What Is Engineering Ethics Education? Exploring How the Education of Ethics Is Defined by Engineering Instructors

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Funder: This research received no external funding

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Chapter · April 2023

DOI: 10.1007/978-3-031-25233-4_20

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WHAT IS ENGINEERING ETHICS EDUCATION? EXPLORING HOW THE EDUCATION OF ETHICS IS DEFINED BY ENGINEERING INSTRUCTORS

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ABSTRACT

The literature on engineering ethics education highlights the diversity of goals and topics employed in its instruction. The contribution aims to examine the conceptualisation of engineering ethics education in terms of how it is defined and how its goals are articulated. The research is conducted in cooperation with the national accrediting body Engineers Ireland. It is based on interviews with instructors teaching modules self-identified by engineering programmes as having a strong ethical component and evaluators serving on accreditation panels. The main findings confirm the existence of a varied and uneven understanding of engineering ethics education. The study encountered conflicting views and lack of clarity as to what falls under the scope of engineering ethics education, especially when considering the topics of sustainability and safety. In terms of goals, instructors emphasize fostering responsibility, enabling agency and developing broad and critical thinkers, while value sensitive design was found to have a lesser conceptual prominence. The study also found that engineering ethics is preponderantly defined through its connection to engineering practice, rather than in its theoretical dimension. The chapter is envisioned to contribute to debates tracing the conceptual domain of engineering ethics education, given that clarifying educational goals is an important prerequisite for employing and designing consistent instructional methods.

Keywords: engineering ethics education; learning goals; macroethics; microethics; interviews

1. INTRODUCTION

There is a diverse conceptualisation of engineering ethics education put forward by dedicated scholars and researchers, representative of broad theoretical approaches such as microethics, macroethics, value sensitive design, virtue ethics or feminism (Martin et al, 2021a). Nevertheless, the reality of the teaching practice points to an uneven conceptualisation of engineering ethics (Colby & Sullivan, 2008; Polmear et al, 2019), such that there is a limited understanding of the extent to which the different theoretical conceptualisations of the subject are present in the classroom (Bielefeldt et al., 2016; Mitcham, 2017; Hess & Fore, 2018). This is compounded by the instructors' lack of familiarity and training in teaching ethics (Walczak et al., 2010; Barry & Herkert, 2014), which risks leading to a limited treatment of ethics that transmits simplistic messages to students (Holsapple et al., 2012).

The contribution is part of a broader mixed-methods study conducted in cooperation with the national accreditation body Engineers Ireland that examined the conceptualisation and education of ethics in engineering programmes in Ireland. It aims to examine how engineering instructors in Ireland define ethics education, aiming to situate their understanding of the subject within theoretical debates. As such, the chapter will contribute to the discussion on how ethics teaching is perceived by instructors and the topics that are relevant for courses on Engineering Ethics. We make clear the limitation that other important issues, such as methodological issues of professional ethics teaching, will not be considered in this chapter, due to the magnitude of these topics.

2. BACKGROUND

Engineering ethics is a branch of professional ethics, focused on the specific social role of engineers (Lynch & Kline, 2000). According to Harris *et al* (2009), professional ethics is one of the three categories of morality, alongside common morality and personal morality. It refers to a set of ethical principles adopted by a particular profession *qua* professionals, and usually instantiated into a body of professional codes.

2.1 Definitions of engineering ethics

In the first report commissioned in the US on the state of engineering ethics, the subject was defined as "dealing with judgments and decisions concerning the actions of engineers (individually or collectively) which involve moral principles" (Baum, 1980, pp.2–3). It studies the decisions, policies, and values that are morally desirable in engineering practice and research (Martin & Schinzinger, 2013). Herkert (2002) considers that the key concept in engineering ethics is "professional responsibility", a concept understood by Whitbeck (1998) as the "exercise of judgment and care to achieve or maintain a desirable state of affairs." As such, engineering ethics must address questions about ethical principles, rules of practice, justification, good judgment and decision making (Pritchard, 2005).

Harris et al (2009) provide a list of possible outcomes for the education of engineering ethics, such as stimulating the ethical imagination of students, enhancing recognition of ethical issues, facilitating the analysis of key ethical principles, helping students deal with ambiguity, encouraging students to take ethics seriously, increasing students' sensitivity to ethical issues, increasing knowledge of relevant standards, improving ethical judgement and increasing ethical willpower. Davis (1999) names four goals of engineering ethics education: enhancing ethical sensitivity, increasing knowledge of relevant standards of conduct, improving ethical judgment and enhancing ethical will-power. Devon (1999) suggests broadening the goals of engineering ethics education, from an individual focus to a new approach he labels "social ethics" which aims to make students aware of the "social relations of expertise" in connection with technology management and decision-making. Similarly, Haws (2001) argues that engineering ethics should aim to cultivate students' concern for public health and safety and help them defend their solutions to ethical problems.

