promoting ethical becoming based on scholarly literature from various social science fields, including social anthropology, moral development, and psychology.

This paper proceeds in five parts. First, we introduce the state of the art of engineering ethics instruction; argue for the need of a lens that we describe as ethical becoming; and then detail the Specific Aims of the I-CELER approach. Second, we outline the three interrelated components of the project intervention. Third, we detail our convergent mixed methods research design, including its qualitative and quantitative counterparts. Fourth, we provide a brief description of what a course modified to the I-CELER approach might look like. Finally, we close by detailing the potential impact of this study in light of existing ethics education research within STEM.

Keywords: Philosophical Ethics; Community-Engaged Learning; Faculty Development

1. Introduction

To support the development of an exemplary generation of STEM professionals, current undergraduate STEM instruction must draw on students' dispositions towards ethical thought and action. Yet, there is currently no consensus on the most appropriate or effective model for STEM ethics instruction [1, 2]. This project seeks to increase the role that community-based learning, *faculty engagement*, and *institutional intentionality* play in the formation of ethical STEM undergraduates. The primary goal of this project is to develop interdisciplinary partnerships to build and research STEM faculty's capacity and competency in ethical theory and community-engaged pedagogy, specifically their ability to integrate the two, in order to transform undergraduate STEM ethics education in two departments at Indiana University Purdue University Indianapolis (IUPUI).

By integrating practice-oriented ethical instruction into departmental curricula and investigating the effects, STEM ethics education at our institution will be infused with a new vitality leading to (i) STEM educators who are adept at addressing ethical matters within their courses and teaching in collaboration with community partners, (ii) the production of ethically-literate, civic-minded, and empathic cohorts of undergraduate STEM students, and (iii) transformed departments that offer pioneering research-supported STEM ethics instruction. More broadly, this project aims to create a scalable modality for constructing departmental curricula that integrates community-engaged learning and philosophical ethics with STEM content. Hence, this project is primarily focused on faculty development, with the undergirding theory that this is the key mechanism for long-term student impact and departmental transformation [3].

A core premise of our project is that ethics is inherent to STEM disciplinary and professional practice, but STEM faculty rarely integrate real-world authentic experiences into their classrooms, nor capitalize on these experiences through intentional means. IUPUI's strategic plan provides the impetus for this initiative, as it promotes and incentivizes the integration of high-impact practices throughout STEM curricula, including community-engaged pedagogy. Yet, nationally, even in instances where faculty utilize community-engaged pedagogy, rarely have faculty used these practices as a means to engage their students in ethical reflection.

With few exceptions [4-6], the ethical paradigm for STEM research and professionalism -- dating back to the Nuremberg Code (1947) and the Declaration of Helsinki (1964) -- has been concerned with one's duty to align behavior in compliance with an established code of ethics or normative standards. Contemporary STEM ethics instruction commonly uses case studies, which can be useful. However, this instruction is usually concerned with the exploration of moral complexity only when principles conflict, consequently requiring students to reconsider and reconfigure their ethical responses [4]. While the utilization of case studies can be productive in developing STEM students' ethical reasoning abilities in normative contexts, these approaches neither ensure that STEM students have authentic opportunities to practice ethical action, nor provide authentic environments in which students can learn to habitually identify the presence of ethical and moral situations within everyday events.

In a study by Holsapple et al. [7], the conventional case-based approach to ethical instruction was argued to be effective only at instilling engineering students with a "laws and rules approach" to ethics. More holistic and meaningful ethics instruction requires the cultivation of a virtuous, active, imaginative, and inquiring individual [8, 9]. Due to the lack of pedagogy and research on this type of instruction, there is a need to explore alternative ethical pedagogies that move beyond the introduction of (or expected adherence to) an established set of codes or normative principles. Cultivating ethical STEM researchers and practitioners requires movement beyond reducing ethical instruction to the rational exploration of moral quandaries via case studies [10] and into the complexity of the ethical issues they will encounter within their careers [11]. In this project, pedagogy that implements a framework of *Integrated Community-Engaged Learning and Ethical Reflection* (I-CELER) into STEM courses will enable undergraduate students at IUPUI to experience, explore, and reflect on the types of ethical issues they will likely encounter as STEM professionals.

In this project, we adopt a theoretical lens on *ethical becoming* which explores how the ethical thought and action of individuals is modified through participation in and reflection on meaningful events [12]. Members of our research team conducted a preliminary investigation of STEM student ethical becoming in a second-year course that utilized a community-engaged pedagogical approach in IUPUI's architectural technology program. Preliminary results using ethnographic methods indicated that throughout the course students engaged in various expressions of ethical thought and action, such as producing designs in compliance with the building code and engaging with community partners across difference. These were opportune moments for students to reflect on and explore the origins and ethicality of their thoughts and behaviors; however, the instructor did not encourage students to reflect on the traditions and frameworks of philosophy during assignments. Therefore, students engaged in ethical processes

and events, but their instructor did not introduce them to the epistemological tools through which they could reflect on or explore their understanding of their place in these processes. These findings suggest targeted faculty development programming in philosophical ethics combined with instruction in ethical pedagogies, like service learning, would empower faculty with necessary teaching and partnership tools to support undergraduates to connect experience with meaningful ethical frameworks and apply this learning in practice (i.e. ethical experimentation).

