Mapping Macroethical Access from Cross-Disciplinary Data Analysis at the University of Illinois Urbana-Champaign

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Abstract

Efforts to integrate ethics and equity into aerospace engineering treat them as separate concerns centered on individual responsibility, overlooking how institutional systems shape both who gain access to ethical learning and whose perspectives define what counts as ethical in the first place. This study applies an information-analytic approach to identify measurable patterns of ethical access and equity across University of Illinois Urbana-Champaign's (UIUC) College of Engineering. Using a mixed-methods design, the project links aerospace faculty interviews to student survey data collected from undergraduate and graduate students across multiple engineering disciplines. The goal is to detect how structural and cultural factors within departments shape two key constructs—ethical access and pathway equity—that together represent students' ability to engage meaningfully with ethics in their coursework.

The survey, developed from patterns found in the faculty interviews, combines existing measures of self-efficacy (Bandura, 1986) and communal or agentic goal perceptions (Diekman et al., 2011) with new likert-scale results capturing three key constructs: the Ethical Access Gap, Institutional Mediation (Support) and Structural Pathway Inequality. Analyses will map and compare patterns across disciplines and degree levels, check reliability, explore how items group together, and interpret results carefully to remain transparent despite varying response rates. By translating qualitative findings into measurable indicators, the study uses visual analytics to reveal how ethics and equity opportunities are distributed based on engineering disciplines within the university. The results will provide evidence of how macroethical access differs within aerospace education and across the broader engineering landscape at a renowned midwest university.

Introduction

Ethics education in engineering has been traditionally framed as an individual responsibility where students are expected to internalize professional values, apply codes of conduct, and make principled decisions when presented with ethical dilemmas. Ethical competence here, is conceptualized to exist primarily at the level of the individual engineer, emphasizing moral reasoning, rule compliance, and personal integrity.[1,2] While this approach has played an important role in advancing professional accountability and safety-oriented decision-making, it has also narrowed the scope of how ethics is understood, taught, and assessed within engineering education. At the same time, efforts around equity and inclusion in engineering have developed along a largely separate track, focusing more on issues of representation, retention, and climate

than on ethical learning itself.[3,4] Despite policy changes, modules on ethics and equity,and case studies, ethics fail to be embedded at the technical core of disciplines. As a result, ethics and equity are often treated as related but distinct concerns despite growing evidence that ethical reasoning, legitimacy, and voice are deeply shaped by institutional structures and power relations.[5,6] This separation obscures a fundamental reality that students' ability to engage ethically depends not only on their values or reasoning skills, but also on whether educational systems provide them with access, legitimacy, and safety to do so.

Macroethics provides a way to address this limitation. Unlike microethics, which focuses on individual decision-making, interpersonal responsibility, and professional misconduct, macroethics focuses on the collective, institutional, and societal dimensions of ethical responsibility in engineering[2]. Macroethics focuses on how engineering systems distribute risk and benefit, how institutional priorities shape technological outcomes, and whose values ultimately get embedded in design, shifting attention away from isolated dilemmas toward the broader structural conditions that make ethical action possible, even though this perspective remains more acknowledged in theory than in everyday engineering education practice. Many curricular interventions remain centered on case studies or professional codes that just assume equal access to ethical learning and participation and produce surface-level engagement.[7] However, research in engineering education and sociology shows how institutional conditions such as curricular design, accreditation pressures, hidden curricula, and disciplinary cultures mold whose voices are recognized as legitimate and whose ethical concerns are sidelined.[8,9,5] From a macroethical perspective, ethics education cannot be disentangled from questions of access, power, and institutional design.

In the ethically and technically complex field of aerospace engineering, examining macroethical access is a particularly important. Aerospace systems operate in high-risk, high-impact environments where engineering decisions have profound consequences for public safety, environmental sustainability, national security, and global equity. Ethical questions in aerospace frequently arise at the system level such as acceptable risk thresholds, long-term environmental impact, militarization, and international responsibility rather than as isolated individual dilemmas.[2,10] Despite the macroethical nature of aerospace practice, ethics education in aerospace programs often remains constrained by densely packed technical curricula and narrowly defined performance metrics. The broader context in which aerospace technologies are designed and deployed is often distant from students' immediate learning experiences. As a result, it becomes easier to focus on technical correctness while losing sight of why these systems are being built, whom they ultimately serve and who are getting affected by their design. At the same time, aerospace engineering programs are embedded within strong institutional pressures related to accreditation, prestige, funding, and workforce pipelines. These pressures also define what is taught, how learning is valued, and which forms of participation are rewarded. For example, ABET Student Outcome 4 requires graduates to demonstrate "an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, considering the impact of engineering solutions in global, economic, environmental, and societal contexts." While this outcome clearly hints at ethical responsibilities, it is again, often articulated as a matter of individual competency.[11,12] The MEAE framework builds on this expectation by shifting attention to the institutional and structural conditions without replacing accreditation standards but by extending them, asking not only whether students can recognize ethical responsibility, but

also whether aerospace educational systems are organized in ways that enable all students to meaningfully cultivate macroethical awareness. For these reasons, aerospace education offers a particularly useful context for examining how institutional conditions shape access to ethical learning and participation, making it a relevant site for macroethical analysis.

