Exploring engineering students' understanding of their professional responsibility by using living library of case studies

Dr. Diana Adela Martin, University College London

Diana Adela Martin is a Senior Research Fellow at The Centre for Engineering Education, University College London. She also serves as the co-chair of the Ethics SIG of SEFI - The European Society of Engineering Education and is a Europe Board representative in REEN - The Research in Engineering Education Network. Diana is Associate Editor of the journals 'The European Journal of Engineering Education' and 'Science and Engineering Ethics'.

Exploring engineering students' understanding of their social responsibility through a living library of ethics case studies

Introduction

Ethics education is increasingly recognized as a crucial component of the undergraduate engineering curricula. Nonetheless, many engineering students show reluctance or outright disengagement when exposed to ethical issues [1] [2]. Traditionally, the engineering curriculum privileges technico-scientific knowledge, seeing it divorced from ethics and societal considerations, and relegating ethics tends to standalone courses or ancillary topics within broader coursework [3], [4]. This hierarchization of disciplines reflects a deeper 'depoliticization' of engineering programs, wherein technical subjects are portrayed as neutral and superior, while ethical, social, and political dimensions are tacitly constructed as peripheral or secondary [5], [6].

Furthermore, when taught, ethics is prevalently introduced in the engineering curriculum through microethical approaches [7], often relying on historical or hypothetical case studies that do not reflect the integration required in real-world practice [8]. In recent years, to broaden engineering ethics instruction, scholars and practitioners have advocated for more authentic and situated approaches that position ethics not as an abstract add-on but as part and parcel of engineering practice [9], [10]. One such approach calls for immersive ways to expose students to ethical issues [11], [12]. This may involve framing ethics education around real-world dilemmas, engagement with communities, personal narratives, or the lived experiences of professionals [13]-[20].

This study builds on the concept of the 'living library', a method originally designed to challenge stereotypes through face-to-face engagement with 'human books,' seeking to translate it within engineering ethics education. The paper reports on the use of living library sessions in a sociotechnical course on Decisions Under Risk and Uncertainty offered at a Dutch technological university. The course featured four guest speakers, who took the role of story tellers, sharing their personal trajectories and professional experiences with ethical engineering and ethical dilemmas. Students had the opportunity to ask questions and discuss how the speakers grappled with consequential ethical issues in their work. By exposing learners to examples of practice, the course aimed to disrupt students' preconceptions about the relative insignificance of ethics, while broadening their views on responsibility. At the end of the course, students submitted a reflection, where they were invited to select one of the guest speakers and write what they learned about responsibility from the respective session.

This paper aims to examine students' understanding of responsibility in the context of an engineering ethics pedagogical innovation that uses case studies as a 'living library.' The method is document analysis of end-of-course reflections collected from 16 students. The reflections are analysed via a conceptual frame developed by the author via a literature review. This empirically informed case study of pedagogical innovation builds on current work on case studies in engineering ethics education, seeking to expand it through the personal narratives of professionals who encountered ethical considerations in their practice.

2. Background

2.1 Case studies in engineering ethics education: limitations and prospects

Case studies have long featured as a popular method for teaching engineering ethics education, due to their capacity to bridge theoretical ideas with the realities of professional practice [3], [8]. By illustrating moral dilemmas through concrete scenarios, case narratives encourage students to see ethical considerations as part of their future work [21]. In many respects, they offer a powerful instructional tool: students become familiar with important historical examples of malpractice as well as more mundane examples of breaches in professional behaviour [22] [23]. Case studies also encourage students to develop their critical thinking and practice judgment calls related to conflicting values and stakeholder interests that are inevitable in real engineering projects [24], [25].

While case studies are an important entry for getting familiar with ethics concepts and moral reasoning, they may offer an overly simplified portrayal of the types of epistemic ambiguity, distribution of risks, value sensitive design and power differentials that affect ethical engineering practices. In some instances, educators condense moral problems into clear-cut scenarios with readily identifiable 'right' or 'wrong' solutions, implying a level of neatness rarely found in the field [26]. This approach may cause students to underestimate the interplay of socio-political, economic, and cultural contexts that shape ethical decision-making, producing a superficial impression that moral questions are reducible to discrete and clear technical choices. Concerns also arise when programs rely on a narrow set of 'classic' case studies, such as iconic disasters like the Challenger explosion or the Ford Pinto controversy. While historically and pedagogically significant, these cases tend to spotlight catastrophic failures rather than the day-to-day ethical tensions engineers confront in iterative design work or routine maintenance processes [23].

Another significant critique involves student engagement. When cases are framed as remote events stripped of personal or community relevance, students may fail to see how such dilemmas connect to their own professional identities, thus perpetuating a 'culture of disengagement' [1]. For students who are now starting their degrees, even more recent global cases of unethical engineering like the Volkswagen emissions scandal appear old, as they occurred during their childhood. The time and scale of historical case studies is considered to lead to 'the problem of professional distance' ([27], p.5). This can foster a check-the-box approach to 'solving' a case with minimal emotional investment, where students apply standardized moral frameworks, without fully internalizing the emotional and social stakes at play ([26], p.277; [24], p.883). Scholars additionally point to the risk of reinforcing a narrow, technocratic perspective if case analyses focus predominantly on compliance with regulations or adherence to codes of conduct [28], [29]. In turn, this could perpetuate the misconception that ethics is a tangential and episodic duty, rather than an ongoing commitment to understanding how engineering actions affect diverse communities [30].

Furthermore, critics note that many case studies lack adequate attention to structural inequities, power differentials, or broader societal implications, which can limit the

transformative potential of ethics education [9], [31], [32]. Examining microethical cases of personal or professional misconduct and negligence may thus benefit from complementary cases that consider broader macroethical questions, such as how political actors, economic and political systems constrain or incentivize certain choices, or how engineers might challenge inequitable practices. By sidestepping issues of race, gender, class, or environmental justice, some case studies reinforce the myth that engineering is value-neutral [33]-[35]. Without careful design and facilitation, discussions may remain superficial, depriving students of opportunities to reflect on their positions of responsibility within complex sociotechnical systems [36]. These critiques underscore the need for context-rich and interactive case study experiences that illuminate the varied dimensions of ethical practice while encouraging students to consider how they, as future engineers, might develop a sustained commitment to responsible practice.