Moreover, the National Survey of Student Engagement results that explored curricular needs in IUPUI's School of Engineering and Technology identified several key areas that represent "opportunities for improvement" in student engagement [13]. Core areas included (i) reflective and integrative learning, (ii) collaborative learning, (iii) discussions with diverse others, and (iv) student to faculty interaction. Building on the suggestions from these data, this project will promote and incentivize community-engaged teaching and learning practices to increase the intentional integration of critical reflection in courses, while also enhancing the extent to which collaboration with diverse others occurs (e.g., community partners, community residents). Insights from philosophical ethics will provide instructors and students with conceptual tools to negotiate differences that invariably arise when working with others to address real-world problems.

1.1 Specific Aims

Our project team shares a long-term scholarly interest in transforming modes of ethical instruction, developing bold, new department-level curriculum informed by a diverse body of literature, and integrating community-engaged learning into STEM to ensure the cultivation of ethical students and practitioners. Towards this end, this project targets three specific aims:

- 1) **The Intervention** – Design and implement a Faculty Learning Community program to promote shared learning that results in changes in ethics instruction in STEM departments and in the ethical subjectivities of faculty and the undergraduates in their courses.
- 2) **Exploring Organizational Change** – Identify and analyze the macro-level organizational outcomes and changes associated with the formation of ethical cultures of STEM, specifically those arising from the project intervention, to identify and explain the factors related to the transformation of ethics curriculum at the department level.
- 3) **Analyzing Individual Change** – Identify and analyze the micro-level individual outcomes and changes associated with I-CELER courses to understand the processes and variables related to the ethical training and formation of STEM faculty and undergraduates.

By addressing these project aims, we hope to conceptualize best practices for STEM ethics education for (i) cultivating students' awareness of moral situations (that is, situations in which moral values conflict) within a community-engaged learning project; (ii) allowing students to practice methods of responding to moral situations consciously and intelligently within authentic contexts (as opposed to automatically or mechanically through blind habit or authoritative rules); and (iii) making explicit the continuity of moral problem solving and methodological approaches in STEM disciplines. To achieve these goals, we will employ Jamieson & Lohmann's [3] research to practice cycle, where findings and insights gleaned from Specific Aim 1 will influence the nature of the investigation in Specific Aims 2 and 3, and vice versa.

2. Project Intervention

The following section describes (i) the theoretical framework undergirding the design of our intervention, (ii) the intervention itself, and (iii) our strategy for sustainability.

2.1. Integrated Community-Engaged Learning and Ethical Reflection

Our team has created the Integrated Community-Engaged Learning and Ethical Reflection (I-CELEER) framework with the objective of improving the delivery and outcomes of STEM ethics education. This framework provides the theoretical underpinning for our proposed project intervention. This section will explain the ethical, philosophical, social, and pedagogical theory informing I-CELEER praxis.

The concept of *ethical becoming* is key to the I-CELEER framework. It was constructed through a critical synthesis of ideas related to process, subjectivity, and ethics within the works of Michel Foucault [14, 15], Gilles Deleuze [16, 17], Felix Guattari [18], Alfred North Whitehead [19, 20], and John Dewey [21]. Drawing on these scholars, we conceive ethical becoming an aesthetic practice of both feeling and utilizing the reverberations and intensities of the multiplicity that each subject embodies and encounters as a shared world continuously unfolds. Herein, ethical becoming is less concerned with compliance and duty and more focused on exploring how one *should* live, participate, and interact with others along an “experiential continuum.” As one enters new experiences, one encounters different potentialities that, through care and concern, are selected for actualization or rejected (see Whitehead [20]). This actualization or becoming may refer to an individual subject’s fashioning, or even the making of context-appropriate designs to address an identified problem. Following Dewey [21], since one of an educator’s primary tasks is assembling the most efficient environment for “growth,” this framework seeks to address: how does the STEM educator transform their pedagogical approaches and instructional strategies to harness the potential of meaningful experience?