Although equity initiatives in engineering education have expanded in recent decades, they are often framed independently of ethics education. Research on belonging, identity, and persistence shows that students' engagement in engineering is shaped by factors such as representation, access to mentoring, and whether they are seen as legitimate members of the discipline.[13,14] However, these studies rarely examine how the same structural conditions also shape ethical engagement. From a macroethical standpoint, if ethical engagement requires legitimacy, psychological safety, and institutional support, then inequities in access and belonging inevitably translate into inequities in ethical participation.

To address these gaps, this work draws on the Macroethical Equity in Aerospace Education (MEAE) framework, a conceptual model developed in a companion theoretical paper that elaborates its identity substrate, structural capital components, and macroethical pathways (Gayen et. al, 2026). The present paper does not re-derive that theory. Instead, it focuses on operationalization in a way that translates MEAE's conceptual pathways into empirically testable indicators and examining whether those mechanisms are observable across institutional roles. To examine whether macroethical access operates across institutional roles, this study intentionally links aerospace faculty interviews with student survey data. Faculty interviews help identify how ethical expectations, structural barriers, and institutional pressures are viewed at the curricular and programmatic level. These themes inform the development of student survey items, which helps assess whether those same institutional conditions are experienced by students in practice. This study aims to:

1. translate MEAE's conceptual constructs into empirically testable indicators;
2. examine disciplinary norms surrounding rigor, legitimacy, and ethics from educator as well as student perspectives and map them for aerospace engineering department; and
3. examine whether macroethical access and structural pathway inequality can be detected across institutional roles

This can help in setting up a foundation for subsequent quantitative and visual analytic work. Advancing ethics in aerospace education requires more than expanding curricular content where the institutional conditions also need review to see who is able to engage ethically in the first place. This study focuses more attention to whether engineering education itself provides equitable access to developing a system-level responsibility in engineering practice and lays the groundwork for diagnostic and design-oriented interventions within aerospace curricula.

MEAE Framework: Macroethical Access (WIP)

This paper is grounded in the MEAE framework, developed in detail in a companion conceptual manuscript. Rather than treating ethics as an individual cognitive competency or a discrete curricular outcome, MEAE conceptualizes ethical engagement as an emergent property of interacting institutional systems. The MEAE framework as shown in Fig 1 places four major