2.2 Expanding engineering ethics case instruction via living libraries

The concept of 'living libraries' (also known as human libraries) originated in 2000 in Denmark as part of the 'Stop the Violence' campaign [37] and later endorsed by the Council of Europe [38]. Living libraries are an innovative social and educational intervention that aims to challenge prejudice, by transforming human experiences into living, interactive 'books' that other people can engage with through interpersonal dialogue [37].

The foundational premise involves creating structured environments where individuals engage in meaningful conversations that strive to enhance awareness on topics with moral weight [39]. The original objective was to confront prejudice by fostering one-on-one interaction, enabling readers to question their own assumptions through meaningful dialogue [38]. Living libraries have been used to foster conversations on racism, violence, persecution, LGBT rights, human rights, mental health - all of which are societal issues that are divisive and subject to discrimination and stereotypes [40], [41]

While living libraries started as an informal pedagogy, they are now gaining traction in formal education, especially in programmes that rely on human contact (Pardasani & Rivera, 2017). In formal educational contexts, living libraries expand conventional knowledge transmission methods. Their methodology aligns closely with experiential learning theories, emphasizing interpersonal contact and narrative exchange as a mechanism for knowledge transfer and perspective transformation. Educators in diverse fields, ranging from social work to health sciences, have embraced the living library format for its capacity to highlight the lived realities behind complex social issues ([39], [42]-[44]). Storytelling and personal experiences, two markers of living libraries, can be more effective pedagogical methods for challenging prejudices than presentations and lectures [45].

Living libraries differ from guest speaker sessions by centering on personal narratives and lived experiences rather than abstract expertise or professional knowledge. Within educational contexts, guest speakers typically function as content experts who deliver structured presentations focused on professional knowledge or disciplinary expertise [46]. The 'human books' share their authentic stories, which may include challenges, dilemmas,

and personal growth, elements often absent from formal guest presentations [47]. In an education setting, this means contextualising personal experiences in professional settings and roles.

The relevance of Living Libraries for engineering education lies in their ability to bridge the gap between technical expertise and socio-ethical responsibility. In particular, given the reticence that many students and technical teaching staff have vis-à-vis ethical content, ethics can be considered a prejudice and 'disempowered' subject in the engineering curriculum [48]. The experiences of engaging with ethics shared by the story-tellers make complex professional challenges more tangible and relatable. By engaging with diverse perspectives, engineering students can better understand the relevance of ethics for engineering and the societal contexts of their work. This pedagogical tool would contribute to a more holistic approach to sociotechnical problem-solving and align with the pedagogical mission of preparing engineers to practice in a socially responsible manner.

In the context of engineering ethics education, living libraries have the potential to refine and extend the case method by incorporating real-world perspectives. This is achieved through direct dialogue with professionals who have navigated ethical challenges, beyond abstract theoretical frameworks. By interacting directly with a storyteller, students confront the emotional, relational, and ethical nuances that might otherwise be flattened in hypothetical case studies. This immersive quality renders living libraries particularly relevant for engineering education, where human-centered perspectives are often overshadowed by technico-scientific content [1]. Instead of reading about an ethical dilemma in a scenario crafted for the classroom, students can engage with a practitioner who navigated that dilemma in practice, thus underscoring the sociotechnical nature of engineering work. These interactions ground ethical discussions in real-world complexity and nuance, fostering a deeper understanding of the societal implications of engineering work.

3. Course Setup

The course Decisions Under Risk and Uncertainty 1 (DURU 1) was offered to second year engineering students following different degrees at a Dutch Technological University. This course was the first sequence of three inter-connected courses spread over 3 quartals, from September until April. The DURU course line was offered in the Challenge Based Learning format, with students working in groups on projects related to the activity of 7 educational partners from the university's ecosystem. The educational partners of the entire DURU course line represented 2 start-ups, two research groups, a large company, one governmental body, and one NGO. The project part of the course line required students to both *identify* a problem involving decisions under risk and uncertainty affecting real-life stakeholders and *propose* a sociotechnical solution for addressing it.

In DURU 1, project work was accompanied by lectures, workshops, and 4 guest speaker sessions (Table 1). This course sequence focused on philosophical approaches to decision-making and how society, public actors and companies can deal with risks and uncertainties pertaining to engineering.

Table 1. Structure of the course Decisions Under Risk and Uncertainty 1

Session type	Description
Thematic sessions	Have the role of introducing and reflecting on key themes for ethical decision-making in engineering. They combine brief lectures with interactive elements. Recommended pre-class readings and additional sources for self-study are available for each session.
Project workshops	Have the role of advancing the project work and connect the course themes presented with the group assignments. The sessions also offer students the opportunity to garner feedback and support on the group assignments from the team of Teaching Assistants.
Coaching sessions	Have the role of receiving support from teachers on team-working aspects or your approach to the assignment. Each group has assigned a coach from Q1 to Q3. It is the students' responsibility to write to their coach and set a meeting, when deemed useful.
Client meetings	Have the role of connecting students to the educational partner who put forward challenges based on their line of work. The role of the meetings is for students to gain information about the project brief and receive feedback on problem statements and proposed solutions or approaches.
Guest speaker sessions	Have the role of connecting key themes introduced in the course with the reality of engineering practice, based on the experience of experts in the field. The sessions bring critical perspectives on broad societal risks affecting engineering practice and strategies for ethical decision-making. To make the most of the session, students are prompted to get familiar with the assigned readings and think of some questions or points of discussion

For the DURU1, the storytellers of the guest speaker sessions represented a community member impacted by an engineering project (Ben Pauli - BP), a whistleblower who has exposed ethical violations (Laura Nolan - LN), an advocate for participatory decision-making practices (Zachary Pirtle – ZP) and a former practising engineer who was asked to falsify data (Diana Bairaktarova - DB). The course introduced the speakers via the syllabus, which provided a description of their profile and a profile photo (Table 2). The timing of each session was linked to specific lecture content, as seen in Table 1.