Since events, or opportunities for experience, are central to the integrated theoretical perspective underlying this project, a pedagogical approach that necessitates experiential learning is imperative to translate theory into educational practice or, in other words, to draw out the latent powers and capacities of the individual student through a conscious engagement in and reflection on meaningful and authentic learning events. Such opportunities for authentic experience promote “legitimate peripheral participation” [22], thereby connecting future STEM professionals with actual disciplinary practice, which is arguably inherently ethical, since everyday disciplinary practice demands care and engagement across difference [23]. Since ethical content can be seen as inherent to disciplinary practice, we argue that educational environments should be constructed that are conducive to authentic STEM practices in order to reveal the ethical potential of those practices. Students can then utilize philosophical ethical theories as tools for reflection-in-practice, thereby making the ethics implicit within disciplinary practices explicit. Deweyian ethics [21] and an ethic of care [24] are two ethical lenses that we intend to employ within I-CELEER praxis.

We have selected community-engaged learning, including service learning, as our modality for producing the educational environment in which students can practice, critically reflect upon, and experience ethical thought and action, thereby opening up possibilities for new subjective

components (e.g. new knowledge, unforeseen potentialities) to be folded into their subjectivities. Hence, community-engaged pedagogy provides faculty with the means to place STEM undergraduates in authentic, real-world ethical situations. This pedagogy, moreover, operates as an evidence-based modality for developing particular expressions of ethical and moral being [25, 26], such as in terms of civic-mindedness [27] and empathic formation [28]. In sum, by bridging ethics, subjectivity, and learning theories within the concept of ethical becoming, the I-CELER framework provides the theoretical foundation for our proposed project.

2.2. Faculty Learning Communities

Ten faculty from two departments, Earth Sciences and Biomedical Engineering, will participate in a Faculty Learning Community (FLC) that includes reflection and iteration on their teaching practices via a series of monthly discussions and activities centered on the state of ethics instruction in their departments. Discussion will center on how refinements to prominent instructional approaches could advance the ethical development of their students. In addition, FLC meetings will provide an opportunity to explore, collectively, the state of ethics instruction within Earth Sciences and Biomedical Engineering, as well as the potential for instruction using community-engaged teaching methods combined with philosophical ethics. Creating “communities of practice” [29, 30] such as FLCs is a way to aid faculty development efforts toward the adoption of service learning pedagogy has demonstrated success [31-33]. Our team will utilize a similar strategy with FLCs to promote faculty growth and confidence in I-CELER utilization. In Year 1 (current), pre-FLC meetings occurred with potential faculty participants to discuss the I-CELER project concepts and expectations.

Each department will receive \$15,000 annually to support the goals of the I-CELER program. Departmental awards will support faculty in one or multiple ways: (i) faculty salary; (ii) graduate student support; (iii) course development and course implementation costs; (iv) faculty research related to I-CELER; and (v) project costs incurred by the partnering organizations. The Earth Sciences and Biomedical Engineering departments opted to partner in this project, and each has identified at least five faculty who will participate in the FLC program. Faculty participants will implement refined courses wherein they utilize the I-CELER framework (potential courses range from introductory to capstone level). Multiple faculty adapting their courses are necessary for the cultural transformative effects this project seeks, because one course alone is not enough to produce, let alone sustain, change in ethical development [34]. By infusing I-CELER into multiple courses, this project aims to transform departmental curricula akin to what has been termed “threaded service-learning,” which aims to connect learning and experiences that accumulate over time across several related courses [35].

In Year 2, faculty will participate in an FLC program involving collaboration with the project team on matters related to curricular and pedagogical transformation, as well as philosophical ethics and ethical reflection. We will utilize Bringle and Hatcher [36] sequenced approach to faculty development. Specifically, the community-engaged learning component of the faculty workshop program will include the following topics: an introduction to principles of good practice in (i) community-engaged learning course design, (ii) ethical reflection, (iii) community partnerships, (iv) student supervision, and (v) course assessment and research. An emphasis on philosophical ethics will be integrated throughout each of these components.

Table 1: Tentative Faculty Learning Community Meeting Schedule, Year 2

Date	Meeting Topic
Aug. 2018	Kick-off Meeting and Community-Engaged Service Project
Sept. 2018	Reading(s) and Discussion on Community-Engaged Learning & Reflection
Oct. 2018	Reading(s) and Discussion on Ethics
Nov. 2018	Integrating Community-Engaged Learning & Ethical Reflection
Jan. 2019	Community Partnerships Networking Session
Feb. 2019	Course Development Workshop (e.g., Backwards Design, Syllabi)
Mar. 2019	Course Development Workshop (e.g., Peer Review, Critiques)
May 2019	Formal Presentations and Team-Building Activity