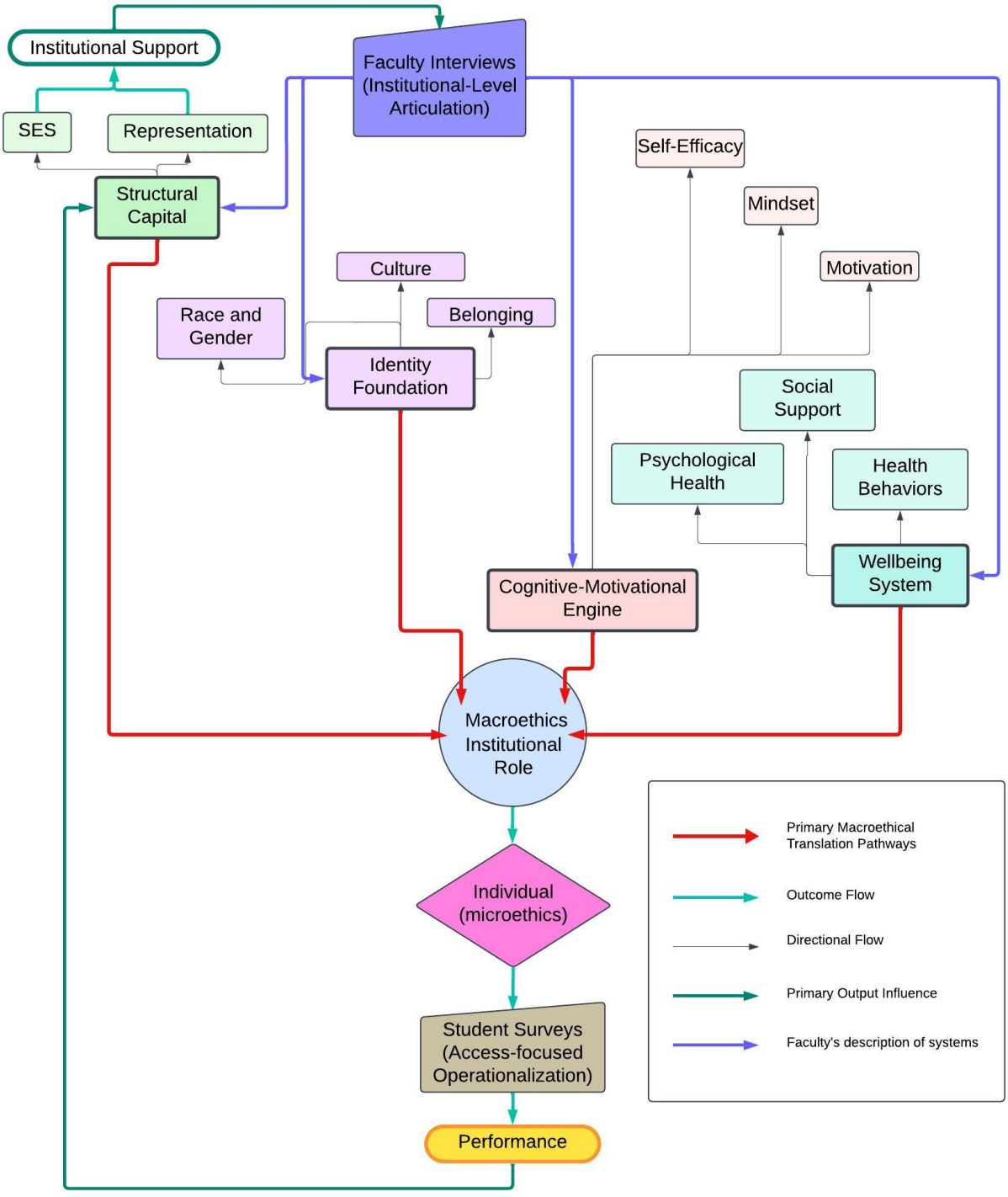

Figure 1: Applied MEAE Framework

interacting systems connected by the primary pathways (in red) at the center of macroethical participation in aerospace and engineering education that ultimately flows down to microethics.

Structural Capital - Macroethics: Ethical Access Gap

The first link between Structural Capital to macroethical outcomes is defined in MEAE as the Ethical Access Gap. Factors such as socioeconomic status, representation, institutional support, and access to prestigious opportunities shape who is able to participate meaningfully in ethical learning and decision-making in the first place. This pathway shows that macroethical engagement is not a matter of values or awareness, it is also a matter of access. Ethical outcomes, therefore, are shaped not only by individual beliefs, but by structural forms of gatekeeping that determine whose ethical voices are heard and legitimized.

Identity Foundation - Macroethics: Ethical Legitimacy and Belonging

The second link connects Identity Foundation (race, gender, culture, and belonging) to macroethical participation, capturing who is perceived as a legitimate ethical actor within aerospace systems. Identity positioning shapes entitlement to question norms, ethical reflections and assertiveness when raising concerns. When belonging is fragile or identity threat is present, students may withhold ethical judgments even when they clearly recognize potential harm. Thus, this pathway highlights that macroethics is not only about knowing what is right, but about being socially authorized to say it and be taken seriously.

Cognitive-Motivational Engine - Macroethics: Microethical Agency to Practice

The third link connects the Cognitive–Motivational Engine to macroethics by tracing how microethical processes scale into macroethical action. Factors like self-efficacy, motivation, and mindset determine how individuals perceive risks, persist in ethical reasoning under pressure or unfavorable circumstances and translate moral awareness into action. In MEAE, this pathway explains why ethical knowledge alone is insufficient and must be supported by confidence and motivation in order to transform ethical sensitivity to ethical practice.

Wellbeing System - Macroethics: Capacity for Ethical Endurance

The fourth link connects the Wellbeing System to macroethics and is described as ethical endurance and sustainability. This pathway emphasizes that macroethical participation is not a one-time act, but a long-duration process. Experiences of burnout, isolation, and psychological distress narrow cognitive bandwidth, reduce risk tolerance, and incentivize withdrawal, even among individuals with strong ethical commitments. Thus, the Wellbeing System shows who can continue to care as a function of well-being. It links directly to chrono-ethics by explaining how structural stressors erode ethical participation over time.