Other goals that have been mentioned are taking a stance towards technological developments (Keirl, 2003), empowering students to reshape the social, economic and legal context of engineering practice (Conlon & Zandvoort 2011), helping students identify which organizational practices can potentially threaten public safety and welfare (Lynch & Kline, 2000), enhance students' awareness of the social dimension of engineering practice (Martin et al., 2019) and raising awareness of how designers implicitly or explicitly inscribe values and modes of use and interaction into their products (Verbeek, 2008). A more detailed description of the goals for engineering ethics education can be found in Table 2 of the literature on engineering ethics education we surveyed in Martin et al (2021a).

2.2 Conceptual models of engineering ethics education

According to Herkert (2005), there are two major theoretical frames for engineering ethics education: the microethical approach focused on the individualistic perspective of an agent faced with an ethical dilemma, and the macroethical approach concerned with the collective responsibilities of the profession and societal decision-making about technology. Another popular theoretical approach is value sensitive design, which shifts the focus away from assigning responsibility in situations of crisis to reflection about the values inscribed in technological artefacts at the design stage (Verbeek 2008). The feminist approach is closely aligned with the precepts of value sensitive design (Whitbeck, 1998), by reflecting on the gendered assumptions inherent in technological design and promoting the development of technological artefacts that do not discriminate against the female gender (Michefelder *et al.,* 2017). It has a common history and agenda with social justice movements, through the focus on ending "different kinds of oppression, to create economic equality, to uphold human rights and dignity, and to restore right relationships among all people" (Riley *et al.,* 2009, Riley, 2013). Finally, virtue ethics is an aspirational theoretical approach, whose focus lies not on the rightness of engineering decisions, actions or outcomes, but on the attitudes or virtues of the deciding moral subjects (Schmidt, 2014; Hillerbrand & Roeser, 2016), thus emphasizing character development (Harris, 2008). These approaches serve as guidance in categorizing how participants understand the discipline of engineering ethics education.

3. METHODS

This contribution is part of the first author's doctoral study conducted in cooperation with the accreditation body Engineers Ireland, which examined the conceptualisation, implementation and teaching of ethics in engineering programmes in Ireland (Martin, 2020). While the larger study employs mixed methods, the research method for exploring how engineering ethics is defined is qualitative in nature. The research questions that are the focus of this chapter are:

RQ1: How is ethics as a subject in the engineering curricula defined?
RQ2: What is understood to fall under the scope of engineering ethics education?
RQ3: How can these understandings of ethics be subsumed under broader theoretical frames?

To address them, we rely on semi-structured interviews with 16 instructors[1] teaching ethics content in six institutions whose engineering programmes underwent accreditation between 2017-2019 and 5 evaluators[2] serving on the accreditation panels of these programmes (Table 1). Given that instructors have the role of "curriculum workers" (Ornstein & Hunkins 2013), it was important to explore through in-depth interviews how they define engineering ethics education and how their understanding of the subject inform their teaching approach. Evaluators serving on accreditation panels were included due to the significant role their recommendations play in shaping the engineering curriculum.

For the interview analysis, we sorted the data into meaningful categories following two coding iterations (Lofland, 2009). While the first coding iteration inspected the interview transcript line by line, enquiring what each item represents and what is an example of, the second coding iteration led to a more analytical organization of the previously identified meanings and examples into themes.

Table 1 Main demographic characteristics

Demographic Category	**Interview participants (n=21)**		
Gender	F: 7	M: 14	non-binary/other 0

[1] Abbreviated as L1 to L16.
[2] Abbreviated as E1 to E5.

Age (in years)	<30: 0 30-39: 3 40-49: 9 50-59: 6 >60: 3
Specialization	Engineering: 18 Philosophy: 3

The analysis process was recorded in a codebook developed by the first author which included the code theme, its definition that specifies inclusion and exclusion criteria, and examples rendering verbatim the participants' answers (DeCuir-Gunby *et al*, 2010). As such, a well-documented audit trail of materials was established, which contributed to the reliability of the analysis. To ensure inter-rater reliability higher than 75%, the authors discussed the thematic categories before coding separately the first four interviews. Any discrepancies in coding were discussed, to understand the rationale for opting for different codes, before rechecking for consistency by coding separately a fifth interview. The remaining interviews were coded by the first author.

4. DEFINING ENGINEERING ETHICS

Exploring the participants' views on engineering ethics education, a variety of –sometimes opposing– conceptions is revealed. In what follows, we are presenting the major ways in which engineering ethics has been defined, rendered in Table 2.