Table 2. Organisation of living library sessions

Order	Guest speaker / Storyteller	Linked lecture(s) of thematic sessions
1	Laura Nolan is a software engineer with two decades of experience, with a focus on reliability in distributed systems. In 2018, Laura left Google after being asked to contribute to Project Maven, a US DoD initiative to work with industry on automating analysis of drone surveillance video. Laura volunteers with the Campaign to Stop Killer Robots and is completing an MA in Ethics at DCU. You can read more about her protest against Project Maven at	Risk and uncertainty in decision-making Precaution in engineering decision-making

	https://www.theguardian.com/technology/2019/sep/15/ex-google-worker-fears-killer-robots-cause-mass-atrocities	
2	Dr. Ben Pauli is Associate Professor at Kettering University in Flint, MI, USA. He holds a Ph.D. in Political Science from Rutgers University (2014). Dr. Pauli has been extensively involved in the response to the Flint water crisis as an activist and researcher. He is the author of *Flint Fights Back: Environmental Justice and Democracy in the Flint Water Crisis* [49], president of the board of the Environmental Transformation Movement of Flint (etmflint.org), vice-chair of the Flint Water System Advisory Council, and a member of the Flint Area Health and Environment Partnership. He is also a representative of the academic community on the Environmental Protection Agency's National Environmental Justice Advisory Council. In that capacity, he has served on work groups focused on water infrastructure, PFAS chemicals and consumer confidence reports.	Experts, activists and laypeople in engineering decision-making Justice in engineering decision-making: acknowledging stakeholders
3	Dr. Zachary Pirtle is a program executive for Exploration Science Strategy and Integration in NASA's Science Mission Directorate, supporting science within NASA's human exploration plans. He is a leading researcher on engineering ethics and epistemology, and co-led a NASA effort to involve the public in informing NASA's exploration plans. At NASA Headquarters in DC, he helped establish the Exploration Systems Development office, including the Space Launch System and Orion programs. He earned his PhD in systems engineering from George Washington University, with undergraduate degrees in both philosophy and mechanical engineering from Arizona State University. Before joining NASA, he was a Fulbright scholar to Mexico in philosophy, and was a Mirzayan science and technology policy fellow at the U.S. National Academy of Engineering.	Participation in engineering: standards and methods for bringing the community in decision-making
4	Dr. Diana Bairaktarova is an associate professor in the Department of Engineering Education at Virginia Tech. She is also an affiliate faculty in the Department of Mechanical Engineering and a Faculty in the Human-Centered Design at Virginia Tech. Diana has over fifteen years of experience working as a Design and Manufacturing Engineer. With her research group, Abilities, Creativity, and Ethics in Design, Diana engages in research with undergraduate and graduate students, educators and practitioners by doing research that crosses disciplines, including engineering, psychology, and the learning sciences; this distinctive combination has enabled research-to-practice partnerships that would otherwise not exist.	Engineering decision-making in day to day practice

At the end of the course, students had a reflective assignment where they had to address the following prompt: 'Please write a ~500 words reflection about your personal and professional take aways about how you view your responsibility as a future engineer, based on any of the guest speaker sessions. You have the freedom to structure and focus your reflection as you see fit, based on what you found valuable in the session and how it may have helped you understand or develop your professional identity. For your orientation, you may consider including aspects such as: how you define responsible engineering, what you learned about risks, engaging with stakeholders or the practice of responsible engineering, any methods or approaches for a responsible practice, what type of conduct to avoid or pursue in the responsible practice of engineering, how the examples presented may be relevant for how you approach your challenge in a responsible way, if any aspect from the speaker's experience or practice was surprising to you or changed your views about the reality of practicing engineering and the responsibilities of engineers, including the constraints to practice engineering in a responsible manner. Of course, it is not possible to include all aspects, so try to focus on one or a few aspects about how you view your responsibilities as a future engineer, in connection to one of the guest speaker sessions, in order to reflect on this thoroughly.'

Students could choose any of the four storytellers and had access to the videorecording of the sessions. As such, the choice was not linked to attendance. Reflections were chosen as an integrative mechanism for implementing living libraries in case-based education, to create an interplay between experiential learning and the theoretical course content and support the processing of experiences. This choice was driven by the belief that when students engage with 'human books' who embody case studies of ethical practice, through shared lived experiences, the reflective practice may serve as the bridge that transforms these encounters from isolated interactions into ethics awareness and deep ethics learning.

4. Method

The study aims to examine how the living library of case studies contributed to students' understanding of their responsibility, as captured at the temporal marker of course completion. The research question of the study is: how do engineering students articulate their responsibility as future engineers upon exposure to guest speakers?
For this, the study reported in this paper uses document analysis of 18 student reflections submitted at the end of the course. The reflections were a mandatory course assignment, and 54 students consented to have their course submissions used for research purposes. Of the 54 student assignments which represented the participant pool, 18 of these were selected to exemplify two of the four story-tellers.

The participant demographic is not recorded. The policy of the university is not to use demographic data related to gender, race or nationality. The disciplinary background of the students includes Chemistry and Chemical Engineering, Mechanical Engineering, Industrial Design, Electrical Engineering, Physics, Mathematics, Urbanism and Building Sciences, with the majority of the students enrolled in Chemistry and Chemical Engineering degrees.

Procedures regarding consent and avoiding power differential were adhered to, considerate of stipulations by the university Ethical Review Board. An extra precaution was conducting the data analysis the year following course completion, after all students received a grade or reexamination.

Data was collected via written reflections. Reflections enable students to collect evidence of their learning and understanding [50]. Asking students to explain their reasoning via reflective assignments facilitates making connections between learning activities, goals, and processes [51]. Reflections can thus provide personalized insights into students' experiences and beliefs [52], [53]. [11] and [54]-[57] have been advocating for reflections as an enhancement of immersive pedagogical approaches for engineering ethics education that connect students to communities or professional environments. They argue that reflections can support sense-making and identity-development. While reflections pose challenges related to subjectivity, their format elicits engagement and rich descriptions and fosters students' authentic voice, making them a valuable method for engineering ethics education research.