MEAE relies on feedback, nonlinearity, and cross-system reinforcement. Cognitive and motivational experiences can reinforce or erode identity and belonging; wellbeing can both reflect and reshape structural access; and learning outcomes can alter future access to structural capital. The framework therefore rejects simple cause-effect explanations in favor of a dynamic systems view in which macroethical inequities are reproduced through interacting mechanisms over time. The full theoretical development of MEAE appears in companion work but this study provides the operationalization and validation logic necessary for MEAE to function as a usable diagnostic framework rather than a purely conceptual model.

To operationalize the MEAE model for empirical validation, this paper introduces two derived

empirical indices, which function as measurement proxies for the framework's macroethical translation pathways (not as additions to the conceptual model itself but a zoomed in version) as shown in Fig 1. Structural capital, reflected through factors such as socioeconomic status (SES) and representation, forms the foundation that influences how students access opportunities, perceive belonging, and navigate engineering pathways. These structural conditions are mediated through institutional support systems to influence how students develop macroethical judgment, which is how they understand the broader societal, political, and human implications of engineering practice. However, when access to these structural and institutional supports is uneven, an ethical access gap emerges, limiting who is able to meaningfully engage with macroethical considerations. This gap ultimately affects microethical expression, where individual engineering decisions may lack depth in ethical reasoning, not due to absence of awareness, but due to constrained pathways through which such reasoning can be developed and applied. The two measurement proxies are stated below as well as shown in Fig 2:

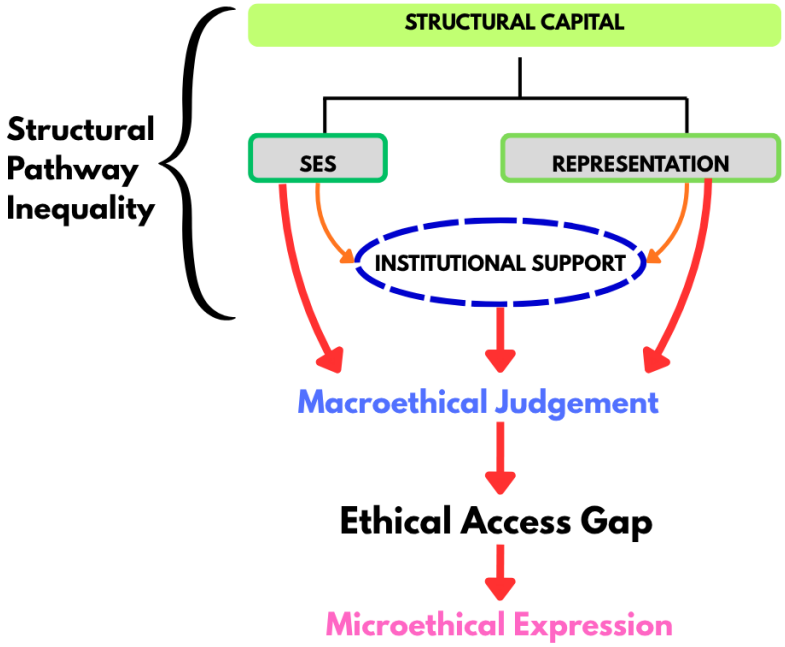

Figure 2: Structural Pathways Inequity to Ethical Access Gap Flowdown

- **Structural Pathway Inequality (SPI)** is an indicator associated with the combined effects of the Structural Capital along with feedback from the other three major systems. Students enter engineering education with unequal access to resources, exposure, and opportunities and the differences persist through Institutional Support, which includes curriculum design, faculty practices, and broader academic systems. It captures unequal access to mentoring, credibility, representation, and opportunity pathways that shape whose ethical perspectives are recognized as legitimate and whose voices carry institutional weight.
- **Instutional Mediation/Support (IM)** refers to the role that academic structure and practices play with elements like curriculum design, course structure, faculty priorities and other factors. These mechanisms determine not only what knowledge is delivered, but also how students are expected to engage, and which perspectives are legitimized within the

learning environment.

- **Ethical Access Gap (EAG)** is an indicator associated with the Structural Capital. When institutional structures do not adequately support the development of macroethical judgement in students, EAG emerges, ultimately influencing Microethical Expression, which is the extent to which students are able to translate ethical awareness into actual engineering decisions and actions. It captures whether students who recognize ethics as important nevertheless experience limited curricular space, legitimacy, or psychological safety to engage ethically.

Together, Fig 2 represents a progression from systemic conditions to individual ethical practice, highlighting how upstream structural and institutional factors shape downstream ethical engagement in aerospace education. These indices are employed because the MEAE framework must be empirically testable to be useful. While the full theoretical development of the MEAE systems model appears in companion work, the contribution of this paper is to provide the operationalization and validation logic that links the conceptual model to measurable patterns in student experience and faculty-described institutional structures. Faculty interviews serve as construct-generating inputs at the institutional level, while student survey items operationalize these constructs as access-focused indicators, allowing examination of whether macroethical conditions identified in institutional articulation are understood in student experience.

