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RESEARCH ARTICLE

Compassion and engineering students' moral reasoning: The emotional experience of engineering ethics cases

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Abstract

Background: There has been an increase in interest in emotion in engineering and science ethics education. There is also evidence that emotional content in case studies may improve students' learning and enhance awareness, understanding, and motivation concerning ethical issues. Despite these potential benefits, however, emotions' relationship to moral reasoning remains controversial, with ongoing debate as to how much and in what way emotional content impacts on moral reasoning. Furthermore, only limited empirical research has explored how emotions affect students' moral reasoning in educational settings.

Purpose: The purpose of this study was to determine whether mild to moderate compassion-induced engineering ethics case contents affected the moral reasoning schemas activated in students.

Design/Method: We conducted experimental research using the Engineering and Science Issues Test (ESIT). First, we modified the six case studies of the ESIT, to increase the compassion associated with the cases' protagonists to a mild to moderate level. We tested this instrument with 207 participants to ensure the changes did affect compassion without impacting on other potential emotions. Then, in a second study with 305 participants, we investigated whether the changed compassion intensity of the protagonists in the case studies affected the moral reasoning schemas activated in participants.

Results: The induction of mild to moderate compassion did not impact the moral reasoning schemas activated. Findings also show that we managed to affect compassion intensity in the case studies without changing other emotions.

Conclusion: This study reveals how to include a targeted emotion in engineering case studies in order to improve students' learning without affecting the moral reasoning schemas activated.

KEYWORDS

case studies, compassion, emotions, engineering ethics education, moral reasoning

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1 | INTRODUCTION

Engineering is often conceived as a highly rational and technocratic activity in which emotions are seen as irrelevant or even detrimental to good decision making (Cech, 2013; Kellam et al., 2018; Lönngren, Adawi, & Berge, 2021). Similarly, the dominant traditions in moral psychology have long focused on rational thinking in moral reasoning, rather than on emotions (Haidt, 2001, 2012). It is perhaps not surprising then that when engineering and moral psychology are brought together in form of engineering ethics, emotions have not, historically, been seen as terribly important. Indeed, as Tormey (2020) has pointed out, the term "emotion" is hardly mentioned at all in a number of mainstream engineering ethics textbooks (e.g., Fleddermann, 2011; Harris et al., 2013; Van de Poel & Royakkers, 2011). There has, however, been some growth in interest in emotions in engineering ethics (e.g., Roeser, 2010, 2012, 2020) and in engineering ethics education (Hess et al., 2019; Hess et al., 2021; Hess, Beever, et al., 2017; Hess, Strobel, & Brightman, 2017; Sunderland, 2014; Sunderland et al., 2014).

Emotion has been argued to be important in enabling engineers to fully recognize and understand engineering risks (Roeser, 2012), while the emotional process of empathy, for example, has been identified as important in enabling engineers to properly assign value in ethical decision making (Hess et al., 2021). In addition to contributing to ethical recognition and judgment, emotions such as guilt and shame have also been identified as playing an important role in ethical motivation (e.g., Higgs et al., 2020). A further potential benefit of including emotions in engineering ethics education is pedagogical: Thiel et al. (2013) have found that the inclusion of information about the emotional state of the case's protagonist in ethics cases also increased participants' learning. There is also, however, evidence that this pedagogical effect may be most evident when the intensity of the emotion included is mild to moderate (Watts et al., 2017, p. 27).

Despite these arguments and evidence in favor of including emotional information in engineering ethics cases, there remain many questions about the impact of emotional information on ethical decision making. While Roeser (2010, 2012), for example, sees emotions as a source of "ethical insight" which can nourish the ethical reasoning of engineers, others see emotions as producing "ethical intuitions" which cloud rational thinking in engineering (Pawley, 2009) and consequently results in poor ethical decision making (Bloom, 2010; Kelly & Morar, 2014; Prinz, 2011). Hoffman (2008) has identified that, for example, while empathetic distress is typically associated with prosocial behavior, it can also affect people's decision-making process and, when very intense, can lead to withdrawal from ethical engagement. Since a person's approach to moral reasoning can be understood as being shaped by the prereflective moral reasoning schemas that are activated in response to a situation (J. Rest, Narvaez, Bebeau, & Thoma, 1999), and since the schemas activated are influenced by both the person's moral dispositions and by factors specific to the context (Thoma & Dong, 2014), it is worthwhile to explore how contextual factors (such as the emotion of the case's protagonist) affect the moral reasoning schemas that are activated by cases.

In doing so, however, it is important to move beyond a focus on emotions in general, and explore specific emotions. While Higgs et al. (2020) found guilt and shame has positive impacts on ethical motivation, Kligyte et al. (2013), for example, have found anger to be disruptive of ethical decision making. Emotions that respond to suffering in others such as empathetic distress and compassion have been identified as particularly relevant both in moral motivation and moral understanding, but also in potentially shifting the moral reasoning employed in a situation. Indeed, there is good reason to think that compassion may be a particularly important emotion to explore (Haidt, 2003). This leads to the following research question:

> *Research question*: Does the inclusion of information related to mild to moderate compassion of protagonists in engineering ethics cases affect the moral reasoning schemas activated in students?

2 | BACKGROUND

2.1 | What are emotions?

Various fields of study define emotions in a wide range of different ways (Bellocchi, 2019). However, it is often argued that emotions contain five components: (i) the cognitive component (appraisal of a situation), (ii) the neurophysiological component (bodily changes, such as changes in heart rate), (iii) the motivational component (action tendencies,

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such as avoidance behavior), (iv) the motor expression component (including facial expressions), and (v) the subjective feeling component (Atiq & Loui, 2022, p. 3; Scherer, 2005, p. 691).

According to multicomponent models, emotional episodes develop over time with a narrative structure involving an evaluation of a situation, linked to physiological changes in the body, subjective experiences of those changes, and a tendency to act and think in particular ways as a result (Shuman & Scherer, 2014). Alongside this, sociological perspectives emphasize that a number of the emotional components are influenced by socially constructed, culturally influenced definitions as well as linguistic labels (Lindquist, 2021) that provide an internal framework for emotions (Turner & Stets, 2005, p. 9).

Emotions, therefore, do not exist independently from cognition, as is frequently implied in folk theories of emotion. Nor are emotions solely the result of psychological or physiological processes. Emotions are dependent on and interconnected with cognition, bodily changes, subjective experiences, culture, language, and social structures.

2.2 | The role of emotion and reason in moral judgment

Philosophers have debated the roles of emotion and reason in moral judgments for centuries. While some stressed that moral judgments are driven by reasoning, others stressed the important role of emotions in moral judgments (e.g., Hume, 2003; Kant, 2002). These debates have also influenced moral psychology. For much of the last 70 years, the dominant tradition in moral psychology was influenced by the work of Kohlberg (1969) who focused on the role of reasoning in pro-social behavior, and whose work has been described as a sustained attack on what he saw as irrational emotive theories of moral development (Haidt, 2001). This almost exclusive focus on rationality in ethical decision making has, however, also long been questioned. Gilligan (1982) argued that Kohlberg's exclusive focus on rationality reflected a gendered and patriarchal perspective and argued in favor of a focus on care ethics. In parallel, researchers on empathy (e.g., Batson et al., 1981, 1997; Hoffman, 2000, 2008) also highlighted that a reasoning-based approach was quite limited in its ability to explain pro-social behavior. The 1990s and early 21st century saw something of an "emotional revolution" (Sutton & Wheatley, 2003) in psychology as in many other disciplines, and this had a notable impact on thinking and researching on the role of emotions in decision making in general (Lerner et al., 2015) and in ethical decision making in particular (Haidt, 2001; Kim, 2022; Roeser, 2012).

These changes were reflected within the Neo-Kohlbergian approach to moral judgments, which expanded to include four components: awareness that an ethical issue exists (moral sensitivity or understanding); ability to apply principles to reason about the issue (moral reasoning); a motivation to act (moral motivation); and a disposition to act in potentially challenging circumstances (moral character or moral agency) (Bebeau, 2002; Bebeau et al., 1999; Narvaez & Rest, 1995). At the same time, the conceptualization of moral reasoning itself also shifted. Within the Kohlbergian framework, moral reasoning had typically been understood as progressing through a series of developmental stages from childhood to adulthood, with mature moral reasoning (called post-conventional moral reasoning) being characterized by a disposition to make judgments based upon the wider social good rather than only based on personal interest (pre-conventional reasoning) or societal conventions (conventional reasoning). This understanding shifted in the 1990s to a schema-based view of moral reasoning. Schemas are understood to be mental models that guide perception, interpretation, imagination, and problem solving (Firat & McPherson, 2010). While schemas are understood as cognitive constructs, emotions are described as integral to moral schemas and operate as signals "activating schemas' salience, intensity and content in people's everyday lives" (Firat & McPherson, 2010, p. 354) In the schema-based model, when faced with a moral judgment, people automatically and intuitively apply particular moral schemas in making the judgment (Thoma & Dong, 2014, p. 56). While these schemas are developmentally ordered, individuals with more life experience are more likely to activate post-conventional schemas than those with less experience. However, contextual factors, such as emotional information, also influence the schemas activated in any moral judgment.