Table 1 outlines our plan for the FLC program, Year 2 (2018-2019), structure. Prior to each FLC meeting, we will share one or two articles with faculty. These articles will provide initial background information, and we will utilize these articles to facilitate discussions within the FLC. All meetings will primarily be discussion based. In addition, the first meeting will involve a service-learning experience and a practice reflection exercise that instructors can utilize as they (re)design their courses in alignment with I-CELEER. The second meeting will explore different modes of philosophical thought in relation to ethics with special consideration of Deweyian ethics [21] and an ethic of care [24]. The third meeting will unpack the I-CELEER framework and demonstrate possibilities for conceptualizing, redesigning existing, and implementing a community-engaged learning course that integrates philosophical ethical reflection. The fourth meeting will discuss best practices for forming community partnerships and working with individual community partners. This workshop will also include opportunities to network with potential community partners. The fifth and sixth FLC meetings will function as mini-workshops designed to provide faculty teams with a supportive space to create syllabi, articulate essential scaffolding (course expectations, course materials, assignments, and assessments), coordinate and collaborate with community partners, and map ethical outcomes across disciplinary courses.

Following the FLC Year 2, a sub-group of faculty will implement their I-CELEER adapted courses. During Years 3-5, faculty will collectively meet four times per year. These meetings will provide a space to support relationship building among faculty participants as well as maintain an iterative, shared space for reflection on teaching practices, curricular refinements, identification, and discussion of implementation outcomes, and consultation on innovative pedagogy. As needed, we will invite community partners to these meetings. Each year, these reflective FLC meetings will further strengthen faculty confidence and skill with the I-CELEER framework, thereby facilitating curriculum transformation at the department level. At the end of the project, after three iterations of I-CELEER implementation and research (Year 3- 5), we will have evidence of transformative impact of this project at student, faculty, and department levels.

2.3. Cultivating and Sustaining Departmental Transformation

In the intervention and research design, we adopt Jamieson and Lohmann's [3] *research to practice cycle*. This project provides the potential for departmental and institutional transformation, specifically because (i) numerous key stakeholders of departmental and

institutional changes are key project personnel, (ii) these stakeholders will have an explicit and integral project role, and (iii) each will have opportunities to share best practices, perspectives, and insights. As Jamieson and Lohmann indicated, “[I]nnovation depends on a vibrant community of practitioners and researchers working in collaboration to advance the frontiers of knowledge and practice” (p. 5). One of the primary strengths of this project is its interdisciplinary nature, specifically, the iterative integration of diverse perspectives from traditional STEM disciplines alongside those not traditionally included, but whose collaboration are essential for STEM transformation in ethics. As Radcliffe [37] described, the two separate STEMs (Science, Technology, Engineering, Mathematics vs. Social Sciences, arTs, Education, and huManities) ought to inform and be infused within one another particularly in order to form students’ ethical competencies.

Additionally, the proposed intervention aligns with two central components for ensuring *innovation with impact* [38] in the form of sustainable institutional change. First, this project will facilitate periodic self-assessments across the two departments. Second, it will expand collaborations and partnerships among STEM education programs and external disciplinary programs and institutions. As a result, upon completion, partnerships between the departments and institutional centers will continue, which will sustain a revised model of STEM ethics education at our institution. Moreover, *institutionalization* and *institutional planning* have been identified as key to sustainability [39, 40].

3. Research Design and Methodology

This section outlines the research design and research questions the investigators will address in order to determine the outcomes of the project intervention. By addressing these questions, we will produce a model for institutional change and research-supported, scalable curricular models for integrating ethical instruction and community-engaged learning in STEM ethics curriculum at and beyond IUPUI.

3.1. Guiding Research Objectives and Questions

The overarching objective of the mixed methods research design is to determine (i) the factors influencing departmental shifts toward an ethics-infused experiential pedagogy and curriculum, (ii) the effect of these shifts on individual faculty, and (iii) the student level outcomes of I-CELER modified courses. Specifically, we will explore the following primary research questions:

1. In what different ways and to what extent does participating in the I-CELER FLC program cultivate **STEM educators’** instructional self-efficacy and ethical becoming?
2. In what different ways and to what extent does participating in I-CELER courses cultivate **STEM students’** ethical becoming?
3. In what different ways and to what extent does the intervention transform faculty participants’ **departmental culture**, including curriculum and instructional strategies?

3.2. Research Design: Mixed Methods and the Educational Practice and Research Cycle

The research questions will be addressed and refined as we implement a mixed methods research to practice cycle [3], where we will interrelate the intervention and research plan to inculcate a systematic process in which one component iteratively informs the other. Research and practice will have a cyclical relationship, where educational practices will identify and motivate additional questions (or add nuance to existing questions) towards which the research will provide insights. Within the research component of the research to practice cycle, the team will utilize a convergent parallel mixed methods research design [41]. Figure 1 depicts this process. As indicated, we will conduct quantitative and qualitative research methods conducted concurrently, wherein we will merge results holistically to inform our understanding of the effectiveness of the I-CELER framework. This cycle will repeat throughout the project duration.