Methodological Design (WIP)

This study employs a mixed-methods design explicitly structured to operationalize and validate the MEAE framework. Rather than testing outcomes or causal effects, the methodological goal is to examine whether the macroethical translation pathways encoded in the MEAE model are empirically legible across institutional roles when appropriately operationalized. The design therefore prioritizes construct fidelity, role-specific translation, and transparency over predictive inference.

Faculty Interviews

This study employs a qualitative, inductive thematic analysis to examine faculty perspectives on macroethical engagement in aerospace engineering education. The goal is to identify how structural, institutional, and experiential factors shape ethical access and reasoning, and to map these insights onto the Macroethical Equity in Aerospace Education (MEAE) framework through semi-structured faculty interviews consisting of ten open-ended questions designed to probe:

- Structural barriers to student success
- Disciplinary norms and institutional practices
- Perceptions and integration of ethics in engineering education

Interviews focused on eliciting both explicit perspectives (e.g., curriculum, policy) and implicit insights (e.g., hidden norms, cultural influences) relevant to macroethical engagement. For the

analysis of the first ten interviews as mentioned in the following section, an inductive thematic analysis was conducted following established qualitative procedures:

- **Familiarization**: Interview responses were reviewed iteratively to identify recurring ideas, patterns, and points of emphasis across participants.
- **Initial Coding**: Key phrases and concepts were extracted and labeled as codes (e.g., SES, hidden curriculum, time constraints, representation). Coding remained data-driven, avoiding pre-imposed categories at this stage.
- **Keyword and Code Consolidation**: Codes were refined and grouped based on semantic similarity and conceptual overlap. Frequently occurring terms (e.g., SES, gap, belonging) were used to support pattern identification.
- **Theme Development**: Codes were aggregated into higher-order themes that captured broader patterns in the data. These themes were not only based on frequency but also on conceptual significance and recurrence across responses.
- **Thematic Structuring Using MEAE**: Emergent themes were then mapped onto the MEAE framework, aligned with its core components like SPI, IM and EAG.

This step transformed the thematic analysis into a conceptual model of ethical access and engagement in aerospace education. In the MEAE validation logic, faculty interviews function as construct-generating instruments, identifying the macroethical mechanisms that the framework claims operate at the institutional level. Themes identified through these interviews would inform the development of the student survey instrument by specifying which access conditions should be measured, rather than how students ought to respond.

Student Survey

At this time of submission, this study is in the data-collection phase, with survey deployment scheduled to begin in Fall 2026 semester start, following final Institutional Review Board (IRB) amendments to be submitted in Summer 2026. The survey will be distributed to all undergraduate and graduate students across all engineering disciplines within the College of Engineering at UIUC, using institutionally approved recruitment channels, including departmental listservs and other effective modes of communications. Participation will be voluntary, anonymous, and non-compensated. No identifying information will be collected, consistent with minimal-risk IRB protocols. The student survey is being designed to measure whether students experience curricular space, legitimacy, psychological safety, and institutional support to engage ethically within engineering education. It does not assess ethical knowledge, moral reasoning ability, or professional behavior. Data collection will happen after amendments to the survey items are made following completion of all faculty interviews and the resulting data will be used to examine whether the derived indices demonstrate internal coherence and whether patterns of macroethical access vary across disciplines and degree levels in ways consistent with the MEAE systems model.

Analysis (WIP)

Faculty Surveys Thematic Coding:

Faculty plays an institutional structure because faculty shape both the formal and informal ways ethics is introduced to students. This is directly tied to IM (or support) and how they prioritize and frame different aspects of engineering education. As such, institutional mediation functions as a critical intermediary between Structural Capital and downstream ethical development, shaping not only access to technical knowledge but also the extent to which students are exposed to and able to engage with macroethical considerations.