2.3 | Moral emotions

Part of the development of thinking on the relationship between emotion and moral reasoning has been a move from thinking about emotion in general to a focus on particular emotions. The emotions relevant to ethics decision making are often referred to as moral emotions, described as those "that are linked to the interests or welfare either of society as a whole or at least of persons other than the judge or agent" (Haidt, 2003, p. 853). Haidt distinguishes a number of

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families of moral emotions: shame, for example, is one of the members of the "self-conscious family" of moral emotions, along with embarrassment and guilt. These three emotions are also called inner-directed negative (Rudolph & Tscharaktschiew, 2014) or self-critical (Moll et al., 2008) emotions and are seen as important in motivating people to act ethically. Other important moral emotions include anger, contempt, and disgust, which are the members of the "other-condemning family" and are generally directed toward those who do not act ethically. Positive emotions such as gratitude and elevation are the members of the "other-praising family"; people may feel these emotions when they see one act with kindness to another.

Perhaps the most commonly referred to emotional construct in the moral emotion framework is empathy: this resides in the final family of moral emotions, the "other-suffering family." Indeed, although the term empathy is widely used, it is a somewhat problematic term in that the same term is used to refer to numerous distinct concepts: Batson (2009), for example, has identified eight distinct phenomena, all of which are referred to as empathy, while Hess and Fila (2016) emphasize that empathy includes both emotional and non-emotional (cognitive) components. They identify two distinct emotions within the construct of empathy: "empathetic distress" and what they refer to as "empathetic concern." Similarly, Haidt (2003, p. 862) identifies two specific emotions within the empathy construct; empathetic distress and compassion, which are both described as members of this "other-suffering family." Of these, the emotion of "compassion" deserves particular attention.

2.3.1 | Compassion as a moral emotion

Lazarus defines compassion as "being moved by another's suffering and wanting to help" (1991, p. 289). The terms "sympathy" and "pity" are synonyms for compassion (Haidt, 2003). Compassion requires (i) knowledge that another is suffering, (ii) identification with the sufferer, and (iii) knowledge of what the sufferer is experiencing (Cassell, 2002). Nussbaum (2001, p. 301) defines compassion as "a painful emotion occasioned by the awareness of another person's undeserved misfortune." For Nussbaum (2013, pp. 142–143), there are three cognitive elements to the emotion of compassion: the judgment of size (something terrible happened to someone); the judgment of non-desert (the person suffers undeservedly); and the eudemonistic (similar possibilities) judgment (one must regard oneself as similarly vulnerable). According to Haidt (2003, p. 862), compassion "is elicited by the perception of suffering or sorrow in another person" and has been seen as an important contributor to pro-social behavior.

While compassion has been seen as important contributors to pro-social behavior, it has also been identified that, along with empathetic distress, it may shift the moral reasoning schemas activated by a situation away from those associated with post-conventional moral reasoning. Prinz (2011) has argued that empathy has significant shortcomings as a basis for moral action. Batson et al. (1995) found that people made decisions about patient care that would benefit one patient and have a negative impact on others when they were encouraged to empathize with that patient. Compassion is also typically more strongly felt toward those who are similar to the person experiencing the emotion (Hoffman, 2008), and this may lead to action in favor of in-group members and to a failure to take responsibility for effects on those who are perceived to be different to or distant from the decision maker. Similar arguments have been made by Bloom (2010) who argues that a reason-based approach to ethics is more productive than one that is emotionally informed or driven.

These arguments arise in the context when the person making the moral judgment experiences compassion. In engineering ethics learning, however, the picture is more complicated in that ethics cases typically refer to action not by the learner but rather by the case's protagonist. To understand this dynamic better, we need to look more closely at ethics education in engineering.

2.4 | Engineering and ethics education

It is perhaps inevitable that engineering, which is commonly considered as a profession based solely upon rationality (Cech, 2013; Guntzburger et al., 2019; Kellam et al., 2018), has been affected by the rationalist models in teaching and learning ethics, and therefore it is not surprising that engineering ethics education has commonly focused on professional ethical standards and on teaching ethical reasoning skills to engineering students by providing them with codes of ethics, moral principles, and opportunities to practice reasoning using these principles (Kim & Jesiek, 2019; Morrison, 2020; Tormey, 2020; Walling, 2015; Yadav & Barry, 2009), rather than on engagement with emotions.

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Although engineering ethics remains very rationality-oriented, there is a growing interest in emotion in engineering education (Lönngren et al., 2023; Lönngren, Bellocchi, et al., 2021; Villanueva et al., 2018) and this is reflected in a growing literature on emotions in engineering ethics education also. Examples include Pantazidou and Nair (1999) and Riley et al. (2009) who have argued for engineering design to be reframed through an ethics of care perspective. While Snieder and Zhu (2020) acknowledge that both the professional (e.g., codes and standards) and philosophical approaches can meet specific ethics education goals in engineering, they argue that neither of these approaches is sufficient to engage students in authentic moral learning on a personal level. They emphasize the importance of connecting ethics education with engineers' hearts. Roeser (2012) has argued that emotions play a key role in the understanding of technological risk, while Davis (2015) has argued that because emotion is inherent to the work of engineers, it must be engaged with as part of the engineering ethics education process. Sunderland (2014) and Sunderland et al. (2014) have looked at how this can be done through work on student voice and on reflection tasks on ethics cases.

Indeed, the use of case studies is one of the most prominent methods used in engineering ethics education (Colby & Sullivan, 2008; Herkert, 2005; Hess & Fore, 2018; Martin, Conlon, & Bowe, 2021), and it has been suggested that "there is widespread agreement that the best way to teach professional ethics is by using cases" (Harris et al., 1996, p. 94). Nonetheless, Thiel et al. (2013) have claimed that little is known about the features of ethics cases that make them effective as educational tools. Hess et al. (2019) have explored how an emotionally engaged process can be used to consider ethics cases in practice, using a Scaffolded, Interactive, and Reflective Analysis (SIRA) approach. They have found that the approach led to increases in (cognitive) empathetic perspective-taking. They also found that empathetic distress was reduced, which they interpreted as being the result of enhanced emotion regulation skills.

2.5 | Case studies and emotional content

While much of this work has focused on the way in which emotions are made explicit and processed in the analysis of ethics cases, emotions can also be made more or less present in the ethics cases themselves. Here the focus is not on emotion in the learners themselves but on how they respond when faced with emotional information within cases. Higgs et al. (2020) looked at the effect of including emotions information in case studies by altering cases such that the protagonist in the case was described in neutral tones (no emotion condition), or was described as feeling remorse and regret (guilt condition), diminished and worthless (shame condition), or foolish (embarrassment condition). They found that, in the shame condition, learners reported highest levels of personal responsibility, while those in the guilt condition saw the problem as more pressing. They note, "contrary to common thought, experiencing no emotion while in an ethical dilemma may actually result in cognitive processes that could lead to less ethical decisions" (2020, p. 53).

Much of the focus on emotions in engineering and science ethics thus far has been on the way in which emotional information may improve ethical awareness and understanding (e.g., Davis, 2015; Riley et al., 2009; Roeser, 2012) or ethical motivation and agency (e.g., Higgs et al., 2020). There is also some evidence that, in addition to the role that it plays in ethical decision making, emotions may also play a role on *learning* ethical decision making. Thiel et al. (2013) also included emotions in case studies through explicitly identifying emotions felt by the case's protagonist ("X feels less guilt and more anger. X is angry ..."). They found that emotional case content improved the participants' memory of the material included in the cases and also their ability to apply the same ethical principles to a different case. Thus, there is some evidence that emotional content may directly aid learning. It is possible, however, that when it comes to emotions in ethics cases, more is not always better. A meta-analysis of 66 studies by Watts et al. (2017) on the effectiveness of ethics instruction found that low to moderate realism and emotional content was associated with greater learning gains than higher levels of emotional content.

This is an important finding to consider in the context of engineering ethics education. The case study tradition in engineering has been informed by work in law, business, and teacher education (Martin, Conlon, & Bowe, 2021; Merseth, 1994), and this has generally led to a focus on realistic cases that allow for exploration of how concepts and theories may apply in a complex reality. It may be, however, that the realism that makes cases applicable in such settings may also make them less appropriate in engineering ethics. Realistic engineering ethics case studies often involve large-scale death and destruction (Netherlands Flood Disaster of 1953, the Ford Pinto Case, Hyatt Regency Walkway collapse, Volkswagen emissions scandal, Challenger and Columbia Space Shuttle disasters, Chornobyl, the Bhopal Union Carbide disaster, and others). This represents a high level of emotional content (even if emotions are not made explicit). It may be that such emotional content can lead to empathetic overarousal (Hoffman, 2008), which leads students to withdraw from, rather than engage with, these cases.

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2.6 | The gap in the literature

In summary then, there are potentially good reasons for including emotion of case protagonists as part of the engineering ethics learning experience. It has been argued that emotions play an important role in ethical decision making by providing information that allows people to better recognize and understand technological risks and their impacts on other people. The literature cited above shows that emotions have also been linked to increased ethical motivation to act, and ethical agency to persist in doing the right thing. There have been some experiments with bringing emotions into learning through building them into the processing of ethical reflection, but this can also be done through directly including emotions in ethics cases used in engineering education. Indeed, evidence suggests that some (mild to moderate) emotional information in ethics cases in science and engineering settings may have positive impacts on students' learning in addition to its effects on their decision making. The inclusion of emotions in ethical learning and decision making remains controversial, however. It has been argued that rather than providing ethical insight, emotions such as empathic distress and compassion may cloud rational thinking, affect moral reasoning, and, consequently, hinder "good" ethical decision making. In educational settings, the problem is further complicated because learning gains have been found through the inclusion of mild to moderate emotional information related to case *protagonists*, but the impact of this on moral reasoning of *learners* is unclear. The evidence does also suggest that not all emotions are equal in this process. There is some evidence on the positive roles that guilt and shame, for example, may play in ethical motivation, but embarrassment was not found to have a similar positive effect (Higgs et al., 2020), while anger has been found to have a negative effect (Kligyte et al., 2013). Historically, empathy has been a significant focus of interest in ethics discussions; however, the term "empathy" is now used to cover a wide variety of different emotions and non-emotional phenomena. In this sense, it perhaps makes sense to focus more narrowly on a specific emotion that is part of the wider empathy phenomenon: compassion.