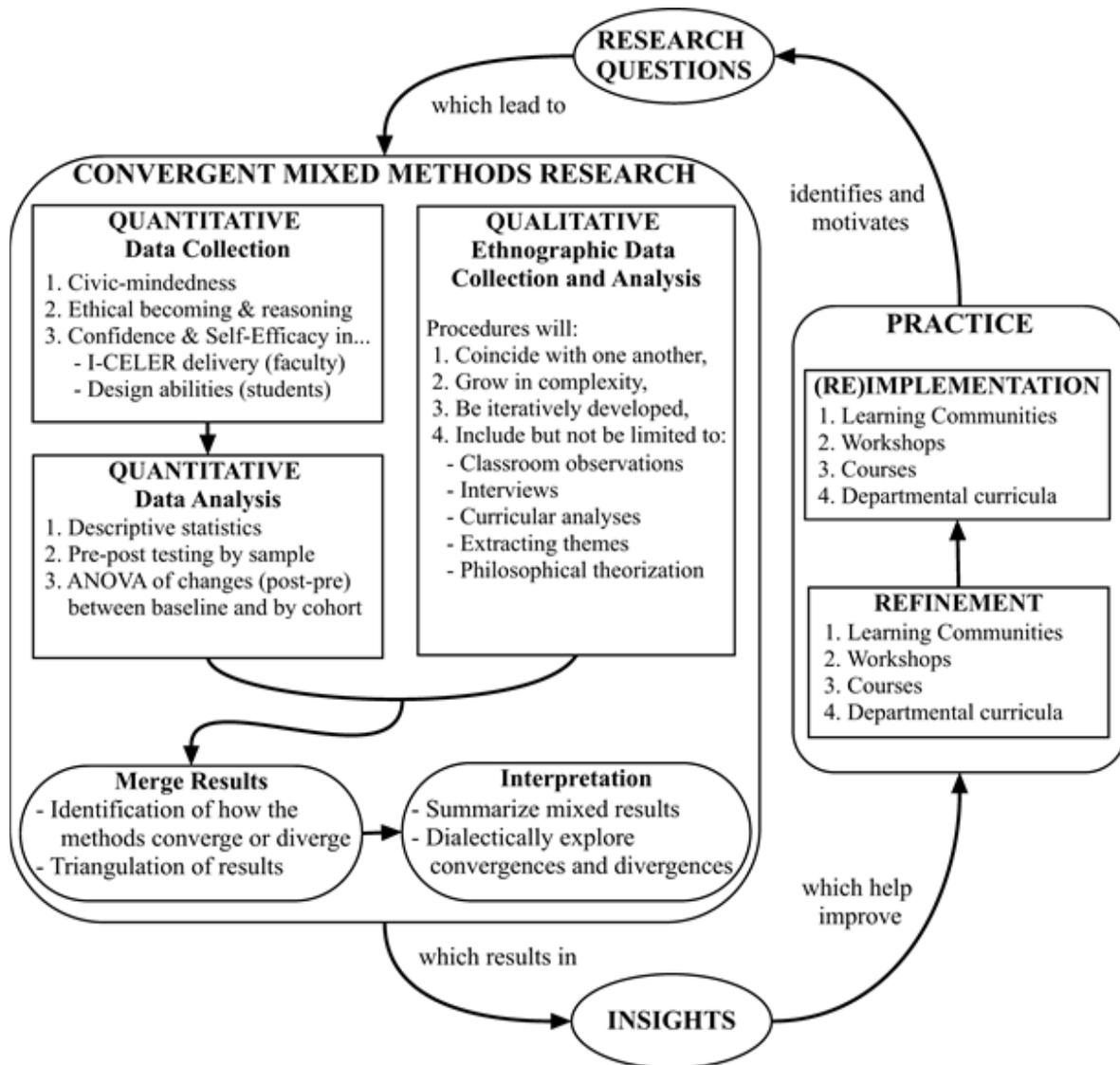


Figure 1: Convergent Mixed Methods Research to Practice Cycle

In the next sections, we discuss each of the quantitative and qualitative research components and sub-questions intended to unpack the higher-level research questions. We conclude this section by identifying strategies for merging the results and describe how these results will lead to research insights, formative modifications to the project intervention, and refinement of the research questions.

3.3. Quantitative Methodologies

To ascertain the effectiveness of the intervention, we will implement and analyze a program of quantitative measures that will inform three separate but inter-related sub-research questions:

1. To what extent does participating in the FLC program influence **STEM educators'** (i) civic-mindedness, (ii) instructional self-efficacy, and (iii) attitudes and perceptions related to I-CELER?
2. To what extent do I-CELER adapted courses influence **STEM students'** civic-mindedness and related ethical values when compared to traditional instructional styles?
3. To what extent do **departmental characteristics** influence the effectiveness of I-CELER implementation?