Table 1. Definition of engineering ethics education (Total=21)

Engineering ethics education is..	**Respondents expressing agreement**	**Respondents expressing disagreement**
about decision-making in complex situations	9 (7L; 2E)	1 (E)
relevant to engineering practice	6 (5L; 1E)	1 (E)
socially embedded	4 (L)	
character shaping	5 (4L; 1E)	1 (L)
common sense and obvious	1 (L)	1 (L)[3]

4.1 Decision-making in complex situations

The interviews revealed a strong focus on the decision-making dimension of engineering ethics. E5, who took part in the discussions about the introduction in Ireland of an accreditation criterion dedicated to ethics, recounted the description of this outcome given by the registrar of Engineers Ireland at that time. The representative of the accreditation body was said to stress to programme chairs that decision-making is at the core of engineering ethics. More

[3] This is the same instructor that agrees that ethics is common sense and obvious, as she expressed these two contrasting opinions during the interview;

specifically, “what falls within the scope of this programme outcome has everything to do with decisions relating to people, to society and to the environment.”

This view is shared by 9 participants, who defined engineering ethics as involving decision-making (L2; L4; L5; L7; L8; L12; L13; E1; E5). In this sense, ethics is conceived to be about confronting dilemmas and making difficult decisions. As instructor L4 claims, “ethics is not about a simple 'this is right, this is wrong' answer. Ethical questions are complicated. If it is a simple question, if it is a case of something that is obvious, it is not really an ethical question.” This view is mirrored by instructor L2, who considers that “ethics always comes in when it is a hard decision to make, a difficult decision. If it is an easy decision, I think ethics just does not come into it.”

Ethical decision-making is described as “complex” and situated in “grey areas.” The increasingly challenging character of decisions that engineers have to make means that “the more complex the world becomes, the more important ethics is” (L7). Closely linked to the previous conception, we encounter a vision of engineering ethics concerned with ambiguous situations and uncertainty. Decision-making situated in “grey areas” was explicitly mentioned by five participants (L5; L7; L9; L14; L15; E3). According to E3, “engineering is very often about being precise, being black and white, and ethics is about being comfortable with grey.” L5 considers that with ethics, “there is always going to be a grey area and you have to make some kind of decisions,” while L14 states that ethics does not deal with “things that are obviously morally wrong, we are talking about very grey areas.”

It is important for ethical decision-making to be “value based” (L8) and considerate of a wide range of “satellite effects” (L10; L15), constricting factors (L7; L9; L14) and stakeholders (L8; L11; L15).

Commenting on how the complexity of ethical decision-making is integrated in engineering education, L8 considers that “traditionally and currently, ethics is seen as being something that is just about the right or wrong thing for an individual to do in a non-problematic environment.” According to L8, “engineering educators should make explicit not just the individualistic moralistic point of view.”

Although the participants revealed a prevalent view according to which engineering ethics is about decision-making in ambiguous and complex situations, one respondent disagrees, considering that “ethics is about life and death situations” and “in engineering the consequences are not so severe” (E1).

4.2 Connection to practice

Another definition expressed points to the practical nature of engineering ethics, set in opposition to "philosophical" ethics. According to six participants, engineering ethics is less theoretical in nature and strongly linked to practice (L4; L8; L9; L10; L11; E3).

This view is best rendered by an instructor with a background in philosophy. L9 describes teaching ethics differently to engineering students than she would teach philosophy students:

> I am not going to talk about Kant and Aristotle, that is not going to do anything. The way I understand professional ethics is very close to professional practice. So I need to understand how and what engineers are doing, what kinds of devices they will be developing, how they interact with people, whether they are working in big companies or individually, in order to have a sense of what are the actual practical challenges.

She considers that a "cognitive divorce from practice" exists in the education of engineering ethics and is "not sure" if a theory focused instruction would "make engineers more ethical."

The distinction between how ethics is understood and taught by philosophers as opposed to engineers has been described as an important reason why instructors and the programmes they are part of do not reach out to philosophy departments to collaborate on the implementation and teaching of ethics. L4 explains why the collaboration with a philosopher specialised in the ethics of technologies and science has ended, noting that

> partly because his presentation was more aimed at philosophers. There was more obvious ethics, and I wanted to give students a background in ethics, but more focused towards things they are likely to experience in work situations […] and trying to make it more practical.

Similarly, L2 does not collaborate with members of the philosophy department "because philosophy sometimes can be not practical enough." L12 also comments on his department's decision to forgo a collaboration with the philosophy department, highlighting the difference between the abstract nature of ethics instruction in philosophy education, as opposed to the practical dimension of ethics encountered in the engineering workplace:

> one option would have been at the extreme end to get our philosophy department to give formal lectures on ethics. We had some very brief discussions about that, but it seemed that they wanted to do a very theoretical sort of ethics, a series of ten lectures and that was it. And we felt that was not the way that it would help our students.

E3 emphasizes the importance for engineering programmes to include the practical dimension of ethics, as opposed to teaching ethics in an abstract way. He thinks that academia and industry "look at ethics completely differently. The academic guys look at ethics very much in the academic sense, referencing, plagiarism, and they talk about responsibility to the environment in kind of abstract terms."