This leads us to the empirical question that this research aims to address: Does the inclusion of information related to mild to moderate compassion of protagonists in engineering ethics cases affect the moral reasoning schemas activated in participants?

If it does, then this would have to be considered in the design of ethical cases. If it does not, it suggests that pedagogical benefits of including emotional information related to case protagonists should be more widely exploited than has been the case until now.

3 | METHOD

We conducted this research as an experimental design with two stages. Before we could assess the impact of increased compassion on students' moral reasoning in engineering cases, we first had to ensure that we could effectively increase the level of compassion associated with cases, without at the same time altering the other emotions linked to the case. In Stage 1, therefore, we attempted to change only the intensity level of compassion in the engineering case studies. Then, we conducted Stage 2 to explore if this increase in compassion-related information in the case studies impacted the moral reasoning schema activated in students.

3.1 | Measures

In this research, we used the Engineering and Science Issues Test (ESIT), which was developed by Borenstein et al. (2010). It is a context-specific (engineering and science issues), valid, and reliable moral reasoning development measure and has previously been used in engineering ethics education research (Clancy, 2020; Kerr et al., 2016; see Hess & Fore, 2018 for a summary). It is designed around six case studies, is based on the Neo-Kohlbergian understandings of moral reasoning development, and is adapted from the Defining Issues Tests (DIT-1 and DIT-2) (Borenstein et al., 2010; J. Rest et al., 1997; J. Rest, Narvaez, Bebeau, & Thoma, 1999; J. R. Rest, Narvaez, Thoma, & Bebeau, 1999; Thoma & Dong, 2014).

We used the French version of the ESIT, which was already translated and used for a previous study (French was the first language of the study participants). For the earlier study, the original English language ESIT was translated into French by a native French speaker. The French version was then reverse-translated into English by a native English speaker. The comparison between the original and reverse-translated versions allowed the translation to be validated. For the present study, the questionnaire was again piloted with 20 participants to revalidate the language and readability. Minor changes in names and terminology were made to reflect the cultural context (the name of the

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protagonist in the first case was changed from "Jameson" to "Jade," for example). Additionally, the first author performed the whole data collection process in case the participants had questions related to the instruments. However, no questions were reported about the language's clarity during or after the data collection process.

3.1.1 | Inducing compassion and measuring emotions in case studies in Stage 1

We designed our study in Stage 1 to test if changes to the text of the ESIT cases increased the level of compassion of the protagonist in the cases without at the same time changing other relevant emotions. Since mild to moderate emotion appears to be associated with better learning (Watts et al., 2017, p. 27), our goal was to induce mild to moderate compassion in the cases. This meant we decided to avoid explicitly naming the emotion of compassion in the cases (as Thiel et al., 2013 had done) and to avoid the kind of death and destruction common to many ethics case studies. As noted above, compassion requires the (i) knowledge that another is suffering, (ii) identification with the sufferer, and (iii) knowledge of what the sufferer is experiencing (Cassell, 2002). The six case studies from the ESIT were adapted to induce compassion as follows: (i) an emotional target was added where necessary (i.e., a person or people that could be the focus of compassion); (ii) a similarity between the decision maker and the emotional target group was added (to increase identification); and (iii) evidence of potential distress of the target was included (to ensure knowledge of the sufferer's condition). In order to ensure comparability of control and experimental case studies, the emotional target was also added to the control case studies. For example, in the original version of the ESIT, the first case is as follows:

> Engineer Jameson owns stock in RJ Industries, which is a vendor for Jameson's employer, Modernity, Inc., a large manufacturing company. Jameson's division has been requested by management to cut one vendor: either RJ Industries or Pandora Products, Inc. Pandora Products makes a component that is slightly higher in quality and slightly more expensive than that made by RJ Industries. Management and the other engineers in her division do not know that Jameson has a financial interest in one of the two vendors.

First, we only added an "emotional target" as follows (in bold below – neither bold font nor the text in square brackets appeared in the research instrument itself):

> Engineer Jameson owns stock in RJ Industries, which is a vendor for Jameson's employer, Modernity, Inc., a large manufacturing company. **Jameson has a lot of interaction with the main sales representative for Jameson's company's products in both RJ Industries and Pandora Products [emotional target]**. Jameson's division has been requested by management to cut one vendor: either RJ Industries or Pandora Products, Inc. Pandora Products makes a component that is slightly higher in quality and slightly more expensive than that made by RJ Industries. Management and the other engineers in her division do not know that Jameson has a financial interest in one of the two vendors.

This version was used for the control group. Then, we added both a similarity between decision maker and target group and potential distress of the target group as follows (again neither bold text not text in square brackets was used in the experiment itself):

> Engineer Jameson owns stock in RJ Industries, which is a vendor for Jameson's employer, Modernity, Inc., a large manufacturing company. Jameson has a lot of interaction with the main sales representative for his company's products in both RJ Industries and Pandora Products, **both of whom are a similar age to Jameson and all three also graduated from the same university [similarity]**. Jameson's division has been requested by management to cut one vendor: either RJ Industries or Pandora Products, Inc. Pandora Products makes a component that is slightly higher in quality and slightly more expensive than that made by RJ Industries. **Jameson knows that this decision could have a negative impact on the career of the sales representative affected [evidence of distress**]. Management and the other engineers in her division do not know that Jameson has a financial interest in one of the two vendors.

The same process was followed for all six case studies. After modifying the six case studies of the ESIT, in Stage 1 each case was followed by a question, which asked the participants to rate the extent to which the central character

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(e.g., in Case 1; the protagonist is Jameson) in the case feels each of a set of moral emotions taken from the typologies of Haidt (2003), Rudolph and Tscharaktschiew (2014), and Moll et al. (2008). These were guilt, shame, embarrassment, pride, anger, contempt, compassion/sympathy, gratitude, regret, awe, and distress. For example, in the case described above, participants were asked "to what extent do you think Jameson feels each of the moral emotions included in the list below." Each emotion was rated using an 8-point scale (from 0 to 7; 0 = not at all to 7 = very strong). Next, they had opportunity to add and then rate other emotions which they thought were not on the list.

3.1.2 | Measuring moral reasoning schemas activated in Stage 2

We designed Stage 2 to investigate if the changed compassion intensity of the protagonist in the case studies affected the moral reasoning schemas activated in participants. The ESIT, like the DIT before it, is designed to measure moral reasoning development by assessing which moral reasoning schema are activated in a set of quite generic and context-free cases (Thoma & Dong, 2014). It was therefore suitable for use in Stage 2 of this research to assess if moral reasoning schemas activated in a moral judgment setting are affected by the inclusion of mild to moderate compassion of case protagonists.

In the Neo-Kohlbergian framework, individuals are thought to pass through different developmentally ordered periods in the development of their moral reasoning. These include one in which the moral reasoning schema activated in generic moral judgment situations (referred to as "bedrock schema") are largely focused on rewards and punishments for decisions (pre-conventional moral reasoning); a period in which the bedrock schema activated are largely guided by social norms, rules, and practices (conventional moral reasoning); and finally a period in which the bedrock schema activated apply universal principles to ethical decisions to make their own decisions (post-conventional moral reasoning) (J. Rest, Narvaez, Bebeau, & Thoma, 1999; J. R. Rest, Narvaez, Thoma, & Bebeau, 1999; Thoma & Dong, 2014).

The ESIT includes six case studies that are related to engineering and science issues designed as moral dilemmas. The dilemmas contain minimal contextual information such that they are thought to activate bedrock schema. The six moral dilemmas in the ESIT are followed by a series of 12 statements that respondents are asked to rate and rank in terms of their importance in the decision. The objective of the ESIT, like the DIT before it, is to activate moral schemas to the extent that individuals have developed them and to assess their importance in a given judgment. If a statement taps into the participant's preferred schema, they will rate it as highly important and rank it accordingly. Alternatively, when a participant encounters a statement that does not make sense or comes across as simplistic and unconvincing, it receives a low rating or is passed over for the following item.

In the ESIT, each of the 12 statements accompanying the case study are associated with one of these schemas of moral reasoning development, or with a nonsense category which is included as a validity check (Borenstein et al., 2010). Considering the ESIT's first case, (presented in Section 3.1.1), an example of a post-conventional item is, "Will Jameson's decision potentially cause harm to the public?"; a conventional item is, "Is it required by law that Jameson report that she owns the stock?"; a pre-conventional item is, "If Jameson remains silent, will RJ Industries hire her in the future?"; and, a nonsensical item is, "Is now a good time to buy Pandora stock?" (Examples derived from Borenstein et al., 2010). Items that refer to emotion as a component in decision making (e.g., "Will Mary feel guilty if someone dies later?") are coded in the ESIT as pre-conventional. Some of the original ESIT cases did not include the opportunity to rank and rate statements related to taking emotion into account in decision making. We therefore added an emotion-related item to these cases (e.g., in the first case we added "How does Jameson feel about the decision?"). The rating of these statements was averaged to compute an "emotion in decision making" score.