3.3.1. STEM Educators' Values and Perceptions

For *faculty*, we will design/utilize the following quantitative assessment measures:

- **CMP:** The Civic Minded Professional Scale (CMP; Hatcher [42] is a 23-item self-report instrument that measures civic-mindedness based on five factors: (i) Voluntary Action, (ii) Identity & Calling, (iii) Citizenship, (iv) Social Trustee of Knowledge, and (v) Consensus across Difference.
- **IRI:** The Interpersonal Reactivity Index (Davis [43] is a self-report psychometric instrument validated in social psychology. It measures empathic tendencies along four subscales: (i) Fantasy, (ii) Perspective Taking, (iii) Empathic Concern, and (iv) Personal Distress.
- **I-CELER-SE:** Our team is developing a self-report measure of I-CELER Self-Efficacy that seeks to measure instructors' comfort with and perceptions of the value of instructional design, community-engaged learning, and integrating ethical reflection into STEM curricula.

As faculty participants will participate in the project longitudinally, we will utilize a repeated measures Analysis of Variance (ANOVA) research design to ascertain changes over time on each of the survey constructs. We will study the following hypothesis: there is a difference between each of the dependent variables with respect to time. Specifically, at time 1 (during Year 1), participants will not have engaged in the FLC program. At time 2 (during Year 2), participants will have engaged in the FLC program but not implemented any courses. At times 3+ (during Years 3, 4, and 5), participants will have implemented one or multiple I-CELER courses.

3.3.2 STEM Students' Values and Dispositions

The investigators will disseminate the following pre- and post-surveys in Year 1 to students in multiple courses throughout each department, as well as in I-CELER adapted courses to measure civic-mindedness, empathy, ethical skills/dispositions, and ethical reasoning:

- **CMG:** The Civic Minded Graduate Scale (CMG; Steinberg, et al. [27]) is a 30-item self-report instrument that measures civic-mindedness among college students. The scale is unidimensional. As with the CMP, the items include the following domains (i) Knowledge – Volunteer Opportunities, Academic Knowledge and Technical Skills, and Contemporary Social Issues, (ii) Skills – Listening, Diversity, and Consensus-Building Skills, (iii) Dispositions– Valuing Community Engagement, Self-Efficacy, Social Trustee of Knowledge, and (iv) Behavioral Intentions.
- **IRI:** The Interpersonal Reactivity Index (Davis [43]), described above.
- **Emotion Regulation:** This four-item construct measures self-reported emotion regulation abilities, which we conceptualize as “the regulation of emotions when faced with uncertainty and complexity while developing solutions or responses to a problem” [44]
- **Interpersonal Self-Efficacy:** This six-item construct measures the “ability to successfully interact with others, including others who may have perspectives that diverge from one’s own, and committing one’s self to bearing in mind these external perspectives when finalizing a decision” [44]
- **DIT2:** Defining Issues Test 2 (DIT2; Rest, et al. [45]). The DIT2 is a recognition task in which students prioritize responses offered in relation to a program of moral dilemmas. The outcome measure of the DIT2 test is students’ ethical reasoning ability. The Center for the Study of Ethical Development at the University of Alabama will compute these results.

Since participants will participate in a single course, we will utilize paired samples t-tests to compare responses before and after course participation for each of the constructs we have collected. The following hypothesis will drive this phase of testing: Students who participated in an I-CELER course will show significantly higher levels of civic-mindedness, empathy, emotion regulation, interpersonal competence, and ethical reasoning post-course when compared to before course participation.

3.3.3 The Transformation of Departmental Culture

First, we will collect demographic data from FLC faculty and students in I-CELER courses through portions of their respective surveys identified above. Second, these student and faculty surveys will gather perceptions of the community partner-student-faculty relations and other variables related to community partnerships. This data will provide additional richness to other readily available data on departmental characteristics provided by the university through both its departments and the institutional data office.

3.4 Qualitative Methodologies

To ascertain the efficacy of this intervention, we will implement and analyze a program of qualitative measures that will inform three separate but related sub-research questions:

1. How do the project intervention and the adoption and implementation of the I-CELER framework affect the instructional practices and the professional and ethical development of **STEM faculty**?
2. How does participation in I-CELER courses shape the processes of ethical becoming as experienced by **STEM undergraduates** and how can this inform best practices for STEM ethics education?
3. What role do I-CELER students and faculty play in the transformation of **departmental characteristics**, such as curriculum and instructional design?