The connection of engineering ethics to practice is traced back to the pervasiveness of ethics (L8, L10, L11, E3). L8 considers that "there are values in anything we do in our engineering practice, embedded in our practice." L11 states that ethics is "imbued across all their activities," while E3 considers that "ethics permeates everything." L10 sees the pervasiveness of ethics:

> everything engineers do has a potentially ethical dimension. They do not have to be a senior manager in Ireland or for a space shuttle to make decisions that have ethical consequences. A very strong example is the medical device industry, where a big percentage of our graduates are working. The work they do every day can have a real impact on the quality of life for people who use these products.

Not all those interviewed agree with the presence of ethical concerns in engineering practice, with E1 stating that "unlike pharmacy," engineering is "isolated from ethics."

4.3 Social embeddedness

According to four participants (L1, L9, L11; L14), engineering ethics is about including the perspectives and needs of different stakeholders. The rationale is that engineering does not happen *in abstracto*. More so, L9 emphasizes the social dimension of engineering as a key to understanding the practical character of engineering ethics, given that "ethical practice is part of social dynamics to some extent." L1 agrees that "a lot of the questioning and the ethics will be looking at something from various sides, from other people's point of view."

4.4 Character shaping and moral development

Six of the participants interviewed mentioned the character shaping nature of ethics education (L2; L4; L8; L11; L15; E1). One instructor considers that ethics is not about moralising, while five participants understand engineering ethics education in terms of its character shaping role. As such, L8 does not consider his "role as to be moralising or telling students this is right and this is wrong, telling them how to think or what to think." Nevertheless, E1 disagrees with this view, considering that ethics instructors should be a role model that guides students in their practice through the power of example. According to E1,

> you need to be ethical in every way, the way you deal with the students, as well as how you deal with the topic, and try to encourage them to deal with it. I suppose you have to practice what you say is about.

L11 considers that engineering ethics education should impact not only the "professional sphere," but also the "personal sphere." According to L11, fostering the development of personal virtues affects how one practices engineering. Virtues such as

> intellectual discipline, intellectual courage and intellectual empathy are woven into everything else that you would do in your professional life in terms of your interactions with all of the stakeholders. I see the building of a certain kind of character as an essential part of what we do.

L4 agrees that ethics education can have a transformative role, stating that "I cannot control how students are like personality wise," but "by broadening their picture, you have some influence on them." L2 emphasizes the role of motives guiding engineering practice. According to L2, engineering ethics implies making decisions based on the right reasons, and that "doing good deeds is not necessarily a good moral behaviour, because you could be doing good deeds for the wrong reason […] and be legally OK, but morally and ethically wrong." L15 considers that "the purpose of an education is formation, essentially. So you are forming these young people into being really good engineers."

4.5 Common sense

According to Harris *et al. (*2009, p.8), common morality is one of the three types of ethics and represents "the set of moral beliefs shared by almost everyone." L1 is the only participant who points to an underlying common-sense view of engineering ethics that informs education, according to which ethics is "obvious" and "a given." As L1 explains,

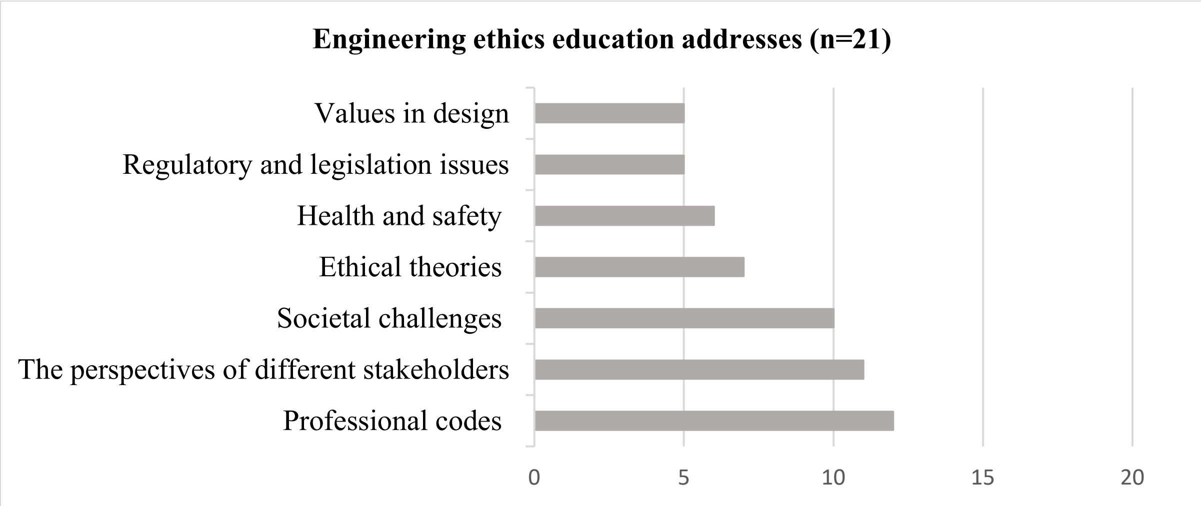
> we know certain things are good and bad. We have a moral compass of our own that we know what is good and bad. […] There is a common sense approach to some of it [..], so ethics seems to be kind of brushed over to a certain degree as a given. […] Probably because some of it is obvious.