In the ESIT, the schemas that the participants activated are measured via the P-index and N2-index based on the participants' ranking of post-conventional items (for more detail on the ESIT and the P-index and N2-index used in DIT-1, DIT-2 and ESIT, refer to Borenstein et al. (2010), J. Rest et al. (1997); J. R. Rest, Narvaez, Thoma, and Bebeau (1999); J. Rest, Narvaez, Bebeau, and Thoma (1999) and, Thoma and Dong (2014)). The P-index is calculated based on respondents' rating of statements associated with post-conventional moral reasoning schemas. It therefore ignores information about the comparative weighting of statements linked to pre-conventional and conventional moral reasoning schemas. The N2-index was developed to also include comparative information on post-conventional statements and statements related to pre-conventional reasoning schemas. Thus, the N2-index is generally preferred over the P-index (J. Rest, Narvaez, Bebeau, & Thoma, 1999; Thoma & Dong, 2014), although both are commonly reported. Researchers are advised to use the N2-index as a summary index when examining graduate and professional school populations because the N2-index better distinguishes differences among the upper level of those who reason with post-conventional schema, with the P-index regarded as being acceptable for university-level

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populations (Thoma & Dong, 2014). In this study, we therefore report both the P-index and N2-index, which were calculated based on the formulas Borenstein et al. have provided (2010, p. 394).

3.2 | Participants

We recruited participants via an experimental pool shared between a large technical university and a general university in mainland Europe in both stages ($N = 207$ in Stage 1 and $N = 305$ in Stage 2). The experimental pool contains more than 6000 registered participants and allows participants' recruitment based on various selection criteria, such as language, age, gender, faculty, main field, educational level, and previous participation in specific experiments. Ethical approval for this study was granted from the institutional research ethics committee. Participants were not asked for any identifiers (e.g., name or other ID). Basic demographic data were collected (e.g., gender, majors, and educational level). In both stages, the instruments were administered on paper and in French, and the testing procedures lasted 60 min. Therefore, participants whose mother language was French were recruited in both stages and the recruited participants were randomly assigned to groups: they randomly took either the control or experimental (compassion-induced) versions of the instruments.

3.2.1 | Stage 1 participants

Table 1 breaks down the participants' demographic statistics for Stage 1. These students all came from the technical university where students complete a 3-year Bachelor cycle before undertaking a consecutive Master. Almost all students in the technical university complete an engineering qualification; only a minority take non-engineering degrees (e.g., in architecture, physics, chemistry, or mathematics). The number of participants in the control and experimental groups were roughly equal: 104 and 103. Those identifying as women made up 43% of the sample. The largest group by educational level were first-year engineering students (38%), while 26% of the sample were Master students.

3.2.2 | Stage 2 participants

In Stage 2 we recruited 305 participants. We excluded questionnaires from the analysis if they met one of several exclusion criteria offered by Borenstein et al. (2010):

- Failed to complete 24 or more rating questions (equivalent to two dilemmas);
- Failed to complete nine or more ranking questions (approximately two dilemmas);
- Received a "nonsense" score of 11 or more points.

TABLE 1 Demographics of participants in Stage 1.

		Experiment ($N = 104$)		Control ($N = 103$)		Total ($N = 207$)	
Demographic group		***N***	**%**	***N***	**%**	***N***	**%**
Gender[a]	Men	55	52.88	63	61.16	118	57.00
	Women	49	47.12	40	38.84	89	43.00
	Another gender	0	0	0	0	0	0
Majors	Engineering sciences	97	93.57	97	94.18	194	93.72
	Other	7	6.73	6	5.82	13	6.28
Educational level	First year bachelor	39	37.49	39	37.86	78	37.68
	Second year bachelor	18	17.30	15	14.56	33	15.94
	Third year bachelor	23	22.11	19	18.44	42	20.28
	Master	24	23.07	30	29.12	54	26.08

[a]In the French language questionnaire, the gender options were *Masculin*, *Féminin*, and *Autres*. We have translated this into English as "men," "women," and "another gender."

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TABLE 2 Demographics of the participants in Stage 2.

		Experiment ($N = 150$)		Control ($N = 150$)		Total[a] ($N = 300$)	
Demographic group		***N***	**%**	***N***	**%**	***N***	**%**
Gender	Men	85	56.66	78	51.99	163	54.33
	Women	63	41.99	70	46.66	133	44.33
	Another gender	2	1.33	2	1.33	4	1.33
Majors	Engineering sciences	79	52.66	88	58.66	167	55.60
	Social sciences	29	19.33	24	15.99	53	17.70
	Other	42	27.99	38	25.33	80	26.70
Educational level	First year bachelor	74	49.33	66	43.99	140	46.70
	Second year bachelor	25	16.66	23	15.33	48	16.00
	Third year bachelor	19	12.66	22	14.66	41	13.70
	Master	30	20.00	29	19.33	59	19.70
	NA[b]	2	1.33	10	6.66	12	4.00
Age	18–20 years	79	52.66	78	51.99	157	52.3
	21–23 years	55	36.66	58	38.66	113	37.7
	24–35 years	16	10.66	14	9.33	30	10
Ethics education	Yes	81	53.99	81	53.99	162	54.00
	No	60	39.99	62	41.33	122	40.70
	NA	9	5.99	7	4.66	16	5.3

[a]Five questionnaires were excluded according to exclusion criteria.
[b]NA means no answer.

After applying the above metrics to the participants' responses, we excluded 5 questionnaires out of 305 from the analysis. In total, we included 300 (150 control group and 150 experimental group) questionnaires in the analysis.

Table 2 breaks down the participants' demographic statistics for our Stage 2 study. The number of participants in both the experimental and control groups was equal, and the demographic characteristics of the participants in the two groups were almost the same. This study drew on participants in both the general university and the technical university. Overall, 44% identified as women, and just over half had a major which would lead to an engineering qualification (engineering sciences). The largest group of participants by educational level were first-year students (47%) and by age were those between 18 and 20 years (52%). Finally, while 54% of the participants have had formal exposure to ethics education in the past, 41% had not.

4 | FINDINGS

4.1 | Findings from Stage 1: Assessing the emotionality of the control and experimental cases

The norm with the DIT and ESIT is not to present data from each case separately but rather to report a mean average score across the six cases. We adopted a similar procedure to measure the emotionality of the adapted ESIT cases, and therefore we report the mean average across the six cases. We performed descriptive statistics for each emotion and group. Then, we conducted independent two-sample *t*-tests on the differences in each mean for the groups. We also calculated Cohen's *d* effect size for the comparisons. Table 3 provides means and standard deviations, while Table 4 presents the comparisons for each moral emotion. We marked the results in Tables 3 and 4 that are significant at the $p = .05$ level.

Considering the means, the emotions that the experiment group participants identified as most felt by the protagonists in the case studies were embarrassment ($M = 3.84$, $SD = 1.54$), compassion ($M = 3.74$, $SD = 1.33$), and guilt ($M = 3.40$, $SD = 1.38$), whereas the emotions the participants thought the protagonists felt the least were awe ($M = 0.38$,

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TABLE 3 Means and standard deviations for each of the moral emotions by groups.

Moral emotions	Group	Mean (*M*)	Standard deviation
Guilt	Experiment	3.40	1.38
	Control	3.15	1.36
Shame	Experiment	2.25	1.33
	Control	2.32	1.26
Embarrassment	Experiment	3.84	1.54
	Control	3.95	1.61
Pride	Experiment	1.03	0.97
	Control	0.98	0.74
Anger	Experiment	2.56	1.06
	Control	2.55	1.10
Contempt	Experiment	2.16	1.20
	Control	2.19	1.14
Compassion/sympathy[a]	Experiment	3.74[a]	1.33
	Control	2.45[a]	1.36
Gratitude	Experiment	0.46	0.66
	Control	0.32	0.56
Regret	Experiment	2.13	1.45
	Control	2.20	1.30
Awe	Experiment	0.38	0.58
	Control	0.33	0.75
Distress	Experiment	3.00	1.73
	Control	2.94	1.60

[a]Statistically significant difference $p < .05$.

SD = 0.58), gratitude ($M = 0.46$, SD = 0.66), and pride ($M = 1.03$, SD = 0. 97). A similar pattern is evident in the control group, with the only notable difference being that the rating for compassion is lower ($M = 2.45$, SD = 1.36). We analyzed each case separately to identify whether there were major differences between compassion scores. Compassion stayed low to moderate across all cases; the lowest score was 1.44 and the highest was 4.83, on a 0–7 range.

As Table 4 shows, there was no significant difference between the experiment and control groups in guilt, shame, embarrassment, pride, anger, contempt, gratitude, regret, awe, and distress. However, there was significant difference between the experiment and control groups in compassion (Experiment [$M = 3.74$, SD = 1.33] and Control [$M = 2.45$, SD = 1.36]; t [205] = 6.881, $p < .001$). Also, the effect size was large (Cohen's $d = 0.96$). Finally, there were no significant differences between means in terms of gender, major, and the educational level.

4.2 | Findings from Stage 2: Assessing the impact of different levels of compassion on moral reasoning

The goal of Stage 2 was to assess whether the increase in the intensity of compassion associated with the protagonist in the cases impacted upon the moral reasoning schemas activated in the participants. First, we conducted two-sample *t*-tests or ANOVA on the differences in P-index and N2-index for comparisons. The results of these tests are provided in tables across several groupings. We marked the results in the tables that are significant at the 5% level. We also calculated Cohen's *d* effect size for differences.

The tables present (Table 5) the means and standard deviations for the P-index and N2-index, and then present (Table 6) the means comparisons (*t*-test or ANOVA) for the P-index and N2-index by groups and subgroups.