In this analysis, only the first ten responses from faculty (coded as F1,F2,..,F10) have been considered as data is still being collected. However, across all responses faculty consistently identify socioeconomic status (SES), early educational preparation, and access to opportunities as the primary structural barriers to student success. Students from more resourced environments are perceived to have greater familiarity with academic expectations and career pathways, while others may lack awareness or access. This influences their graduation timeline, financial load, ability to participate in student organizations that help in application of the knowledge and navigating course load. Cultural and socioeconomic contexts also shape how students seek help and engage with institutional resources. All faculty also agree that there is lack of macroethical considerations and identified several gaps in current ethics education, including limited coverage of sustainability, lifecycle impacts, societal consequences, and the broader implications of engineering decisions. However, most of them seem to be reluctant to include it in the curriculum in a way that it permeates through all courses and would rather have students take a separate ethics course either when undergraduates are in their freshman year or in their senior design class or as separate seminar, facilitated by someone who has profound ethical knowledge. This hesitation is compounded by a lack of clear institutional guidance and, in some cases, limited faculty preparedness to facilitate macroethical discussions, despite the acknowledgment of the need for greater intentionality in integration. Before explicit prompting for macroethics, faculty even often default to individual or micro-level interpretations of ethics, with limited explicit engagement with system-level or societal dimensions. This suggests that macroethics is not yet fully conceptualized or operationalized within engineering education.

Additionally, faculty responses highlight variability in how ethics is treated across fields, with some disciplines engaging (multiple mentions of medical fields) more directly due to perceived immediate human impact, while aerospace contexts are perceived to be indirect. Topics associated with defense are approached with caution and mostly with avoidance. As a result, institutional mediation operates as a filtering mechanism, determining not only what ethical content is introduced but also how, when, and to what extent students are encouraged to engage with it. As the macroethical gap is acknowledged and the need to incorporate it somehow in the curriculum is also agreed upon, there lies discomfort about how it can be implemented with close associations to military work, concerns of students not having the freedom to choose ethics over financial gain. Here, institutional support can either act to mitigate structural inequalities by creating inclusive and integrative learning environments, or reinforce them by maintaining narrowly defined, technically driven systems that limit broader engagement. The preliminary thematic analysis is shown below in Fig 3.