Through the course of the interview, while reflecting on some instances of ethical decision-making in engineering practice, L1 starts to cast doubt on the view previously expressed, admitting that "maybe, maybe ethics is not as common sense as I think it is." This change of mind is also reflective of the confusion generated by attempts to define engineering ethics education and what falls under its scope, an issue which we will return to later in the chapter.

5. THE SCOPE OF ENGINEERING ETHICS EDUCATION

During interviews, we encountered different views about what counts as engineering ethics education (Figure 1), in some cases marked by confusion and disagreement. In what follows we present how the coverage of engineering ethics education, as understood by the participants interviewed, could be interpreted as falling under the major theoretical approaches. Only one participant (L8) explicitly situated his teaching in one of these approaches, as macroethical.

Figure 1. The scope of engineering ethics education



5.1 Macroethical scope

Ten participants (L4; L6; L8; L9; L10; L11; L12; L13; L16; E3) highlight the need to extend the scope of ethics content to broader societal considerations, including how to tackle grand challenges. Reflecting on current educational practices, L8 considers that this "broader societal understanding of ethics is perhaps slightly deficient or wanting". L10 emphasizes the role of engineering ethics education in contributing to the betterment of society and addressing the "massive societal challenges ahead," while also stressing the need for "the engineering profession as a whole in stepping up to that." L10 considers that preparing engineers to take such responsibilities to heart "begins in education." According to L10, "ethics is not only about engineers as employees, but as citizens and their responsibilities for far bigger things."

The need for a broad set of responsibilities is highlighted by L13, who considers that

> one of the discriminators between scientists and engineers is that the engineer must think broader in their solution of a problem. They just do not come up with a numerical value to solve a problem, they have to consider […] any issues that could have an impact on society in general. Coming into all that focus, ethics has a huge role to play.

L12 also emphasizes the inclusion of "a wider picture with a wider group and community that would be affected by the work of engineers."

When describing what falls under the extended scope of engineering ethics education, three main areas of coverage are revealed: sustainability, the societal dimension of engineering and legislation. These coverage areas can "make explicit not just the individualistic moralistic point of view," as L8 considers.

5.1.1 Sustainability

Sustainability is the topic most often mentioned in connection to broadening the education of ethics (L3; L4; L6; L8; L10; L11; L13; L15; L16; E2). Its role is linked with the impact of engineering on the environment and fighting climate change. According to L6, "the responsibility for global sustainability and influencing or not influencing climate change is included in what we do, but it is getting stronger." The sustainable goals are mentioned by instructors L2, L8 and L16, but also waste disposal and recycling, with E2 considering that "anything you are disposing of would be under the category of ethics."

While we see a strong focus on sustainability in the participants' interpretation of what type of coverage falls under the scope of engineering ethics education, we also encountered a dissenting opinion. For example, L2 does not consider that ethics is about sustainability, sharing this view also with her students. According to L2, "students do not really understand ethics. I find they get it confused with sustainability or corporate social responsibility and all that kind of things, which is not ethics." The point is reinforced and questioned later on during the interview, hinting to a diminished expertise. When discussing the challenges encountered while teaching ethics, L2 points to the fact that

> the students do not always grasp what ethics is and they get it confused with sustainability or doing the right thing for the environment. It is kind of that, but really it is not. So it is challenging trying to get them to understand what ethics actually is. I do not always understand it myself.

Of a different opinion is L4, who also points to the challenge of making students recognize the wider range of issues falling under ethics, but who considers sustainability to be among these. According to L4, "one of the big problems was the students' ability to categorize something as being ethics."

5.1.2 Societal dimension of engineering

Another significant coverage area that falls under the scope engineering ethics education refers to the societal dimension of engineering. Ten participants (L1; L6; L8; L9; L10; L11; L12; L13; L16; E4) consider that ethics coverage should include the responsibilities that engineers have towards society and the impact of engineering practice on different stakeholders. According to L8, this can be understood to "incorporate the broader context of the organizational culture and societal culture." L11 adds that ethics education needs to comprise "the balance of issues around justice and fairness, harm and prevention of harm," given that "these are significant issues that are going to impact not just the stakeholder you are working for, but the community where that stakeholder is." For L10, engineering has an impact on the quality of life and growth of society, such that ethics education should address

> the kind of responsibility of engineers to do with that and also look historically at the correlation between the growth of technology and the growth of energy production with standards of living. […] We can see the historical advances over the last 200 years, and to connect that as a positive ethical achievement.