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TABLE 4 Independent samples *t*-test for each of the moral emotions by groups.

Moral emotions	*F*	Significance	*t*	*df*	Significance (*p*)	Mean difference	Standard error	95% confidence		Cohen's *d*[a]
Guilt	0.01	0.89	1.33	205	0.182	0.255	0.190	−0.12	0.632	0.19
Shame	0.91	0.34	−0.40	205	0.688	−0.072	0.180	−0.42	0.282	0.03
Embarrassment	0.20	0.65	−0.50	205	0.617	−0.109	0.219	−0.54	0.322	0.07
Pride	4.32	0.03	0.38	205	0.699	0.046	0.120	−0.19	0.284	0.04
Anger	0.00	0.94	0.07	205	0.945	0.010	0.149	−0.28	0.305	0.00
Contempt	0.41	0.52	−0.17	205	0.862	−0.028	0.162	−0.34	0.292	0.02
Compassion/ sympathy	1.15	0.28	6.88	205	0.000[b]	1.288	0.187	0.91	1.658	0.96[a]
Gratitude	3.42	0.06	1.64	205	0.102	0.139	0.084	−0.02	0.307	0.23
Regret	2.46	0.11	−0.37	205	0.707	−0.072	0.191	−0.45	0.305	0.05
Awe	0.00	0.98	0.53	205	0.597	0.049	0.093	−0.13	0.233	0.07
Distress	0.98	0.32	0.26	205	0.794	0.060	0.231	−0.39	0.517	0.03

[a]Cohen's $d = 0.20$ indicates a small effect, $d = 0.50$ indicates a medium effect, and $d = 0.80$ indicates a large effect.
[b]Statistically significant difference $p < .05$.

TABLE 5 Means and standard deviations (SD) for the P-index and N2-index by groups.

		P-index			N2-index		
		Mean	SD	*N*	Mean	SD	*N*
Group	Experiment	0.474	0.124	150	4.777	2.605	150
	Control	0.481	0.127	150	4.749	2.540	150

TABLE 6 Comparisons (*t*-test) for the P-index and N2-index by groups.

	Levene's test		*t*-Test for equality of means							
							Standard error difference	95% confidence		Cohen's *d*[a]
Indexes	*F*	Significance	*t*	*df*	Significance (two-tailed)	Mean difference		Lower	Upper	
P-index	0.010	0.920	−0.505	298	0.614	−0.007	0.014	−0.036	0.0212	0.05
N2-index	0.022	0.883	0.093	298	0.926	0.027	0.297	−0.557	0.612	0.01

[a]Cohen's $d = 0.20$ indicates a small effect, $d = 0.50$ indicates a medium effect, and $d = 0.80$ indicates a large effect.

As Tables 5 and 6 show, despite the fact that the experimental group were exposed to cases that had a significantly higher level of compassion associated with the protagonists, there was effectively no difference in post-conventional moral reasoning schema activation between the control and experimental groups. Similar results were found for the experiment and control groups in the P-index: (Experiment [$M = 0.474$ SD $= 0.124$] and Control [$M = 0.481$, SD $= 0.127$] groups; t [298] $= -0.505$, $p = .614$, $d = 0.05$) and in the N2-index (Experiment [$M = 4.777$, SD $= 2.605$] and Control [$M = 4.749$, SD $= 2.540$] groups; t [298] $= 0.093$, $p = .926$, $d = 0.01$). Put simply, the higher level of compassion of the protagonists in the experimental cases did not affect the moral reasoning schema activated in the participants. We also examined the "emotion in decision making" scores to see whether they differed between the control and the experimental group. There was no evidence of any difference in rating of these scores (Experiment [$M = 2.754$, SD $= 0.872$] and Control [$M = 2.807$, SD $= 0.886$] groups, t (298) $= -0.525$, $p = .60$, $d = -0.06$).

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TABLE 7 Means and standard deviations for the P-index and N2-index by gender.

	Gender[a]						
		Men			Women		
Indexes	**Group**	**Mean**	**Standard deviation**	***N***	**Mean**	**Standard deviation**	***N***
P-index	Experiment	0.458	0.128	85	0.491	0.115	63
	Control	0.467	0.131	78	0.491	0.118	70
N2-index	Experiment	4.434	2.639	85	5.190	2.538	63
	Control	4.580	2.468	78	4.829	2.544	70

[a]Those identifying with a gender other than man or woman were not included in this analysis because of the small sample size ($n = 4$).

TABLE 8 Comparisons (ANOVA) for the P-index and N2-index by gender.

Indexes		**Sum of squares**	***df***	**Mean square**	***F***	**Significance**
P-index	Between groups	0.063	3	0.021	1.352	0.258
	Within groups	4.520	292	0.015		
	Total	4.583	295			
N2-index	Between groups	23.207	3	7.736	1.188	0.314
	Within groups	1900.659	292	6.509		
	Total	1923.866	295			

TABLE 9 Means and standard deviation for the P-index and N2-index by ethics courses.

Ethics courses/education							
		Yes			**No**		
Indexes	**Group**	**Mean**	**Standard deviation**	***N***	**Mean**	**Standard deviation**	***N***
P-index	Experiment	0.485	0.118	81	0.456	0.134	60
	Control	0.472	0.122	81	0.490	0.138	62
N2-index	Experiment	4.751	2.754	81	4.835	2.573	60
	Control	4.897	2.232	81	4.478	2.972	62

TABLE 10 Comparisons (ANOVA) for the P-index and N2-index by ethics courses.

Indexes		**Sum of squares**	***df***	**Mean square**	***F***	**Significance**
P-index	Between groups	0.045	3	0.015	0.924	0.430
	Within groups	4.555	280	0.016		
	Total	4.520	283			
N2-index	Between groups	6.788	3	2.263	0.327	0.806
	Within groups	1935.613	280	6.913		
	Total	1942.401	283			

As Table 7 and 8 present, for the whole sample there is no clear pattern of gender differences. While there is a gender difference in the P-index (Women [$M = 0.491$, SD $= 0.117$] and Men [$M = 0.463$, SD $= 0.130$], t [294] $= -0.1.96$, $p = .051$, $d = 0.226$), the N2-index scores are not significantly different (Women [$M = 5.000$, SD $= 2.538$] and Men

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TABLE 11 Means and standard deviation for the P-index and N2-index by age, educational level, and major.

Age										
		18–20 years			21–23 years			24–35 years		
Indexes	Group	Mean	Standard deviation	N	Mean	Standard deviation	N	Mean	Standard deviation	N
P-index	Experiment	0.473	0.111	79	0.477	0.135	55	0.466	0.146	16
	Control	0.474	0.127	78	0.498	0.127	58	0.451	0.130	14
N2-index	Experiment	4.730	2.535	79	4.941	2.768	55	4.440	2.486	16
	Control	4.375	2.562	78	5.261	2.594	58	4.708	1.890	14
Educational level										
		First year bachelor			Second and third year bachelor			Master		
Indexes	Group	Mean	Standard deviation	N	Mean	Standard deviation	N	Mean	Standard deviation	N
P-index	Experiment	0.462	0.119	74	0.476	0.123	44	0.487	0.129	30
	Control	0.482	0.131	66	0.470	0.124	45	0.486	0.130	29
N2-index	Experiment	4.642	2.689	74	4.602	2.581	44	5.162	2.428	30
	Control	4.626	2.365	66	4.667	2.566	45	5.023	2.882	29
Major										
		Engineering sciences			Social sciences			Other		
Indexes	Group	Mean	Standard deviation	N	Mean	Standard deviation	N	Mean	Standard deviation	N
P-index	Experiment	0.472	0.124	79	0.460	0.142	29	0.487	0.111	42
	Control	0.489	0.136	88	0.476	0.106	24	0.466	0.119	38
N2-index	Experiment	4.700	2.817	79	4.683	2.167	29	4.985	2.511	42
	Control	4.857	2.680	88	4.711	2.562	24	4.522	2.222	38

[$M = 4.504$, SD $= 2.552$], t [294] $= -1.667$, $p = .097$, $d = 0.196$). We then looked at how the results compared between control and experimental, controlling for gender. The participants' gender had no significant impact between control and experimental groups with respect to the P-index (Women-Experiment [$M = 0.491$, SD $= 0.115$] and Men-Experiment [$M = 0.458$, SD $= 0.128$]; Women-Control [$M = 0.491$, SD $= 0.118$] and Men-Control [$M = 0.467$, SD $= 0.131$]; [F{3,292}$= 1.352$, $p = .258$]) and N2-index (Women-Experiment [$M = 5.190$, SD $= 2.538$] and Men-Experiment [$M = 4.434$, SD $= 2.639$]; Women-Control [$M = 4.829$, SD $= 2.544$] and Men-Control [$M = 4.580$, SD $= 2.468$]; [F{3,292} $=1.188$, $p = .314$]).

One of the demographic questions on the ESIT asked respondents to report the amount of their prior exposure to ethics education. More than half of the participants ($N = 162$, 54%) in our research either reported prior ethics experience or received a full semester of ethics course. However, as Tables 9 and 10 show, there was no significant differences between control and experimental groups with respect to the P-index (F[3,283] $= 0.924$, $p = .430$) and N2-index (F[3,283] $= 0.327$, $p = .806$) when controlling for prior ethics experience.