The student reflections were subject to thematic analysis, guided by the categories of responsibilities identified in the literature on engineering ethics (see section 5). The analysis was conducted in several rounds of thematic coding, inspired by the guidelines for open, axial, and selective coding of the interview data [58]. In the first iteration, the author assigned one or more codes to each sentence, while in the second iteration, the author grouped these codes at a more abstract level. After four months, the author redid the analysis, to enhance intra-rater reliability. The foundational principle of intra-rater analysis involves creating temporal distance between coding sessions. After completing an initial round of coding across the dataset, the author allowed four months to elapse before revisiting the material. This interval helped diminish the influence of memory on the second coding attempt, creating conditions to approach the data with fresh perspective while retaining the theoretical lens. The percentage agreement between the coding iterations was 96%, above the threshold for reliability. Given that the thematic analysis was conducted by a single coder, an additional measure for ensuring reliability was to develop a detailed codebook with explicit definitions and analytical memos documenting the decision-making processes.

5. Theoretical lens

The theoretical lens for analysing the data is based on a taxonomy of engineering responsibilities developed by Author 1 via a review of the literature in engineering ethics [59]. It builds on the distinctions developed by [60] and [61] to articulate and structure formulations of engineers' responsibilities.

Herkert differentiates between *Micro* ethical approaches focused on individual responsibilities and *Macro* approaches focused on the collective responsibility of the profession and societal decisions about technology [60]. Conlon [61] incorporates an

additional level inspired by the sociologist George Ritzer to distinguish between the *Subjective* or *Objective* origin of the phenomena.

In the conceptual frame used in this article, the *Micro/Macro* level retains its original meaning referring to the magnitude of responsibilities engineers have as individuals or collectives [60] and adapts the *Subjective/Objective* level to refer to the orientation of responsibility towards internal or external aspects [61]. The refined *Subject/Object* level distinguishes whether the perspective is on the individual' (the subject's) internal motivations, values, beliefs, and actions or on external factors (objects) such as rules, regulations, systems, and structures.

The four levels for situating responsibility with their specific understandings are rendered in Table 3. *Micro-Subject* responsibilities refer to the values, characteristics, and decision-making of individual engineers. *Micro-Object* responsibilities refer to the values, characteristics, and culture of organisations where an engineer practices. *Macro-Subject* responsibilities refer to the values, mission and decision-making of the engineering profession or collectives. *Macro-Object* responsibilities refer to the social, economic and political structures and context driving engineering practice.

Table 3. Quadrant frame of engineering responsibilities (based on Blind)

Micro		
Micro-Subject Identify and mitigate immediate risks Develop and enact specific values, character traits, and attitudes Comply with legislation and professional standards Uphold human rights	**Micro-Object** Oppose unethical actions of managers or colleagues Contribute to workplace conditions for ethical practice Oppose work for unethical employers Act as a workplace ally	
Macro-Subject Foresee the long-term consequences of technological developments Develop technology for the public good Include stakeholders in technological innovation and exnovation Reflect on the values of the profession and integrate them in practice	**Macro-Object** Engage in collective activism Be involved in policy-making Engage in reforming unsustainable and unethical industries Engage in reforming the engineering profession	
Macro		

The left margin of the table reads vertically "Subject" and the right margin reads vertically "Object".

6. Findings

In what follows, the main themes purporting to students' views on their responsibility are presented for two guest storytellers.

6.1 Students' understanding of responsibility for storyteller Laura Nolan

The reflections on Laura Nolan's session reveal an understanding of engineering responsibilities shaped by her experience with Project Maven and her decision to speak out against the development of autonomous weapons. This session provided students with an opportunity to explore aspects related to professional practice when facing companywide misconduct, inspiring thoughtful analysis of individual action within a constrained environment.

One of the most frequently discussed themes was the responsibility to identify and mitigate immediate risks. Students recognized the high stakes involved in AI related projects, particularly the risks posed by autonomous weapons to human life and security. Reflecting on the potential harm caused by killer drones, one student noted, 'The risks this killer robot could create in the long run [...] show the importance of evolutionary normative uncertainties' (LN1). This comment highlights the students' awareness of the complexities in evaluating risks, especially those that may evolve over time. The emphasis on risk mitigation views engineering to be not only about simple technical solutions but also about addressing the ethical and societal consequences of technical operations.

Closely related to this is the importance of including stakeholders in technological innovation, a responsibility identified in all 8 reflections. Students emphasized that ethical engineering requires meaningful collaboration with stakeholders, especially those most vulnerable to the consequences of technological decisions. One reflection observed that 'the stakeholder group that could be a potential target of these automated drones is only affected by this risk, which puts them in a vulnerable position' (LN2). This critique demonstrates an appreciation for the power dynamics inherent in technological development and a call for engineers to actively engage and represent diverse perspectives to prevent harm.

The lecture also inspired students to reflect on the ethical foundations of engineering and the need to develop and enact specific values, character traits, and attitudes. Laura Nolan's decision to leave a major company rather than compromise her principles was a powerful example that resonated deeply with students. One student remarked that 'I find the decision of Laura for quitting the project Maven brave and valuable. The ethical consideration of Laura has outweighed the high revenue of this project' (LN1) suggesting that students view integrity as a cornerstone of professional responsibility. Laura's story brought students an awareness that engineers may have to prioritize ethical considerations over financial or career advantages, even when it requires personal sacrifice.

Another prominent theme was the responsibility to oppose unethical actions of managers or colleagues, particularly through whistleblowing. Students expressed admiration for Nolan's

advocacy and her decision to expose the risks of autonomous weapons, reframing whistleblowing as a moral obligation when other options have been exhausted. Two students described whistle-blowing as a 'last resort' (LN2, LN3). According to LN3, 'being a whistleblower can be seen as a last resort since you can get severely harmed [...] but you the engineer have the duty and most importantly the power to do this.' For LN2, the session 'basically explained when whistleblowing should be done. Which made it clear to me that is used as a last resort, not to just reveal information to the public about an activity that may be considered immoral, illicit, or unsafe.' These perspectives position whistleblowing as a critical, albeit challenging, act of responsibility, requiring courage and a commitment to the broader public good.

The reflections also revealed a strong awareness of the long-term consequences of technological developments. Students recognized the interconnectedness of engineering decisions and societal outcomes, acknowledging the difficulties of predicting and mitigating future risks. One participant reflected, 'technology grows exponentially, and sometimes ethics can't keep up with this speed' (LN4), highlighting the tension between rapid technological advancements and the slower pace of ethical and regulatory frameworks. This awareness points to the need for engineers to think critically about how their work will shape the future, particularly in high-impact fields like artificial intelligence and autonomous systems.