Several instructors note that ethics education should prompt students to engage with stakeholders in their practice. According to L14, students should tolerate different perspectives because "very few are going to spend the rest of their lives in a lab or in a purely design role, they will progress into some sort of management role, which means they are dealing with people." For L6, this means tackling dissenting opinions about the societal challenges engineers address, such as climate change, given that

> the debate and the public is becoming more and more polarised. Engineers have to work in that environment, so they have to be aware of it. Even if some of the extreme views are not consistent with the engineers' own beliefs, they have to be aware that they would come across it.

Stakeholder perspective and societal considerations are considered pivotal for engineering ethics education. According to L11, "when you are working in engineering, you have to think about all stakeholders," and ethics education can foster this type of reflection. L8 agrees that the mission of engineering ethics education is to develop "more fit for purpose engineers who can productively engage with society." Overall, for L13 it helps prepare "a more holistic engineer, who is more conscious of their role in society".

5.1.3 Regulation and legislation

Five respondents consider that engineering ethics education should include regulatory and legislative issues (L7; L9; L10; L14; L16). Such topics are seen to offer students an "all rounded view of engineering management" (L14).

According to L9, "it would make sense for engineers to know more about protected disclosures and whistle blowing in terms of the legislative part of it." Other topics that engineering students would benefit from are rooted in "which legislation do people want to be covered, for example, and […] how much data protection legislation do they actually need to know." L9 noticed that within an engineering programme "sometimes you get the law and it is totally separate from the ethics, and I think it needs to be integrated because a lot of the ethical questions are around the edges of the legal questions."

L10 considers that the inclusion of regulatory and legal issues could prompt engineers to take a more active role in policymaking. He singles out the medical profession, who "takes a role in advising the governments and in regulating, a much stronger role than the engineering profession has." Given the "massive societal challenges ahead now with climate change," L10 favours the inclusion of these topics to prepare "the engineering profession as a whole for stepping up to that. I guess that begins in education." L6 mentions topics such as "environmental directives," the "precautionary principle" and the "polluter pays principle" for preparing students to address climate change.

5.2 Microethical scope

The interviews revealed three main areas representative of microethics. These pertain to health and safety, professional codes and ethical theories.

5.2.1 Professional codes

Professional codes are a popular topic, included by twelve instructors (L1, L2, L3, L5, L6, L7, L9, L11, L12, L13, L15, L16).

Several instructors emphasize the importance of introducing students to the code of ethics from the first year. For L1, "it is worth highlighting to students at an early stage, if they become charter members of Engineers Ireland or members of any of the institution, what they are actually agreeing to do." L2 agrees and presents Engineers Ireland's code of ethics "even from the first year. So we are trying to tell them the criteria for just being a good engineer."

Although national code is presented by all participant instructors, three of them also include other professional codes. L6 includes

> the Irish Engineers Ireland code as well as the American Society of Civil Engineers code, just to show that they have a lot in common. […] What I have tried to give students is a view on what the situation is in a number of different countries, so they are not exclusively based on the way the codes are formulated in Ireland, because we expect them to be able to work anywhere in the world.

While L6's motivation for introducing students to different ethics codes is cast in terms of the globalization of the engineering workplace, L16 does so in order to frame concrete examples of improper practice and engineering failure. L16 introduced

> Engineers Ireland's code of practice and also the eight canons of the American Society of Civil Engineers, and we use these to understand and to discuss things that might be really high profile engineering failures, that might violate two different aspects of the code of ethics or where there was fundamentally a lack of understanding.

For a similar reason, L13 introduces "codes of ethics from various professional bodies and how they pertain to the work they are doing."

L15 addresses the rationale for an ethics code to guide engineers' work, stating that he includes "the more pertinent aspects of Engineers Ireland code, and why Engineers Ireland presents what it presents and why it does what it does, why it exists." L5 is "looking at the Code of ethics from the point of view of money," adding that "it is my view that the Engineers Ireland code of ethics is actually quite weak in this area."

L9 looks at the professional codes through the lens of "the ethical governance of the profession." The approach described by L9 starts with "Engineers Ireland's ethics code: this is what your profession says, those are the things your profession wants you to be aware of and those are their concerns, and that is what it means in practice." The code is also seen as facilitating students' understanding of the "concepts or ideas behind it, such as responsibility or accountability or sustainability and client management and consent and then transparency.

L3 noticed that students' reception is oftentimes problematic, as codes are regarded as irrelevant: "the problem is that many of our students are not members, and do not see it as relevant in their careers."