As Tables 11 and 12 show, an analysis of the participants' P-index and N2-index, when controlling for additional demographic variables, did not yield any significant results. There was no significant difference between control and experimental groups when controlling for age cohorts with respect to the P-index (F[5,299] $= 0.478$, $p = .793$) and N2-index (F[5,299] $= 0.897$, $p = .484$). No significant difference was found between control and experimental groups when controlling for participants' educational level in the P-index (F[5,287] $= 0.300$, $p = .912$) and N2-index (F[5,287] $= 0.309$, $p = .907$). There was no significant difference between control and experimental groups in the P-index (F[5,299] $= 0.407$, $p = .844$) and N2-index (F[5,299] $= 0.168$, $p = .974$) when controlling for participants' major.

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TABLE 12 Comparisons (ANOVA) for the P-index and N2-index by age, educational level, and major.

Indexes		Sum of squares	*df*	Mean square	*F*	Significance
Age						
P-index	Between groups	0.038	5	0.008	0.478	0.793
	Within groups	4.677	294	0.016		
	Total	4.715	299			
N2-index	Between groups	29.649	5	5.930	0.897	0.484
	Within groups	1943.853	294	6.612		
	Total	1973.501	299			
Educational level						
P-index	Between groups	0.024	5	0.005	0.300	0.912
	Within groups	4.466	282	0.016		
	Total	4.489	287			
N2-index	Between groups	10.263	5	2.053	0.309	0.907
	Within groups	1871.596	282	6.637		
	Total	1881.859	287			
Major						
P-index	Between groups	0.032	5	0.006	0.407	0.844
	Within groups	4.682	294	0.016		
	Total	4.715	299			
N2-index	Between groups	5.615	5	1.123	0.168	0.974
	Within groups	1967.886	294	6.693		
	Total	1973.501	299			

5 | DISCUSSION

We designed our Stage 1 study to test whether the changes we made to the ESIT cases increased the level of compassion in the case studies without changing other emotions. The question in Stage 1 was: "Does the inclusion of information aimed to induce mild/moderate compassion in the case study protagonist change the emotional character of the case studies?"

As is seen in Tables 3 and 4, the participants rated the moral emotions at low to moderate level even if they rated some emotions like embarrassment and shame somewhat higher than others. This means that the original case studies already had an emotional character. The results of case studies examining engineering ethics demonstrate that even events that seem as though they are not emotionally charged evoke emotional responses when they unfold (Dunbar, 2005). We have similar findings here. Prior studies, however, suggest that the intensity of emotion should be considered because intensive emotional exposure can lead to withdrawal (Hoffman, 2000), and it can reduce student learning from engineering case studies (Watts et al., 2017). On the other side, educational research on emotions shows that emotionality impacts positively learning, engagement, and memory (Pekrun et al., 2017; Pekrun & Linnenbrink-Garcia, 2012; Tyng et al., 2017). In our research, the findings, regarding the means, show that the intensity of moral emotions in the case studies was at low to moderate levels, including the targeted emotion, namely compassion. However, the difference between control and experimental instruments is large ($d = 0.96$) and statistically significant ($t\,[205] = 6.881$, $p < .001$) only for the targeted emotion (compassion). Stage 1 shows that our method for inducing the targeted emotion was successful, without affecting the other emotions of the original case studies.

We designed Stage 2 to investigate whether the mild to moderate compassion of the protagonist in the case studies impacts the moral reasoning schema activated in participants. Within the Neo-Kohlbergian framework, emotionally driven moral decision making is seen as reflecting pre-conventional moral reasoning schema. If the hypothesis that the inclusion of emotional information would drive or affect decision making was correct, we would have expected to see a change in post-conventional moral reasoning in the experimental group in Stage 2 of our study. As Tables 5 and 6

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show, we found in Stage 2 that the emotional content of the case studies does not appear to affect the moral reasoning schema activated: participants in both control and experimental groups had effectively identical levels of post-conventional moral reasoning (P-Index is 0.481 for the control and 0.474 for the experimental group; N2-Index is 4.749 for the control group and 4.777 for the experimental group). The differences are very small and not statistically significant. As a result, an increase to mild to moderate levels of compassion in the case protagonist did not seem to have an impact on moral reasoning schema activated in participants.

The developers of the DIT-2 and ESIT often report scores by demographic variables such as gender, age, educational level, and majors to present the reliability and validity of the tests, as a way of verifying that the DIT-2 and ESIT scores are reacting as intended (Borenstein et al., 2010; J. R. Rest, Narvaez, Thoma, & Bebeau, 1999; Thoma & Dong, 2014). We also carried out a similar analysis. While some researchers have found significant differences in the indexes between women and men participants (J. R. Rest, Narvaez, Thoma, & Bebeau, 1999), others have not (Borenstein et al., 2010). Our findings do not show a consistent pattern of difference between women and men participants; while the difference is statistically significant for the P-index, it is not statistically significant for the N2-index. In both cases, Cohen's *d* indicates a small effect. Broadly speaking, this lack of clear gender difference is in line with what Borenstein et al. (2010) found. There are studies in different fields which report that compared with women, men participants exhibited lower empathic concern (Baron-Cohen & Wheelwright, 2004; Eisenberg & Lennon, 1983) and also that emotional empathy can cause gender differences in moral judgments (Rosen et al., 2016). However, we did not find gender differences in the impact of the emotional information on moral reasoning. The gender differences in both Stage 1 and Stage 2 were small.

The developers of the DIT-2 (J. Rest, Narvaez, Bebeau, & Thoma, 1999) stated that the scores were expected to be higher for individuals with more life experience than those with less experience. Indeed, although the findings of the research on the relation between age, gender, emotional empathy, and moral decision making are controversial, Rosen et al. (2016) found that emotional empathy mediates age and gender effects on moral decisions. In our study, dividing the participants into groups based on their age yielded no difference in the impact of emotional information on moral reasoning (P-index and N2-index). However, this is not surprising given that most are quite similar in age.

5.1 | Implications for practice

Our starting point for this study was that including some specific types of emotional information in cases might have a positive learning impact. Nonetheless, we probably underestimated just how emotional engineering ethics cases already are. When Higgs et al. (2020) explored the role of specific emotions in engineering cases, they described their control condition as being "neutral in tone and did not elicit any emotions" (2020, p. 35). Similarly, at the outset, we worked on the belief that the pre-existing cases that did not explicitly aim to induce emotions would not, in fact, elicit any. Our Stage 1 study showed us that this assumption was wrong: even in their neutral format, students identified that the protagonist in the case study would feel a wide range of moral emotions including embarrassment, guilt, compassion, and anger. The clear implication here is that even when emotional elicitation is not the intention, ethics cases are not emotionally neutral. This is an important finding, since it implies that emotional processing should be a constituent part of how ethics cases are explored whenever cases are used. We noted above that emotions are typically not presented as an important factor in mainstream engineering ethics texts (such as Fleddermann, 2011; Harris et al., 2013; or Van de Poel & Royakkers, 2011). At the same time, these texts are filled with emotionally resonant cases about dam failures, exploding space shuttles, crashing trains, and collapsing buildings. Watts et al. (2017) have noted that such realistic cases seem to be among the pedagogically least valuable cases. Given how emotionally resonant our (rather more gentle and small-scale) cases were found to be, it does seem likely that these more extreme cases involving large-scale death and destruction may lead to empathetic over-arousal (Hoffman, 2008) unless these emotions are effectively processed. Some models for processing emotions as part of engineering ethics teaching have been explored by Hess, Strobel, and Brightman (2017), by Hess et al. (2019), and by Sunderland et al. (2014). The work of Walther et al. (2017) and Walther et al. (2020), while not focused on ethics per se, also provides relevant models.

Our primary focus was not on the emotional processing of cases however, but rather on the elicitation of emotions within cases. Those who criticize the elicitation of emotions in ethics cases often point to a risk that emotions such as compassion can affect moral decision making. We found that this was not the case. Although there was a large ($d = 0.96$) change in the level of compassion identified with the case study protagonist between the control and experimental setting, this change did not lead to an impact on the moral reasoning schemas activated in participants as

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measured by the ESIT. Another way of framing this finding is to say that the ESIT is robust enough that the inclusion of mild to moderate compassion related information in the cases does not change the bedrock schema activated by the cases and does not affect the ESIT's ability to measure moral reasoning development. While a key feature of the DIT family of tests is that the cases contain little contextual information in order to ensure that they activate bedrock schema, we have found that the inclusion of contextual information linked to mild to moderate levels of compassion does not change the schema activated in participants. If the inclusion of such information might lead to learning benefits (Thiel et al., 2013), and if it does not come at a cost in terms of impacts on moral reasoning schema activated in students, then it certainly seems to make sense to include such information in ethics cases.

5.2 | Limitations

Our study was carefully designed, used a pre-existing instrument that has been found to be valid and reliable (the ESIT), and had sufficiently large numbers of participants in both studies to have adequate power to be able to draw meaningful conclusions. Nonetheless, like all studies, it has some limitations.

In this study, we used the ESIT to assess moral reasoning schema activated. As discussed above, schemas are activated, in part as a result of a person's level of moral reasoning development, and in part as a result of contextual factors in the situation. While the kind of emotional information we included does not appear to have impacted the moral reasoning schema activated, it remains possible that more intense emotional information would affect the moral reasoning schema activated (and consequently would affect the ESIT's ability to identify a participant's bedrock schema). Emotional intensity has also been identified as important in ethics education (Watts et al., 2017). This study did not address higher intensity levels of emotion: it studied the impact of mild to moderate compassion in case study protagonists.