The reflections suggest that Laura Nolan's story served as a powerful case study for exploring the multifaceted nature of engineering responsibility. Her decision to leave Google, her advocacy for ethical practices, and her work with initiatives like 'Stop Killer Robots' provided students with a vivid example of how engineers can align their professional actions with societal values and engage in activism. Laura Nolan's lecture not only inspired critical reflection but also was described by students as 'practical' by offering insights into how to practice engineering with integrity.

Despite these strengths, certain responsibilities received less attention. For example, complying with legislation and professional standards and engaging in policy-making were mentioned infrequently. While students acknowledged the importance of laws in regulating harmful technologies, there was limited discussion about engineers' roles in shaping these laws or engaging with policymakers. Similarly, reforming industries was only briefly addressed, with a few reflections noting aspirations to work in sustainable sectors or improve existing practices. These gaps suggest that students primarily view their responsibilities through an individual or project-specific lens, with less emphasis on systemic change or collective action.

The reflections also revealed an interesting balance between micro and macro responsibilities. Students frequently emphasized individual-level actions, such as risk assessment and ethical decision-making, while also recognizing the broader implications of their work, such as stakeholder engagement and long-term foresight. However, macro-object responsibilities, like policy engagement and systemic reform, were less frequently mentioned,

indicating a need for situating both Micro and Macro subject responsibilities within broader socio-economic systems. By broadening their understanding of systemic issues and emphasizing their potential to influence policy and reform industries, students can be better equipped to navigate the complex challenges of the profession.

6.2 Students' understanding of responsibility for storyteller Zach Pirtle

The reflections on Zach Pirtle's session point to an understanding of responsibility as shaped by his insights into public engagement, interdisciplinary approaches, and the integration of philosophy in engineering project management. These reflections consider both immediate challenges and broader systemic issues

The responsibility of including stakeholders in technological innovation emerged as the most frequently mentioned category. Pirtle's discussion of NASA's deliberative processes resonated with students, who reflected on the value of diverse public participation. Through this session, ZP4 gained the insights that 'community participation can bring a whole new perspective to a project.' Another student noted his new awareness of participatory methods inspired by the detailed accounts of stakeholder inclusion in NASA deliberations, including strategies to minimize bias, emphasizing the importance of ensuring that public forums are representative and inclusive. For ZP3, 'Having diverse deliberators avoids the bias […] The deliberations yielded insights into people's priorities regarding costs, risks and schedules. […] Zach taught me the value of understanding society's view on research by showing how it can be applied in practice.' This approach not only enhances the legitimacy of engineering decisions but also ensures that solutions address the concerns and values of diverse communities. According to ZP1, 'values turn out to be a big part of decision making, and engineering students, myself included, focus so much on the factually correct solution, without taking real world influences into account. People have different opinions and values and when it comes to bridging the gap between science, engineering and philosophy, context is a major perspective which needs to be considered.'

Like for previous speakers, another prominent responsibility was the importance of identifying and mitigating immediate risks. Students frequently discussed the importance of managing risks associated with large-scale and publicly funded projects, particularly in the context of NASA's work. Several reflections highlighted the importance of discussions on managing risks associated with public funds and societal expectations, highlighting the need for engineers to balance technical solutions with public accountability. By addressing risks in a transparent and inclusive manner, engineers can build trust and ensure that their work aligns with societal needs. ZP5 'considered his approach and view as a proof of responsible engineering, which gave me valuable information and very interesting points of view regarding risk assessment on stakeholders. It made it clearer how important it is to analyse the risks properly and whom they may affect.'

The reflections also underscored the need to foresee the long-term consequences of technological developments. Students appreciated Pirtle's focus on the precautionary principle and the role of interdisciplinary perspectives in anticipating future risks. According

to ZP3, 'using participatory knowledge assessments is advantageous […] and raises the point of the importance of the precautionary principle.'

Pirtle's emphasis on developing and enacting specific values, character traits, and attitudes also resonated deeply with students. His integration of philosophy into engineering practice was particularly inspiring, as students recognized the importance of moral decision-making and interdisciplinary thinking. One reflection mentioned 'the value of interdisciplinary perspectives and moral decision-making,' suggesting that students are increasingly aware of the ethical dimensions of their work. For ZP2, 'by finding this middle ground between engineering and other disciplines you open a world of possibilities and opportunities for yourself in the future.' Through Zach Pirtle's story of his professional trajectory, students gained insights on how combining technical expertise with a philosophical outlook they can approach problems with greater depth and empathy as future engineers.

The responsibility to develop technology for the public good was another key theme, reflecting students' recognition that engineering should ultimately serve societal interests. Reflection emphasized the role of repeated discussions on engineering solutions aligning with public benefit and 'understanding what the public expects'(ZP3). Pirtle's examples from NASA illustrated how engineering projects can balance expert-driven innovation with public accountability, ensuring that technological advancements align with collective values and priorities.

Overall, the reflections highlighted the interplay between micro-subject and macro-subject responsibilities. Students frequently addressed micro-level responsibilities, such as risk mitigation, while also recognizing the importance of macro-level considerations, such as stakeholder inclusion, public accountability and systemic change. This may reflect Zach's detailed description of examples from NASA and his emphasis on public engagement, philosophical inquiry, and interdisciplinary collaboration.

While these responsibilities were prominently addressed, certain categories received less attention. For instance, complying with legislation and professional standards was mentioned infrequently, despite the importance of adhering to legal frameworks in publicly funded projects. This suggests that students may prioritize immediate ethical dilemmas and project-specific challenges or decisions.

Pirtle's personal story also challenged students to think critically about the role of philosophy in engineering. His discussion of using philosophical frameworks to approach complex problems encouraged students to adopt interdisciplinary perspectives and consider diverse viewpoints. One student reflected, 'philosophy has many different theories and lenses [...], allowing engineers to see problems through different ideologies and with the support of community participation' (ZP4). This insight highlights the potential for engineers to broaden their problem-solving approaches by integrating technical perspectives alongside societal considerations. As Z4 describes his new realisation that 'being an independent morally aware

engineer helps with decision-making [...] whether it is technical like landing a man on the moon or sociotechnical like community participation.'