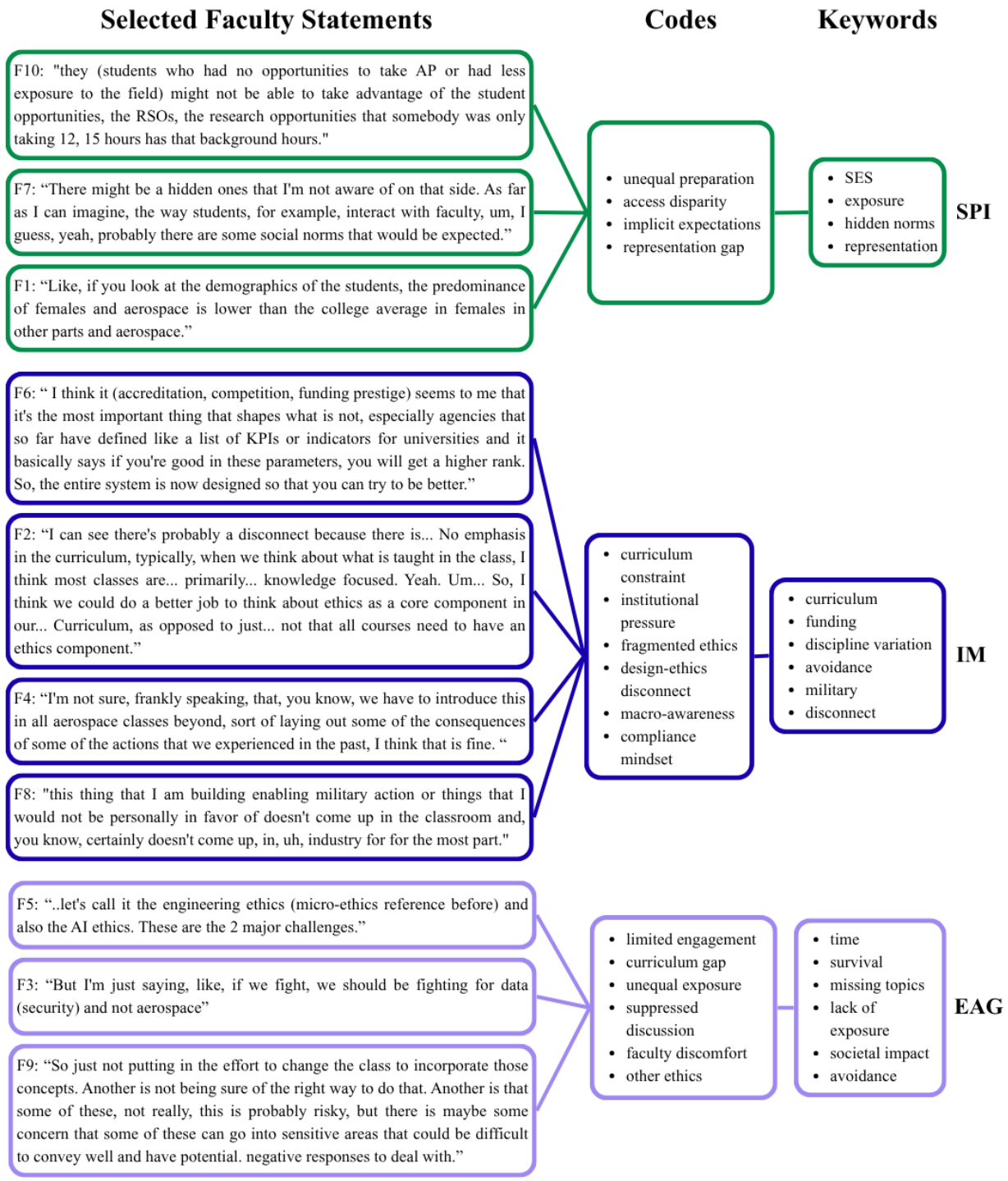

Figure 3: Faculty Interview Thematic Analysis

Validation Logic:

The validation logic of this study is grounded in the premise that macroethical mechanisms operate across institutional roles, even though they are experienced and articulated differently by faculty and students. In the MEAE framework, macroethical access emerges from the interaction of four systems: Structural Capital, Identity Foundation, Cognitive-Motivational Processes, and Wellbeing, connected to macroethics through four primary translation pathways (Fig 1). If these pathways meaningfully structure ethical participation, then their effects should be observable both in how faculty describe institutional conditions and in how students report access, legitimacy, and capacity to engage ethically. This study does not seek convergence in opinions between faculty and students, nor does it treat either perspective as ground truth. Instead, validation is defined as structural alignment: evidence that the same institutional mechanisms appear across roles when translated into role-appropriate indicators. Faculty interviews are used to elicit descriptions of structural, cultural, and institutional conditions shaping ethics in aerospace education, while student survey items operationalize these conditions as access-related experiences.

Mapping Logic: How Constructs Travel Across Roles

The mapping is not simply a side-by-side comparison of the old survey questions and interview prompts without the constructs and is subject to further refinement. Faculty speak about structures, norms, and pressures at the system level, while students experience those same forces as access, legitimacy, opportunity, or constraint in their everyday academic lives. Table 1 shows how institutional themes identified in faculty interviews were translated into student-facing survey items, thereby grounding the MEAE framework in lived educational practice rather than abstract theory.

Table 1: Faculty-Student Mapping for Operationalizing MEAE Constructs

Student Survey Item	**Faculty Interview Question**	**Mapping Rationale**	**MEAE Construct**
I face structural barriers (such as prerequisites, departmental policies, resource limitations) that affect my ability to succeed in engineering.	What do you see as the biggest structural barriers students face in accessing success in aerospace?	Translates institutional barriers into student-accessible indicators, validating that structural constraints are legible at the learner level.	Ethical Access Gap
My socio-economic or educational background affects the academic opportunities available to me in engineering.	How do socioeconomic or educational backgrounds influence student opportunities?	Operationalizes opportunity stratification as a structural phenomenon rather than an individual deficit.	Structural Pathway Inequality

Student Survey Item	**Faculty Interview Question**	**Mapping Rationale**	**MEAE Construct**
Differences in students' backgrounds and prior preparation influence teamwork and design performance in engineering projects.	How do students' backgrounds affect design choices or team behaviors?	Tests whether structural inequities propagate into collaborative and technical design contexts.	Structural Pathway Inequality
My background and available resources influence how comfortable I feel engaging with ethical issues in engineering.	How do structural factors influence students' access to ethical learning?	Defines ethical engagement as institutionally mediated rather than purely motivational.	Ethical Access Gap
There are unspoken academic rules or expectations in engineering that are not obvious to all students.	Do you think there are hidden codes of conduct in academia?	Captures hidden curriculum effects as macroethical barriers to participation.	Ethical Access Gap
Institutional pressures (such as accreditation, rankings, research demands) influence what is taught in my engineering courses.	How do institutional pressures shape what is taught?	Aligns faculty-level institutional constraints with student-experienced curricular priorities.	Structural Pathway Inequality
The emphasis on ethical or societal issues varies significantly across different engineering disciplines.	Do you see differences across engineering disciplines in how ethics is taught or valued?	Enables cross-disciplinary comparison central to MEAE's macroethical framing.	Both
I understand how engineering decisions in my discipline affect society at a macro or systemic level.	How do you interpret macroethical responsibility within your discipline?	Tests whether macroethical framing is transmitted to students as disciplinary understanding.	Ethical Access Gap
I believe important ethical and societal topics are missing from my engineering coursework.	What ethical topics do you believe engineering education often misses?	Identifies curricular absences as structural features rather than instructional oversights.	Ethical Access Gap