The discussion on emotions in engineering and engineering ethics have moved rapidly in the last few years. While emotions were only mentioned in passing by Barry and Herkert (2014) in their review of the field, and while Davis (2015) was still making the case to engage with emotions in general only 8 years ago, there is now a recognition that not all emotions are the same and we need to distinguish between the different impacts of emotions such as guilt, shame, embarrassment, anger, pride, awe, distress, and compassion. Emotional intensity has also been identified as important in ethics education (Watts et al., 2017). This study did not address emotions in general or across different intensity levels: it studied the impact of mild to moderate compassion in case study protagonists. Further research is clearly needed to see how other moral emotions impact on learning and on reasoning.

The ESIT, like the DIT, assesses moral reasoning not by asking a person what they themselves would do in a scenario but rather what the principal character (protagonist) should do, and how important different factors should be in that decision (see Martí-Vilar, Escrig-Espuig, & Merino-Soto, 2023 for a summary of reviewing of moral reasoning measures). In doing this, we followed the standard format that has been used in thousands of studies on moral reasoning for the last 70 years (Martí-Vilar et al., 2023). This long tradition of research has established that this is an effective way of measuring moral reasoning. In our case, and in line with work by Higgs et al. (2020) and Thiel et al. (2013), the emotions were also identified as being experienced by the protagonist. We did not assess the student's own emotions in relation to the case study or the impact of their own emotions on the moral reasoning schemas activated. Our logic is that the emotionally infused cases that have been found to have positive benefits for learning (Thiel et al., 2013), and moral motivation (Higgs et al., 2020) also identify emotions not with the reader but with the protagonist. Hence, even though we did not assess how the participants own emotions impact on their moral reasoning, we did nonetheless assess whether infusing emotion in ethics cases affects their moral reasoning. We found that it does not.

While our research was prompted by questions about emotion in case studies for teaching, our research itself was based on the ESIT, which uses shorter and more generic cases (more properly called vignettes). Typical teaching cases may include more contextual information and details than are found in these vignettes (which are, as we have discussed, specifically designed to minimize contextual features). These typical teaching cases may, therefore, have stronger effects on the moral reasoning schemas activated than we found using the ESIT cases. It is worth noting that Watts et al. (2017, p. 27) found that while longer cases seem to have a stronger benefit than shorter cases, those with low to moderate realism were associated with stronger learning effects than highly realistic cases. It is possible, therefore, that teaching cases may be more effective were they to move closer to the style (but perhaps not the length) of those used in the ESIT vignettes.

The participants of this research were from a large technical university and a nearby general university in mainland Europe. Undergraduate students (first, second, and third year Bachelor students), who made up the bulk of

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our participants, were largely drawn from two neighboring countries that share a common language and have many cultural similarities. Master students are, however, more diverse in terms of their origin and languages. The questionnaire-style research instrument we used assumed that those completing the questionnaire understood the emotional and ethical terms used in the questionnaire in similar ways. We recognize that there can be linguistic differences in the naming of emotions, especially complex emotions (Jackson et al., 2019). This may be a factor in this study, although we did not come across any notable difficulties in interpretation when the questionnaires were being completed. We would, nonetheless, be slow to assume that the patterns identified here would be identical in other languages and cultures (Matsumoto & Hwang, 2013; Mesquita & Walker, 2003). In emotions research, assumptions of psychological universality are best avoided. Clearly, there remains a need for further research in cultural and linguistic contexts different to our own to see if different patterns emerge.

6 | CONCLUSION

There is now a growing focus on emotions in engineering education research (Lönngren et al., 2023), and this is matched by a growing interest in emotions in engineering ethics education. Indeed, there are particular reasons why emotions should be seen as important to teaching and learning in engineering ethics. There is good evidence that emotions matter to ethics learning. Cases with mild to moderate emotional content have been found to enhance ethics learning in science and engineering (Thiel et al., 2013), while higher levels of emotional content have been found to reduce ethics learning (Watts et al., 2017). Many mainstream ethics engineering ethics texts pay little or no attention at all to the emotionality of the cases (Fleddermann, 2011; Harris et al., 2013; Van de Poel & Royakkers, 2011). There is now adequate evidence that this is a mistake.

As we described in Section 2.5, both Higgs et al. (2020) and Thiel et al. (2013) had previously identified different strategies for *explicitly* putting emotional information in case studies. We have described (in Section 3.1.1) a different approach for *implicitly* regulating the level of compassion in case studies. We have also empirically identified that our approach is very successful. We expect that this approach could well be a model that case study writers who wish to include mild to moderate compassion in their cases could adopt in the future. Given the potential learning benefits, we would suggest that case study authors should certainly consider doing so. We would also suggest there is a need for further research on the ways in which different methods for including emotion in cases may give rise to different levels of emotionality and, as a consequence, different learning effects.

Our data suggests that even small-scale ethics cases that do not involve significant death and destruction are resonant with a range of moral emotions. It seems likely that many, more commonly used, ethics cases are even more resonant with emotion. Even if these emotions are ignored by ethics teachers, they are probably having an impact – often a negative impact – on learning. Even if teachers and authors do decide to jettison these large-scale studies of death and destruction, emotional processing of ethics cases (such as in the matter suggested by Hess et al., 2019) will still need to become a mainstream part of engineering ethics education. Other methods and approaches for doing this should continue to be explored and researched.

We started this work asking if emotions should be added to engineering ethics cases. We found out that they are already there. Since emotions cannot be avoided in engineering ethics cases, we would suggest that engineering ethics teachers and researchers need to be much more deliberate in addressing emotion. Ignoring them will not make them go away.

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REFERENCES

Atiq, Z., & Loui, M. C. (2022). A qualitative study of emotions experienced by first-year engineering students during programming tasks. *ACM Transactions on Computing Education (TOCE)*, *22*(3), 1–26. https://doi.org/10.1145/3507696

21689830, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20538 by Bibliothèque De L'Epfl-, Wiley Online Library on [20/06/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Baron-Cohen, S., & Wheelwright, S. (2004). The empathy quotient: An investigation of adults with Asperger syndrome or high functioning autism, and normal sex differences. *Journal of Autism and Developmental Disorders*, *34*(2), 163–175. https://doi.org/10.1023/B:JADD.0000022607.19833.00

Barry, B. E., & Herkert, J. R. (2014). Engineering ethics. In A. Johri & B. Olds (Eds.), *Cambridge handbook of engineering education research* (pp. 673–692). Cambridge University Press. https://doi.org/10.1017/CBO9781139013451.041

Batson, C. D. (2009). These things called empathy: Eight related but distinct phenomena. In J. Decety & W. Ickes (Eds.), *The social neuroscience of empathy* (pp. 3–15). MIT Press. https://doi.org/10.7551/mitpress/9780262012973.003.0002

Batson, C. D., Batson, J. G., Todd, R. M., Brummett, B. H., Shaw, L. L., & Aldeguer, C. M. R. (1995). Empathy and the collective good: Caring for one of the others in a social dilemma. *Journal of Personality and Social Psychology*, *68*(4), 619–631. https://doi.org/10.1037/0022-3514.68.4.619

Batson, C. D., Duncan, B. D., Ackerman, P., Buckley, T., & Birch, K. (1981). Is empathic emotion a source of altruistic motivation? *Journal of Personality and Social Psychology*, *40*(2), 290–302. https://doi.org/10.1037/0022-3514.40.2.290

Batson, C. D., Polycarpou, M. P., Harmon-Jones, E., Imhoff, H. J., Mitchener, E. C., Bednar, L. L., Klein, T. R., & Highberger, L. (1997). Empathy and attitudes: Can feeling for a member of a stigmatized group improve feelings toward the group? *Journal of Personality and Social Psychology*, *72*(1), 105–118. https://doi.org/10.1037/0022-3514.72.1.105

Bebeau, M. J. (2002). The defining issues test and the four-component model: Contributions to professional education. *Journal of Moral Education*, *31*(3), 271–295. https://doi.org/10.1080/0305724022000008115

Bebeau, M. J., Rest, J. R., & Narvaez, D. (1999). Beyond the promise: A perspective on research in moral education. *Educational Researcher*, *28*(4), 18–26. https://doi.org/10.3102/0013189X028004018

Bellocchi, A. (2019). *Emotion and teacher education*. Oxford Research Encyclopedia of Education. https://doi.org/10.1093/acrefore/9780190264093.013.773

Bloom, P. (2010). How do morals change? *Nature*, *464*(7288), 490. https://doi.org/10.1038/464490a

Borenstein, J., Drake, M. J., Kirkman, R., & Swann, J. L. (2010). The engineering and science issues test (ESIT): A discipline-specific approach to assessing moral judgment. *Science and Engineering Ethics*, *16*(2), 387–407. https://doi.org/10.1007/s11948-009-9148-z

Cassell, E. J. (2002). Compassion. In C. R. Snyder & S. J. Lopez (Eds.), *Handbook of positive psychology* (pp. 434–445). Oxford University Press.