These student insights underscore the importance of integrating ethics, philosophy, and public accountability into engineering education. Zach's session seems to have contributed to a broadening of students' understanding of participatory practices and the role of interdisciplinary thinking in navigating the complexities of modern engineering projects.

7. Discussion and limitations

The attempt to translate the concept of living library in engineering ethics education and complementing with reflective assignments may have several practical implications that point to its potential.

First, the integration of student reflections with living library case studies operated on multiple educational levels. First, reflections provided a structured opportunity for students to process the emotional dimensions of narratives shared by the speakers. Unlike traditional case studies presented as text, living libraries evoked affective responses as students witnessed firsthand accounts of ethical dilemmas, professional challenges, or social impacts. Reflective writing then created the space for students to acknowledge and examine these emotional reactions. This suggests the potential for further research on the role of living libraries and reflections in developing students' empathy.

Second, reflections seemed to facilitate the transition between abstract ethics theories and values to concrete experiences of practice. As the sessions followed theoretical sessions on ethics topics such as social justice, power relations, risk analysis, or participatory approaches to engineering. During the speaker sessions, students could connect the speakers' shared experienced to the course content presented via traditional lecturing. The end of course reflections then may give students the opportunity to make this learning personal and connect it to their own emerging identity as future professionals, a developmental process that might otherwise remain incomplete if the living library experience stands alone.

Third, the integration of student reflections with living library case studies can support a pedagogical approach that preserves the transformative potential of personal narrative exchange while ensuring these experiences contribute meaningfully to formal learning objectives.

Furthermore, reflections preserved the distinctive dialogic quality of living libraries when implemented within formal educational structures. The conversational nature of living library interactions represents a significant departure from traditional pedagogy, but this dialogic element risks being diminished or difficult to implement into conventional academic frameworks. Reflective assignments extend this dialogue beyond the initial encounter, encouraging students to continue engaging with the perspectives and experiences shared, albeit through internal conversation rather than direct exchange. This is linked to an inherent limitation of the 'formalisation' of an informal method of engagement, such as living libraries. Any attempt to translate it into formal educational settings is not a 1:1 replica of this informal approach. Either it is difficult to scale the number of speakers to the number of

students to preserve the intimate experience and dialogical nature of a living library, or it is difficult to find an appropriate space given the design of engineering campuses.

I suggest experimenting with and documenting different manners of implementing living libraries, tailored also to the specific aims of a course, the institution's profile or the local context in which it is set. This case study of teaching practice is seen by the author as an incipient attempt to make the ethics learning experience personal and for students to resonate with what may be complex and abstract concepts that they might not associate with engineering practice or an engineer's professional identity. For this, I recommend studies aiming to understand how reframing case studies as living libraries contributes to how students view themselves as future professionals and their main ethics take-aways.

8. Conclusion

As engineering educators continue to refine pedagogical methods that address ethics and social responsibility, living libraries offer a powerful extension and reimagining of the classic case study approach. While standard case studies can be effective in showcasing ethical principles, they sometimes remain abstract or detached from the immediacy of lived experience. Living libraries, by contrast, situate engineering dilemmas in personal narratives, rendering them more vivid and relatable.

This study represents an expansion of the traditional case method, transforming passive narrative analysis into interpersonal knowledge generation. The concept of living library was translated into the context of a Challenge Based Learning course on Decisions Under Risk and Uncertainty by having 4 guest speakers who took the role of storytellers, sharing with students their personal trajectory and professional experience with ethical decision-making and responsible practice. At the end of the course, students reflected on what they learned about responsibility from these sessions.

The living library as used in the course sparked transformative sharing of views and experiences that contributed to students' understanding of the societal impact of technological decisions and designs, as well as the role of stakeholder considerations and participatory approaches to mitigate short term and long terms risks. These real-world narratives challenged students to think critically about their values, their responsibilities as engineers, and the broader impact of their work. The present study points to the need for further research into integrating external perspectives of real-world practice in the engineering curriculum

References

[1] E. A. Cech, "Culture of disengagement in engineering education?," *Science, Technology and Human Values*, vol. 39, no. 1, pp. 42–72, 2014.

[2] M. Polmear, A. Bielefeldt, D. Knight, C. Swan, and N. Canney, "Faculty perceptions of challenges to educating engineering and computing students about ethics and societal impacts," in *Proc. American Society for Engineering Education Annual Conference Exposition*, Washington, DC, 2018.

[3] J. L. Hess and G. Fore, "A systematic literature review of US engineering ethics interventions," *Science and Engineering Ethics*, vol. 24, no. 2, pp. 551-583, 2018. doi: 10.1007/s11948-017-9910-6

[4] D. A. Martin, E. Conlon, and B. Bowe, "A multi-level review of engineering ethics education: Towards a socio-technical orientation of engineering education for ethics," *Science and Engineering Ethics*, vol. 27, no. 5, Article no. 60, 2021. doi: 10.1007/s11948-021-00333-6

[5] E. A. Cech and H. M. Sherick, "Depoliticization and the structure of engineering education," in *International Perspectives on Engineering Education*, S. Christensen, C. Didier, A. Jamison, M. Meganck, C. Mitcham, and B. Newberry, Eds. Cham: Springer, 2015, pp. 203-216. doi: 10.1007/978-3-319-16169-3_10

[6] S. Niles, S. Roudbari, and S. Contreras, "Integrating social justice and political engagement into engineering," *International Journal of Engineering, Social Justice, and Peace*, vol. 7, no. 1, pp. 52–64, 2020.

[7] A. R. Bielefeldt, M. Polmear, N. E. Canney, C. Swan, and D. Knight, "Institutional variations in ethics and societal impacts education: Practices and sufficiency perceptions among engineering educators," in *Proc. 2019 ASEE Annual Conference and Exposition*, 2019.

[8] M. Polmear, T. Børsen, H. A. Love, and A. Hedayati, "Literature review of teaching methods: Trends and ways forward to support engineering ethics instruction," in *The Routledge International Handbook of Engineering Ethics Education*, S. Chance, T. Børsen, D. A. Martin, R. Tormey, T. T. Lennerfors, and G. Bombaerts, Eds. Routledge, 2025.

[9] D. Riley, *Engineering and Social Justice*. Morgan & Claypool, 2008.