Student Survey Item	Faculty Interview Question	Mapping Rationale	MEAE Construct
I believe ethics, equity, and societal impact should be more deeply integrated into engineering education.	What would it take for ethics and equity to become an integral part of engineering education?	Captures normative alignment and perceived institutional inertia regarding ethics integration.	Both

Mapping Analyses

Once data collection is complete, analyses will proceed in four stages in accordance with MEAE validation goals:

- Descriptive Mapping of Ethical Access: Aggregate distributions of student responses will be examined across disciplines and degree levels to identify initial patterns of ethical access and perceived structural constraints.
- Reliability and Internal Consistency: Reliability analyses (e.g., Cronbach's alpha) will be conducted on item groupings corresponding to Ethical Access Gap and Structural Pathway Inequality to assess internal coherence.
- Exploratory Factor Analysis (EFA): EFA will be used to examine how survey items cluster empirically and whether they align with MEAE's conceptual constructs. Given the validation focus, factor analysis will be treated as exploratory rather than confirmatory.
- Cross-Disciplinary and Degree-Level Comparisons: Comparative analyses will examine whether ethical access patterns differ across engineering disciplines and between undergraduate and graduate populations, consistent with MEAE's hypothesis that macroethical access is institutionally and disciplinarily patterned.

Visual analytics will be used to represent ethical access patterns transparently and accessibly, particularly in light of uneven response rates across departments. Rather than presenting ethics as a single score or outcome, visualizations will emphasize relative access conditions, variation, and clustering, reinforcing the macroethical framing of the study. These analytic steps will enable the translation of MEAE from a conceptual framework into an empirically testable diagnostic tool, while maintaining transparency about the study's work-in-progress status.

Implications (WIP)

Although empirical results are not there yet, the design and validation logic presented in this study already demonstrate the feasibility and value of the MEAE framework as a tool for engineering education research and practice. This section would discuss the broader implications of MEAE, drawing on existing literature to establish proof of concept and to illustrate how macroethical access framing can benefit students, educators, and institutions. Especially since prior work has repeatedly called for ethics education approaches that move beyond individual-level moral reasoning toward systemic, sociotechnical, and justice-oriented perspectives.[2,4,6]

MEAE contributes a measurement-oriented proof of concept: it demonstrates that macroethical concerns and aligns with research showing that students' engagement with ethics is shaped less by abstract instruction and more by institutional signaling and perceived legitimacy.[15] By measuring access conditions, MEAE provides a mechanism for identifying where ethical engagement is structurally enabled or constrained. For students, MEAE reframes ethical engagement as something they are entitled to access, rather than something they must independently pursue or justify. Prior studies have shown that students from historically marginalized or first-generation backgrounds often experience uncertainty about unspoken academic norms and expectations, which can suppress participation in discussions perceived as peripheral to "real" engineering work.[16,17]

By mapping ethical access rather than prescribing content, MEAE supports aerospace programs in:

- Identifying where ethics is implicitly constrained by curricular overload;
- Understanding how institutional prestige and competition shape pedagogical choices;
- Designing ethics integration strategies that are structurally supported rather than symbolic.

This approach aligns with calls for aerospace education to better prepare students for complex sociotechnical decision-making in an era of rapid technological and societal change.[18]

Discussion (WIP)

The Macroethical Equity in Aerospace Education (MEAE) framework is developed here as a way of understanding how ethical learning, participation, and voice take shape within aerospace education. Rather than treating ethics as an individual cognitive skill or a standalone curricular component, this work positions ethical engagement as emerging from the interaction of structural conditions, institutional mediation, and access to participation. From this perspective, macroethics is not peripheral to technical work, but is embedded in the system-level conditions that influence aerospace practice.

Preliminary analysis of faculty interviews reveals the emergence of three dominant constructs: SPI, IM, and EAG. Faculty consistently identify disparities in preparation, exposure, and representation as shaping student entry into aerospace education, while institutional factors such as curriculum design, accreditation pressures, and disciplinary norms determine how ethics is framed and whether it is meaningfully integrated. Across these responses, a key pattern emerges that although faculty demonstrate awareness of broader societal, political, and ethical dimensions of aerospace practice, these macroethical considerations are not consistently translated into structured teaching or student engagement. This points to the presence of a macroethical gap, where awareness exists but is not systematically operationalized within educational practice. The next stage is modifying the student surveys to examine linkages between institutional structures and student outcomes. Taken together, these two data sources allow the analysis to move across levels, linking institutional structures to students' lived experiences, and making it possible to assess whether macroethical conditions identified by faculty are actually visible and consequential in everyday educational contexts.

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