5.2.2 Health and safety

Six participants consider that ethics education should include health and safety (L2; L6; L9; L10; L11; L13). L16 understands this topic in terms of "putting appropriate safety measures in place and risk assessment," while L11 emphasizes the "focus on issues around safety and design, on quality control." L13 gives the example of robots in agriculture in order to prompt students to consider "what do we need to be aware of in terms of what can happen and what are the safety implications." One instructor explicitly mentioned that health and safety coverage by itself is insufficient (L9).

The topic attracted different opinions on its connection (or lack thereof) to engineering ethics education. While for L10, ethics "of course" includes health and safety considerations, 3 respondents expressed a lack of clarity towards the interpretation of health and safety as falling under the scope of ethics. L5 admits that until the members of an accreditation panel pointed out that this topic is part of ethics, there was an institutional lack of awareness of this fact. L5 explains how "it was pointed out to us by a preliminary review panel that whenever you are talking about safety issues you are addressing ethical matters, and we had not appreciated that fact until that point."

One evaluator also expressed doubts whether health and safety fall under ethics. E2 was "not sure exactly if safety may not be under the category of ethics." L2 views health and safety alongside ethics, but different from it, considering that ethics "is in there along with communication, teamwork, universal design, health and safety."

5.2.3 Ethical theories

Seven instructors mentioned ethical theories as falling under the scope of engineering ethics education (L1; L2; L4; L6; L7; L11; L15). Nevertheless, one instructor expressed doubts about how fitting this topic is because "there is nothing that is totally universal" (L9).

L6 includes issues such as "morality versus ethics, also environmental ethics, and here we look at different ways of thinking about it, the Western thinking, but there are also others approaches, extensionist and biocentric." L15 uses "various theories, both grounded in religion and in philosophy". L2 presents "all the different types of ethics, rights ethics, duty ethics, utilitarian ethics, virtue ethics, the different moral frameworks and the pros and cons of each of them." L1 also introduces different ethical theories and "the types of ethical decisions and that what is important is actually having that discussion where there is an ethical dilemma."

L4 notes that while "a small amount on ethical theories" is covered in the module, he considers that "I am not qualified to teach that, there is not enough time to cover it, and also they may not be particularly interested." L4 is not the only one who notes the challenges of preparing teaching ethical theories. L1 describes struggling in her first year of teaching, as she "just went with what I was given and it was very much just talking to the students and telling them these are the facts and I have read a few things about them." L2 "still can't really wrap my head around this" and finds the textbooks "too hard", so she prepares by watching and referring to the TV series The Good Place and videos on ethics posted on social media channels.

No other topic falling under engineering ethics education has been described as particularly challenging to grasp, as is the case with ethical theories. One possible explanation could be related to the demographic characteristics of those interviewed, who were educated during a time when ethics was largely absent from the engineering curricula.

5.3 Value sensitive design

Five instructors note that value sensitive design should be part of the ethical education of students (L3; L4; L8; L10; L15). The topic is presented through considerations about universal design (L4) and ergonomical design (L3), by inviting students to reflect on values inscribed in the development of engineering artefacts at the design stage. Although L12 admits not teaching about value sensitive design, he is aware that "some people bring it into their design work," coming across this approach during his experience as an accreditation evaluator.

6. DISCUSSION

The qualitative data gathered in the study found two main sources influencing engineering ethics instructors' understanding of the subject: the instructor's connection with engineering practice and the motivation to teach engineering ethics. The data is inconclusive for drawing inferences about the scope and understanding of the engineering ethics based on the participants' demographic, although it provides light on the confidence with which participants approach the subject based on their disciplinary profile.

First, the instructors' connection with engineering practice seemed to favour an understanding of ethics in more practical terms. As such, instructors who have professional experience outside academia, either in the private sector, in policymaking or healthcare, show a high concern with ethical decision-making in complex situation, the embeddedness of ethics in social situations and with topics related to sustainability, policy or professional codes. This is line with findings of our broader study into the teaching methods employed, who found that the non-academic background led to favouring the use of real-life case studies (Martin et al., 2021b). Instructors with an academic background seems to suggest a higher reliance on ethical theories, philosophical concepts and the character shaping role of ethics instruction.

Second, considering the motivation for teaching ethics, only four instructors admitted that they intended to teach a module that includes ethical content, while the majority of instructors mentioned the "necessity" of teaching ethics. The latter category is teaching ethics due to being asked at programme level to do so. Ten instructors admitted that initially they were not interested in teaching ethics, but there was no one else that could teach the subject and their non-academic background marked them as suitable instructors to the programme leadership. At the opposite end, we have two instructors who aimed to introduce ethical content in the curriculum of their engineering programme, and to attain this, had to pursue what they described to be an institutional battle. These two extreme attitudes are revealing of the status of ethics in the engineering curriculum, highlighting that ethics is a topic for which appears to be a lack of expertise and institutional support, minimum resources allocated and no dedicated hiring process minimum (Martin, 2020; Martin & Polmear, 2022).