[10] A. L. Pawley, "'Asking questions, we walk': How should engineering education address equity, the climate crisis, and its own moral infrastructure?," *J. Eng. Educ.*, vol. 108, no. 4, pp. 447-452, 2019. doi: 10.1002/jee.20295

[11] M. Hughes Miller, Englehardt, E., Pritchard, M., LeFrancois, S., Centeno, G., Reeves, K & Roman, I. C., "Cultivating the ethical identities of STEM students through enhanced internships," in *Proc. ASEE Annual Conference & Exposition*, 2022. doi: 10.18260/1-2—40848

[12] D. A. Martin, E. Conlon, and B. Bowe, "Using case studies in engineering ethics education: The case for immersive scenarios through stakeholder engagement and real life data," *Australasian Journal of Engineering Education*, vol. 26, no. 1, pp. 47–63, 2021.

[13] A. R. Bielefeldt, "Listening to community voices as part of ethical civil engineering: Experiences in civil engineering courses," in *Proc. 2020 ASEE Virtual Annual Conference Content Access*, 2020.

[14] Y. Lambrinidou et al., "Ethnography in engineering ethics education: A pedagogy for transformational listening," in *Proc. 2014 ASEE Annual Conference & Exposition*, Indianapolis, Indiana, 2014. doi: 10.18260/1-2—20433

[15] G. Bombaerts, K. Doulougeri, S. Tsui, E. Laes, A. Spahn, and D. A. Martin, "Engineering students as co-creators in an ethics of technology course," *Science and Engineering Ethics*, vol. 27, no. 4, Article no. 48, 2021.

[16] S. M. Lord et al., "Creative curricula for changemaking engineers," in *Proc. 2018 World Engineering Education Forum - Global Engineering Deans Council (WEEF-GEDC)*, pp. 1-5, 2018.

[17] M. C. Loui, "What can students learn in an extended role-play simulation on technology and society?," *Bulletin of Science, Technology & Society*, vol. 29, no. 1, pp. 37–47, 2009.

[18] M. C. Loui, "Fieldwork and cooperative learning in professional ethics," *Teaching Philosophy*, vol. 23, no. 2, pp. 139–156, 2000.

[19] J. Lucena, J. Schneider, and J. Leydens, *Engineering and Sustainable Community Development*. Morgan & Claypool Publishers, 2010.

[20] A. Mazzurco and S. Daniel, "Socio-technical thinking of students and practitioners in the context of humanitarian engineering," *Journal of Engineering Education*, vol. 109, no. 2, pp. 243–261, 2020

[21] C. E. Harris, M. S. Pritchard, M. J. Rabins, R. James, and E. Englehardt, *Engineering Ethics: Concepts and Cases*, 6th ed. Cengage Learning, 2019.

[22] M. Lundeberg et al., "Case it or else! Fostering ethical awareness about human genetics," *Journal of College Science Teaching*, vol. 32, no. 1, pp. 64-69, 2002.

[23] C. Herzog, A. Johri, and R. Tormey, "Teaching ethics using case studies," in *The Routledge International Handbook of Engineering Ethics Education*, London, UK: Taylor and Francis, 2024, pp. 363-377. doi: 10.4324/9781003464259-25

[24] D. A. Martin, E. Conlon, and B. Bowe, "The role of role-play in student awareness of the social dimension of the engineering profession," *European Journal of Engineering Education*, vol. 44, no. 6, pp. 882–905, 2019. doi: 10.1080/03043797.2019.1624691

[25] W. R. Wilson, "Using the Chernobyl incident to teach engineering ethics," *Science and Engineering Ethics*, vol. 19, no. 2, pp. 625-640, 2013.

[26] J. Beever and A. O. Brightman, "Reflexive principlism as an effective approach for developing ethical reasoning in engineering," *Science and Engineering Ethics*, vol. 22, no. 1, pp. 275–291, 2016.

[27] B. Perlman and R. Varma, "Teaching engineering ethics," in *Proc. ASEE Annual Conference*, Albuquerque, New Mexico, 2001. doi: 10.18260/1-2—9860

[28] J. Radoff et al., "Examining the 'narrow' and 'expansive' socio-technical imaginaries influencing college students' collaborative reasoning about a design scenario," in *Proc. 2022 ASEE Annual Conference & Exposition*, 2022. doi: 10.18260/1-2

[29] C. A. Turpen et al., "Examining how engineering educators produce, reproduce, or challenge meritocracy and technocracy in pedagogical reasoning," in *Proc. ASEE Annual Conference & Exposition*, Tampa, Florida, 2019. doi: 10.18260/1-2—32778

[30] Y. Lambrinidou and N. E. Canney, "Professional formation of engineers' conceptions of 'the public'," in *Proc. ASEE Annual Conference & Exposition*, New Orleans, Louisiana, 2016. doi: 10.18260/p.25970

[31] P. Little, D. Barney, and R. Hink, "Living up to the code: Engineering as political judgment," *International Journal of Engineering Education*, vol. 24, no. 2, pp. 314-327, 2008.

[32] E. Conlon, "Prisoners of the capitalist machine: Captivity and the corporate engineer," in *The Engineering-Business Nexus*, S. H. Christensen, B. Delahousse, C. Didier, M. Meganck, and M. Murphy, Eds. Cham: Springer, 2019, pp. 67-83. doi: 10.1007/978-3-319-99636-3_3

[33] A. E. Slaton, "Meritocracy, technocracy, democracy: Understandings of racial and gender equity in American engineering education," in *International Perspectives on Engineering Education*, S. Christensen, C. Didier, A. Jamison, M. Meganck, C. Mitcham, and B. Newberry, Eds. Cham: Springer, 2015, pp. 171-189. doi: 10.1007/978-3-319-16169-3_8

[34] M. Lachney and D. A. Banks, "Teaching the non-neutral engineer: Pathways toward addressing the violence of engineering in the classroom," in *Proc. ASEE Annual Conference & Exposition*, Columbus, Ohio, 2017. doi: 10.18260/1-2—28928

[35] L. A. Morrison, "Situating moral agency: How postphenomenology can benefit engineering ethics," *Science and Engineering Ethics*, vol. 26, no. 3, pp. 1377–1401, 2020. doi: 10.1007/s11948-019-00163-7

[36] R. Lawlor, "Teaching engineering ethics: A dissenting voice," *Australasian Journal of Engineering Education*, vol. 26, no. 1, pp. 38–46, 2021. doi: 10.1080/22054952.2021.1925404

[37] "Human Library Organization," [Online]. Available: http://humanlibrary.org, Accessed on: May 1, 2025.

