Using case studies in engineering ethics education: the case for immersive scenarios through stakeholder engagement and real life data

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ABSTRACT

Our contribution is part of a broader study conducted in cooperation with the national accreditation body Engineers Ireland that examined the conceptualisation and education of ethics in engineering programmes in Ireland. The paper is a qualitative examination of the use of case studies in engineering ethics education and includes 23 engineering programmes from 6 higher education institutions in Ireland. The qualitative study aims to determine (RQ1) how cases are selected, (RQ2) the goals envisioned for engineering ethics case instruction, (RQ3) the characteristics of the scenarios employed and (RQ4) the preferred application by instructors. A first finding notes the diverse set of goals and application of ethics case studies. The focus is more on decision-making in professional contexts and less on power relations, equity and the broader societal mission of engineering. The second finding highlights the discrepancy between how instructors employ cases and their preferred application. Engineering ethics cases typically include individualistic, hypothetical and historical scenarios. Nevertheless, instructors favour immersive cases set in real or realistic contexts of practice, containing factual or real-time data, which can provoke students to reflect on broader ethical issues. Considering this aspirational discrepancy, we conclude with recommendations that can guide the development of engineering ethics case instruction.

1. Introduction

Case studies are considered to be the most popular method to teach engineering ethics (Herkert, Citation2000; Haws Citation2001; Colby and Sullivan Citation2008; Fotheringham Citation2008; Freyne and Hale Citation2009; Bairaktarova and Woodcock Citation2017). Nevertheless, there is little known on how cases are presented and the type of cases used (Yadav et al. Citation2007), how they should be taught (Davis and Yadav Citation2014, 172), and what approach serves the achievement of which learning goals (Romkey Citation2015). Empirical research on the use of case studies in engineering ethics education has preponderantly focused on students' reception and engagement with case content, as

well as their own perception in regard to the method's effectiveness (Lundeberg Citation2008; Yadav et al., Citation2010; Davis and Yadav Citation2014). Moreover, the unit of analysis was found to target one course or student group (Lundeberg Citation2008, 6). As such, as Dolmans et al. (Citation1997, 185) point out, principles of effective case design cannot be deduced from existing studies. This highlights the importance of designing and using cases that are evidence based rather than building on the instructor's experience or intuitive guidelines.

In light of the 'paucity of clear documentation regarding what and how ethics is taught' (Fore and Hess Citation2020, 1357), our contribution aims to respond to the need for scholarship in the area of engineering ethics case instruction highlighted by Yadav et al. (2010) and Davis and Yadav (Citation2014), as to determine how this teaching method is employed and what support might be needed to foster its development. This examination is prompted by the preference for teaching engineering ethics with case studies recorded in the literature, as well as by the calls for the development and adoption of case instruction issued by the Royal Academy of Engineering in the United Kingdom (Fotheringham Citation2008) and the National Academy of Engineering (Citation2005) in the United States. Our study is thus envisioned to contribute to engineering ethics research and instruction by revealing patterns in the application and goals of engineering ethics case instruction. It is also the first study in Ireland examining the use of case studies in engineering ethics education.

2. Background

There is a diverse set of goals envisioned for engineering ethics education (Hess and Fore Citation2018), but also a lack of clarity as to how to ensure the alignment between goals and teaching methods (Romkey Citation2015, p.25; Keefer et al. Citation2014, 250). A coherent curricular strategy implies that learning goals inform decisions about assessment (Borrego and Cutler Citation2010, 366), and are congruent with the delivery and pedagogical methods employed (Li and Fu Citation2012, 343). As Li and Fu (Citation2012) warn, lack of clarity might lead to missed educational opportunities.

In what follows, we aim to explore how case studies have been conceptualised in the literature in terms of their goals and the nature of the scenario employed.

2.1. Goals of engineering ethics case studies

Case studies are described as scenarios meant to closely reflect features of a profession (Herreid, Citation1994). They are expected to contain authentic professional problems, thus raising students' awareness of the type of situations and problems they might encounter in the workplace (Merseth Citation1994; Davis Citation1997; Davis and Yadav Citation2014; Martin et al Citation2019). While there is no empirical study exploring the goals of engineering ethics education specifically in connection to the use of case studies, the literature mentions a broad and diverse set of goals.

2.1.1. Goals related to professional conduct

A major goal set for cases is to provide opportunities for students to focus on standards of conduct for the members of the engineering profession, as well as increasing students' ethical sensitivity to professional standards (Davis Citation1999). Case studies can also strengthen the voice of engineers within large organisations (Herkert, Borenstein, and Miller Citation2020).

2.1.2. Goals oriented towards stakeholders

Another goal is raising awareness of the perspectives of different stakeholders (Haws Citation2001; Beever & Hess, Citation2016; Dempsey, Stamets, and Eggleson Citation2017; Martin, Conlon, and Bowe Citation2018, Citation2019; Børsen et al. Citation2021; Herkert, Borenstein, and Miller Citation2020). According to Haws (Citation2001, 227), case instruction needs to facilitate students' understanding of engineering outcomes from the perspective of the larger community. Cases inviting students to reflect on the nature of their own and others' engineered and technologically mediated lived-experiences could enhance their social responsibility (Morrison Citation2020, 1397). To ensure a strong social justice component, cases need to connect ethics with equity concerns (Rottmann and Reeve Citation2020). Scenarios that interrogate systemic patterns of privilege can encourage students to ensure just decisions and outcomes for the users and beneficiaries of engineering artefacts and technologies (Rottmann and Reeve Citation2020).

2.1.3.Goals related to global practice

Broadening the focus from the local community to the global aspects of engineering practice, case studies can raise awareness of the multinational and cultural differences enacted in engineering practice and how engineers from different backgrounds might define and solve problems differently (Jesiek et al., Citation2014; Zhu et al., Citation2020)

2.1.4.Goals focused on decision-making

Cases are also used to develop students' decision-making skills when confronted with ill-structured and fractious problems (Jonassen et al. Citation2009). Ill-structured problems are described as unanticipated problems that possess conflicting goals, multiple forms of representation and solution paths, as well as non-engineering success standards and constraints, making use of distributed knowledge and collaborative activity systems and placing a high importance on experience (Jonassen, Strobel, and Lee Citation2006). Fractious problems are characterised as novel, complex, ethically fraught, unavoidably public and divisive, and could lead to policy dysfunction (Berry Citation2007).

2.2. Nature of scenario

There are considerable variations in the content and implementation of engineering ethics case studies, marked by a lack of consensus as to which approach is more effective and towards which goals (Davis Citation1999; Gorman, Mehalik, and Werhane Citation2000; Herkert, Citation2000; Haws Citation2001; Harris, Pritchard, and Rabins Citation2009; Jonassen and Hernandez-Serrano Citation2002; Herreid, C. F. Citation2007a, Herreid, C. F. Citation2007b; Abaté Citation2011; Romkey Citation2015; Martin, Conlon, and Bowe Citation2019).