We will address these research sub-questions using an ethnographic design with a distinct set of methods and qualitative protocols that vary between the students and faculty. Creswell [46] defined ethnography as “a qualitative design in which the researcher describes and interprets the shared and learned patterns of values, *behaviors*, beliefs, and language of a *culture-sharing group*” (emphasis original, p. 68). Here, we conceive of a cultural group as a group in which there exist shared beliefs, values, practices, norms, and assumptions held by the individuals within it. We consider that each department is a distinct subculture encapsulated by a larger institutional culture. Faculty may also be part of their own unique subculture, as could students. Case and Light [47] indicated that the data range that ethnographers use varies widely. Of the ethnographic data collection methods identified by Case and Light [48], we will implement interviews, focus groups, and observations of FLC Programs and I-CELER implementation. In addition, project personnel will analyze course faculty artifacts/products (e.g., syllabi, course assignments, and learning objectives) and the students’ course artifacts (e.g., final projects and reflection journals).

3.4.1. *STEM Faculty Development in Ethics Education*

An observation protocol will be developed to ensure that each of our researchers collect data around the same thematic areas, such as faculty perceptions of instructional strategies and teaching ethics. This observation protocol will be iteratively designed so that as the intervention shifts into the more in-depth FLC program and I-CELER course design and implementation (Years 2-5), and as analysis and interpretation deepens over time, new observational themes can be added. We will also collect course artifacts (e.g., syllabi, lecture notes, slides) in Year 1. This will provide baseline data for course content prior to any faculty development. As faculty learn about and implement I-CELER in Years 2-5, we will collect and analyze their new/modified course artifacts in order to explore how course designs are changing due to the FLC program.

Beginning in Year 2, we will invite faculty participating in the FLC program to participate in an annual focus group. We will devise a protocol comprised of a program of questions that address the same thematic areas as the observation protocol. The focus group protocol will be iteratively refined as the project progresses. Additionally, to develop a better understanding of the lived experience of I-CELER faculty and the transformational impact of the workshop

program on their instructional practice, we will conduct interviews with three randomly selected participants from each department both before and after each workshop as a modality for tracking their individual change. This data will aid in determining how faculty experience ethical becoming and the effectiveness of and means to improve the FLC Programs. We will also invite community partners to attend end of semester focus groups in order to obtain their perspectives on the experience of working with faculty on an I-CELER course.

3.4.2. STEM Students and Effective Ethics Education

In Year 1, we will identify FLC members teaching ethics in some way and arrange observations to coincide with the introduction of ethics in their course. Two project personnel will conduct classroom observations of 8-10 different courses on days they implement some form of ethics content. Similar to the Year 1 FLC observations, we will utilize an observation protocol to focus on how students engage with ethics in the classroom. This will contribute to the establishment of a baseline dataset. Like the faculty observation protocol, we will iteratively design the student protocol so that as instructors adapt courses to I-CELER, we will be able to incorporate new observational themes. In addition, we will collect student artifacts, including assignments that require an ethical component. In Years 3-5, we will gather artifacts following the introduction of I-CELER content. We will explore student artifacts by analyzing the content of those artifacts and interviewing students using artifacts as a source of dialogue. These course artifacts include (i) journals recording moral situations observed by students; (ii) written analyses by students of a particular moral situation; and (iii) written reflection on attempted resolution of moral situations. Consideration of these moral situations encountered by students will provide insights into how students negotiate the events fundamental to their ethical becoming and the most effective instructional strategies for teaching ethics in STEM education.

Beginning in Year 3, we will invite a subset of students from I-CELER courses to attend an end of semester focus group. The protocol will comprise a program of questions that address the same thematic areas as the observation protocol. We anticipate that insights from these methods will contribute to a greater understanding of the key subjective components of students that may play a role in their ethical becoming, such as the ideal methods for delivering ethical content to aid in this transformation. Similarly, we will invite community partners to attend end of semester focus groups to offer their perspectives on how well the students worked with their organizations.

3.4.3. Role of I-CELER in Departmental Transformation

We will conduct individual interviews twice per year with the chairs of the departments receiving faculty stipends and with the deans of the schools that house those departments. These interviews will focus on the perspectives of these administrators on ethics instruction in their departments/schools and their perception of the influence the I-CELER framework has had, or has not had, on institutional transformation. This will enable us to assess the perceived efficacy of I-CELER, the cultural values of the larger institution framing this project, and the receptivity of administrators to the I-CELER intervention.

In addition to these administrator interviews, data collected under Qualitative RQ1&2 will be used to explore the transformation of departmental characteristics, such as curriculum and

instructional design. Specifically, the perspectives of administrators will be compared with the perspectives and actions of faculty and students and the documentable outcomes of the intervention (e.g., the number and quality of I-CELER courses delivered) to see if there are any contradictions. This will help the research team understand how departmental change has occurred throughout the project and what that change looks like within particular departments. Therefore, data analysis will utilize codes that unpack the agentive and culturally situated roles played by faculty, students, and community partners in the transformation of departmental curricula and how they are in turn affected by that transformation.