[38] R. Abergel, A. Rothemund, G. Titley, and P. Wootsch, "Don't judge a book by its cover: The Living Library Organiser's Guide," Council of Europe, Budapest, Hungary, 2005.

[39] R. Pardasani and W. Rivera, "Human library: An anti-oppressive tool: Implementation guidelines for a human library," Diaconia University of Applied Sciences, Finland, 2017.

[40] R. G. Garbutt, "The living library: Some theoretical approaches to a strategy for activating human rights and peace," in *Proc. Activating Human Rights and Peace: Universal Responsibility Conference 2008*, Southern Cross University, 2008.

[41] N. Little, G. Nemutlu, J. Magic, and B. Molnár, "Don't judge a book by its cover: The Living Library Organiser's Guide 2011," Council of Europe, 2011.

[42] R. Malhi, G. Perez, J. Shafiq, and A. Johnston, "Practical tips for using a Human Library approach in medical education," *MedEdPublish*, vol. 13, Article no. 208, 2023. doi: 10.12688/mep.19746.1

[43] K. Pope, H. Hewlin-Vita, and E. M. Y. Chu, "The Human Library and the development of cultural awareness and sensitivity in occupational therapy students: A mixed methods study," *Frontiers in Medicine*, vol. 10, Article no. 1215464, 2023. doi: 10.3389/fmed.2023.1215464

[44] R. Sen et al., "The Living Library in social work education," in *Involving Service Users in Social Work Education, Research and Policy: A Comparative European Analysis*, K. Driessens and V. Lyssens-Danneboom, Eds. Policy Press, 2021, pp. 73-84. doi: 10.51952/9781447358350.ch007

[45] A. Pedersen, I. Walker, and M. Wise, "'Talk does not cook rice': Beyond anti-racism rhetoric to strategies for social action," *Australian Psychologist*, vol. 40, no. 1, pp. 20-31, 2005.

[46] S. Jablon-Roberts and A. McCracken, "Undergraduate student perceptions of industry guest speakers in the college classroom," *Journal of the Scholarship of Teaching and Learning*, vol. 22, no. 3, 2022. doi: 10.14434/josotl.v22i3.32317

[47] T. Dreher and J. Mowbray, "The power of one on one: Human libraries and the challenges of antiracism work," UTS Publishing, 2012.

[48] D. A. Martin, G. Bombaerts, and A. Johri, "Ethics is a disempowered subject in the engineering curriculum," in *Proc. SEFI 49th Annual Conference: Blended Learning in Engineering Education: Challenging, Enlightening – and Lasting?*, pp. 357-365, 2021. [Online]. Available: https://www.sefi.be/wp-content/uploads/2021/12/SEFI49th-Proceedings-final.pdf

[49] B. Pauli, *Flint Fights Back: Environmental Justice and Democracy in the Flint Water Crisis*. Cambridge, MA: MIT Press, 2019.

[50] A. D. Christy and M. Lima, "The use of student portfolios in engineering instruction," *Journal of Engineering Education*, vol. 87, no. 2, pp. 143-148, 1998. doi: 10.1002/j.2168-9830.1998.tb00334.x

[51] P. Wallin and T. Adawi, "The reflective diary as a method for the formative assessment of self-regulated learning," *European Journal of Engineering Education*, vol. 43, no. 4, pp. 507-521, 2018. doi: 10.1080/03043797.2017.1290585

[52] S. Warmington, M. Johansen, and H. Wilson, "Identity construction in medical student stories about experiences of disgust in early nursing home placements: A dialogical narrative analysis," *BMJ Open*, vol. 12, Article no. e051900, 2022. doi: 10.1136/bmjopen-2021-051900

[53] P. Hermsen, S. van Dommelen, P. Hueso Espinosa, and M. van den Bogaard, "The power of perspective dialogue: Unlocking transformative reflection in engineering education (practice)," in *Proc. European Society for Engineering Education (SEFI)*, 2023. doi: 10.21427/ED54-6E19

[54] S. Daniel, A. Yeaman, and W. Oakes, "Ethics in service-learning and humanitarian engineering education," in *The Routledge International Handbook of Engineering Ethics Education*, S. Chance, T. Børsen, D. A. Martin, R. Tormey, T. T. Lennerfors, and G. Bombaerts, Eds. London: Routledge, 2025,

[55] L. Marin, Y. Jalali, A. Morrison, and C. Voinea, "Reflective and dialogical approaches in engineering ethics education," in *The Routledge International Handbook of Engineering Ethics Education*, S. Chance, T. Børsen, D. A. Martin, R. Tormey, T. T. Lennerfors, and G. Bombaerts, Eds. New York, NY: Routledge, 2025, pp. 441-458.

[56] G. Bombaerts, D. A. Martin, A. Watkins, and K. Doulougeri, "Reflection to support ethics learning in an interdisciplinary challenge-based learning course," in *Proc. 2022 IEEE Global Engineering Education Conference (EDUCON)*, pp. 1393–1400, 2022. doi: 10.1109/EDUCON52537.2022.9766569

[57] N. Dukhan, M. R. Schumack, and J. J. Daniels, "Implementation of service learning in engineering and its impact on students' attitudes and identity," *European Journal of Engineering Education*, vol. 33, no. 1, pp. 21-31, 2008.

[58] J. Saldaña, *The Coding Manual for Qualitative Researchers*. Sage Publications, 2016.

[59] D. A. Martin, "A conceptual framework for defining the responsibilities of engineers," in *Proc. Association for Practical and Professional Ethics Annual Conference*, 2025.

[60] J. R. Herkert, "Ways of thinking about and teaching ethical problem solving: Microethics and macroethics in engineering," *Science and Engineering Ethics*, vol. 11, no. 3, pp. 373-385, 2005.

[61] E. Conlon, "Marco, micro, structure, agency: Analysing approaches to engineering ethics," in *Proc. SEFI Conference*, 2011.