Third, considering the demographic characteristics of the participants, the limited data does not allow us to trace patterns about how instructors understand and define engineering ethics. Our study found examples of microethical and macroethical understandings of engineering ethics among instructors with an engineering background or a philosophy background, distributed evenly across the different genders and age categories. The difference between instructors with a philosophy background and those with an engineering background consists in the confidence in teaching the subject expressed by the former demographic group, even if the scope was understood differently by the three philosopher participants, as comprising religious topics, professional aspects of engineering responsibility or applied ethics. The finding highlights the need for continuous professional development courses or trainings for instructors assigned to teach ethics, irrespective of their disciplinary background.

The diminished confidence and perceived lack of expertise for teaching ethics expressed by engineering instructors can be traced down to the education that engineering participants received, which did not include a mandatory requirement for ethics instruction. Ethics is a more recent component of the engineering curricula, such that our limited data seems to point towards a lower perceived expertise among the older cohort of participants in the study. Desha and Hargroves (2014, p. 46) found a similar rationale for the "lack of faculty competences" in sustainability education. According to Desha and Hargroves (2014, p. 46), "educators teach according to their education and experience" and "where sustainability has not formed part of their training, faculty are unlikely to consider it as a skill of value or be prepared to include it in programs".

7. CONCLUSION

The study confirms the existence of a varied and uneven understanding of engineering ethics education among instructors, which prompts us to suggest that there is a need for additional research in other geographical contexts about how engineering ethics education is understood and what theoretical approaches are made manifest to students. As our study found that the understanding of the discipline varies based on the experience of the instructor outside academia and the instructor's motivation to teach the subject, we recommend that future studies examine in more depth the influence of the disciplinary background on instructors' understanding of engineering ethics.

Several common themes emerge that point to the practical and decision-making character of the subject, but there are also points of contention as to what exactly engineering ethics education is about.

The study found that engineering ethics is preponderantly defined through its connection to engineering practice, rather than in its theoretical dimension. As Godfrey and Parker (2010, p.10) remark, “abstract, philosophical concepts, such as ethics and sustainability were unacceptable to both faculty and students unless taught in a practical, relevant context.” Participants reported a low engagement with ethical theories, with learning goals seldom targeting the development of theoretical knowledge about ethics in the form of knowledge of formal definitions, ethical theories and vocabulary, supporting the findings of Hess and Fore (2018). According to participants, engineering ethics is considered to come into play when decision-making in complex situations is required. The study also encountered an emphasis on the societal dimension of engineering, reflecting a similar focus to that identified by van de Poel and Roakkers (2011, p.25), who highlight the role of different actors in influencing “the direction taken by technological development and the relevant social consequences.”

While both the micro and macroethical approaches are endorsed by the participants in our study, other approaches such as value-based design are less represented in the education of engineering ethics, with feminist considerations being absent.

It is also notable that virtues representative of virtue ethics approaches, such as discipline, courage or empathy, are present at the level of how engineering ethics education is defined, but there is less information on how they are included. Only one instructor made explicit reference to virtue theories. The focus on the embeddedness of ethical decision-making in contexts of practice that require careful deliberation and critical reflection hints at developing the intellectual virtue of practical judgement or *phronesis* (Nair & Bulleit, 2020).

Similar to observations made by Herkert (2005) and Conlon and Zandvoort (2011), participants consider that sustainability, the societal dimension of engineering and legislation could provide a focus for broadening the curriculum to integrate ethics and STS.

Finally, it is notable that the study encountered disagreement and confusion as to what counts as engineering ethics education. A major challenge revealed by our study is experienced by instructors unfamiliar with the subject when identifying the ethical dimension of technical topics. The instructors expressed conflicting views and lack of clarity whether topics such as sustainability or health and safety purport to ethics. Reed *et al.* (2004) have similarly encountered situations when ethics has been incorporated without the awareness that ethical content has been touched upon. We suggest that this can be remedied through institutional support for the development of CPD training programs and resources, which could address the different conceptualisations of engineering ethics.

Of major importance is also the development of communities of engineering ethics instructors and sharing examples of teaching practice. The fPET meetings offer a crucial context for discussing the theoretical tenets of engineering ethics educations and ways to be passed on to students. As an outcome of these meetings, we see the aspirational approach put forward by Bowen (2010) towards a vision of the good inspired by McIntyre's practice of virtues, a virtue-based approach championed by Harris (2013) or Kanemitzu's (2018) take on Verbeek's mediation theory as a way to develop an aspirational view of ethics among engineers. This is exactly the type of curricular content that the research study found to be barely present in the teaching of ethics and also considered by instructors to be challenging, either due to students' lack of engagement or instructors lack of familiarity with philosophy. Ultimately, the chapter confirms the timeliness of dedicated sessions during the fPET biennial events and the need to further develop philosophically oriented educational strands at future fPET conferences.

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