3.5. Merging Findings to Inform I-CELER Refinement

Each year, following analysis of the quantitative and qualitative portions, investigators leading their respective quantitative and qualitative portions will discuss their findings. The objective of these conversations is to understand convergences and divergences in the findings from each. For example, we will utilize qualitative thematic to explore how they support and challenge the quantitative findings, as well as to identify factors or variables that may be tested in subsequent quantitative analyses. Conversely, quantitative findings will identify potential lenses for future qualitative analyses. For example, quantitative findings may reveal patterns that the qualitative data analysis had not thematically identified.

Following the logic of the research to practice cycle, insights from the research will inform or refine the I-CELER framework. For example, we will share course-by-course research and evaluation results with faculty to show the impact of their intervention, which faculty can then use to inform any course improvements they deem necessary. This is a central component of institutional transformation as described by Finelli et al. [49]. Moreover, research results will provide project investigators with insights into what has been effective in terms of faculty development and where faculty may need additional instructional support. The annual review of I-CELER outcomes will help refine ethics pedagogy in STEM contexts. The cyclical nature of the research to practice design (see Figure 1) is thereby receptive to refined research questions and new modes of data analysis identified throughout project implementation.

4. Possible Design of an I-CELER Course

Faculty participants in this project will redesign disciplinary course(s) to the project framework throughout the 2018-2019 academic year, and then iterate on I-CELER courses between Fall 2019 and Spring 2022. We expect courses to include three core components:

- **Community-Engaged Learning:** Students partner with the community to identify and, when possible, address problems
- **Ethics:** Students engage with ethical concepts (i.e., ethic of care; pragmatism)
- **Reflection:** Students apply ethical theory to interpreting and reframing community-engaged experiences

Table 2: A possible outline for an I-CELER course

Curricular Component	1. Problem Scoping	2. Concept Generation	3. Solution Realization
Duration	~1.5 month	~1 month	~1.5 months
Community-Engaged Learning (CEL)	Information Gathering; Service Project; Co-Identification of Problem with Partners	Immersion in the Community; Interviews; Presentation of Ideas to Partners	Implementation and Iteration; Presentation of Findings; Written Report
Ethics (E)	Pragmatism (i.e., Dewey) Class discussion on ethics materials	Ethic of Care (i.e., Gilligan) Class discussion applying ethical concepts	Synthesis and application of ethical concepts in-situ
Reflection (R)	Class Discussion on potential partners; Reflective journaling	Class Discussion on meetings with community partners; Reflective journaling	Debriefing with community partners; Reflective journaling

Importantly, faculty participants have the autonomy to engage with community partners of their choosing; to incorporate ethical theory that they perceive relevant to their course context; and to have students reflect at times that they perceive as most opportune to reach course goals for student learning. Table 2 outlines what a course may look like, pulling from phases included in Davis et al. [50]. Importantly, the FLC program can and will (hopefully) encourage faculty to creatively pursue a myriad of pathways. In other words, I-CELER modified courses may take on a shape widely distinct from that shown here.

5. Conclusion

This project will inform a largely lacking ontological discourse about the ethical becoming of STEM students and faculty. Many prominent pedagogies in STEM ethics focus on ethical reasoning or sensitivity of students, but rarely have scholars investigated how the enactment of care practices and an authentic engagement with diversity influences the ethical subjectivities of STEM students and educators. In this project, faculty will explore, discuss, and implement instructional strategies that integrate community-engaged learning and ethical reflection (I-CELER) into STEM courses. More importantly, incentivizing and researching the implementation of I-CELER will produce several positive outcomes and deliverables.

First, incentivizing the FLC program and the adaptation of existing courses to the I-CELER framework with 10 faculty will lead to two transformed departments at IUPUI that offer holistic STEM ethics instruction, as well as research evidence that will support similar efforts in other university contexts. Our team's research on I-CELER courses will guide the development and validation of a framework of ethical becoming within STEM education research. We will leverage the collective skill sets and resources of the partnering centers at IUPUI to support the completion of these objectives and to ensure sustainability of the institutional transformation beyond the duration of the grant.

Second, I-CELER adapted courses will enable undergraduates to explore discipline-specific ethical issues akin to those they will encounter in their everyday lives as STEM professionals. More importantly, by participating in I-CELER courses, students will have the opportunity to critically reflect on their abilities and ethical dispositions, specifically, within authentic disciplinary events.

Third, beyond IUPUI, this project will create a scalable modality for constructing departmental curricula through faculty development that innovatively integrates community-engaged learning and philosophical ethics with STEM content. Specifically, findings from this project will support models for infusing STEM ethics education across our institution and others.

Finally, this research will lead to the development of an evidence-based approach for faculty development focused on institutional transformation through innovation at the level of departmental curricula. This will provide structure for others to transform the way STEM departments incentivize the infusion of ethics across the curriculum.

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