Cech, E. A. (2013). The (mis) framing of social justice: Why ideologies of depoliticization and meritocracy hinder engineers' ability to think about social injustices. In J. Lucena (Ed.), *Engineering education for social justice* (pp. 67–84). Springer. https://doi.org/10.1007/978-94-007-6350-0_4

Clancy, R. F. (2020, June). *Ethical reasoning and moral foundations among engineering students in China*. Paper presented at the ASEE Virtual Annual Conference Content Access, Virtual Online. https://doi.org/10.18260/1-2–34587

Colby, A., & Sullivan, W. M. (2008). Ethics teaching in undergraduate engineering education. *Journal of Engineering Education*, *97*(3), 327–338. https://doi.org/10.1002/j.2168-9830.2008.tb00982.x

Davis, M. (2015). Engineers, emotions, and ethics. In S. S. Sethy (Ed.), *Contemporary ethical issues in engineering* (pp. 1–11). IGI Global. https://doi.org/10.4018/978-1-4666-8130-9.ch001

Dunbar, W. S. (2005). Emotional engagement in professional ethics. *Science and Engineering Ethics*, *11*(4), 535–551. https://doi.org/10.1007/s11948-005-0025-0

Eisenberg, N., & Lennon, R. (1983). Sex differences in empathy and related capacities. *Psychological Bulletin*, *94*(1), 100–131. https://doi.org/10.1037/0033-2909.94.1.100

Firat, R., & McPherson, C. M. (2010). Toward an integrated science of morality, linking mind, society and culture. In S. Hitlin & S. Vaisey (Eds.), *Handbook of the sociology of morality (Handbooks of sociology and social research)* (pp. 347–371). Springer.

Fleddermann, C. B. (2011). *Engineering ethics* (4th ed.). Pearson Prentice Hall.

Gilligan, C. (1982). New maps of development: New visions of maturity. *American Journal of Orthopsychiatry*, *52*(2), 199–212. https://doi.org/10.1111/j.1939-0025.1982.tb02682.x

Guntzburger, Y., Pauchant, T. C., & Tanguy, P. A. (2019). Empowering engineering students in ethical risk management: An experimental study. *Science and Engineering Ethics*, *25*(3), 911–937. https://doi.org/10.1007/s11948-018-0044-2

Haidt, J. (2001). The emotional dog and its rational tail: A social intuitionist approach to moral judgment. *Psychological Review*, *108*(4), 814–834. https://doi.org/10.1037/0033-295X.108.4.814

Haidt, J. (2003). The moral emotions. In R. J. Davidson, K. R. Scherer, & H. H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 852–870). Oxford University Press. https://pages.stern.nyu.edu/~jhaidt/articles/alternate_versions/haidt.2003.the-moral-emotions.pub025-as-html.html

Haidt, J. (2012). Moral psychology and the law: How intuitions drive reasoning, judgment, and the search for evidence. *Alabama Law Review*, *64*(4), 867–880. https://www.law.ua.edu/pubs/lrarticles/Volume%2064/Issue%204/4%20Haidt%20867-880.pdf

Harris, C. E., Jr., Davis, M., Pritchard, M. S., & Rabins, M. J. (1996). Engineering ethics: What? Why? How? And when? *Journal of Engineering Education*, *85*(2), 93–96. https://doi.org/10.1002/j.2168-9830.1996.tb00216.x

Harris, C. E., Jr., Pritchard, M. S., Rabins, M. J., James, R., & Englehardt, E. (2013). *Engineering ethics: Concepts and cases*. Cengage Learning.

Herkert, J. R. (2005). Ways of thinking about and teaching ethical problem solving: Microethics and macroethics in engineering. *Science and Engineering Ethics*, *11*(3), 373–385. https://doi.org/10.1007/s11948-005-0006-3

21689830, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20538 by Bibliotheque De L'Epfl-, Wiley Online Library on [20/06/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Hess, J. L., Beever, J., Strobel, J., & Brightman, A. O. (2017). Empathic perspective-taking and ethical decision-making in engineering ethics education. In D. Michelfelder, B. Newberry & Q. Zhu (Eds.), *Philosophy and engineering* (pp. 163–179). Springer. https://doi.org/10.1007/978-3-319-45193-0_13

Hess, J. L., Beever, J., Zoltowski, C. B., Kisselburgh, L., & Brightman, A. O. (2019). Enhancing engineering students' ethical reasoning: Situating reflexive principlism within the SIRA framework. *Journal of Engineering Education*, *108*(1), 82–102. https://doi.org/10.1002/jee.20249

Hess, J. L., & Fila, N. D. (2016, June). *The development and growth of empathy among engineering students*. Paper presented at the ASEE Annual Conference and Exposition, New Orleans, LA. https://doi.org/10.18260/p.26120

Hess, J. L., & Fore, G. (2018). A systematic literature review of US engineering ethics interventions. *Science and Engineering Ethics*, *24*(2), 551–583. https://doi.org/10.1007/s11948-017-9910-6

Hess, J. L., Miller, S., Higbee, S., Fore, G. A., & Wallace, J. (2021). Empathy and ethical becoming in biomedical engineering education: A mixed methods study of an animal tissue harvesting laboratory. *Australasian Journal of Engineering Education*, *26*(1), 127–137. https://doi.org/10.1080/22054952.2020.1796045

Hess, J. L., Strobel, J., & Brightman, A. O. (2017). The development of empathic perspective-taking in an engineering ethics course. *Journal of Engineering Education*, *106*(4), 534–563. https://doi.org/10.1002/jee.20175

Higgs, C., McIntosh, T., Connelly, S., & Mumford, M. (2020). Self-focused emotions and ethical decision-making: Comparing the effects of regulated and unregulated guilt, shame, and embarrassment. *Science and Engineering Ethics*, *26*(1), 27–63. https://doi.org/10.1007/s11948-018-00082-z

Hoffman, M. L. (2000). *Empathy and moral development: Implications for caring and justice*. Cambridge University Press. https://doi.org/10.1017/CBO9780511805851

Hoffman, M. L. (2008). Empathy and prosocial behavior. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (pp. 440–455). The Guilford Press.

Hume, D. (2003). *A treatise of human nature*. Courier Corporation.

Jackson, J. C., Watts, J., Henry, T. R., List, J. M., Forkel, R., Mucha, P. J., Greenhill, S. J., Gray, R. D., & Lindquist, K. A. (2019). Emotion semantics show both cultural variation and universal structure. *Science*, *366*(6472), 1517–1522. https://doi.org/10.1126/science.aaw8160

Kant, I. (2002). *Critique of practical reason*. Hackett Publishing. https://doi.org/10.1017/CBO9780511809576

Kellam, N., Gerow, K., Wilson, G., Walther, J., & Cruz, J. (2018). Exploring emotional trajectories of engineering students: A narrative research approach. *International Journal of Engineering Education*, *34*(6), 1726–1740. https://www.ijee.ie/latestissues/Vol34-6/02_ijee3672.pdf

Kelly, D., & Morar, N. (2014). Against the yuck factor: On the ideal role of disgust in society. *Utilitas*, *26*(2), 153–177. https://doi.org/10.1017/S0953820813000290

Kerr, A. J., Brummel, B. J., & Daily, J. S. (2016, June). *Using the engineering and science issues test (ESIT) for ethics instruction*. Paper presented at the ASEE Annual Conference and Exposition, New Orleans, LA. https://doi.org/10.18260/p.27166

Kim, D. (2022). Promoting professional socialization: A synthesis of Durkheim, Kohlberg, Hoffman, and Haidt for professional ethics education. *Business and Professional Ethics Journal*, *41*(1), 93–114. https://doi.org/10.5840/bpej202216115

Kim, D., & Jesiek, B. K. (2019, June). *Work-in-progress: Emotion and intuition in engineering students' ethical decision making and implications for engineering ethics education*. Paper presented at the ASEE Annual Conference and Exposition, Tampa, FL. https://strategy.asee.org/33666

Kligyte, V., Connelly, S., Thiel, C., & Devenport, L. (2013). The influence of anger, fear, and emotion regulation on ethical decision making. *Human Performance*, *26*(4), 297–326. https://doi.org/10.1080/08959285.2013.814655

Kohlberg, L. (1969). Stage and sequence: The cognitive developmental approach to socialization. In D. Goslin (Ed.), *Handbook of socialization theory and research* (pp. 347–480). Rand McNally.

Lazarus, R. S. (1991). *Emotion and adaptation*. Oxford University Press.

Lerner, J. S., Li, Y., Valdesolo, P., & Kassam, K. S. (2015). Emotion and decision making. *Annual Review of Psychology*, *66*(1), 799–823. https://doi.org/10.1146/annurev-psych-010213-115043

Lindquist, K. A. (2021). Language and emotion: Introduction to the special issue. *Affective Science*, *2*(2), 91–98. https://doi.org/10.1007/s42761-021-00049-7

Lönngren, J., Adawi, T., & Berge, M. (2021). Using positioning theory to study the role of emotions in engineering problem solving: Methodological issues and recommendations for future research. *Studies in Engineering Education*, *2*(1), 53–79. https://doi.org/10.21061/see.50

Lönngren, J., Bellocchi, A., Bøgelund, P., Direito, I., Huff, J., Mohd-Yusof, K., Murzi, H., & Tormey, R. (2021, December). *Emotions in engineering education: Preliminary results from a scoping review*. Paper presented at the Proceedings of Research in Engineering Education Symposium and Australasian Association for Engineering Education Conference, Perth, Western Australia. https://vbn.aau.dk/files/457946775/REESfullpaper20210921.pdf

Lönngren, J., Direito, I., Tormey, R., & Huff, J. L. (2023). Emotions in engineering education. In A. Johri (Ed.), *International handbook of engineering education research* (pp. 156–182). Routledge. https://doi.org/10.4324/9781003287483-10

Martin, D. A., Conlon, E., & Bowe, B. (2021). Using case studies in engineering ethics education: The case for immersive scenarios through stakeholder engagement and real-life data. *Australasian Journal of Engineering Education*, *26*(1), 47–63. https://doi.org/10.1080/22054952.2021.1914297

Martí-Vilar, M., Escrig-Espuig, J. M., & Merino-Soto, C. (2023). A systematic review of moral reasoning measures. *Current Psychology*, *42*(2), 1284–1298. https://doi.org/10.1007/s12144-021-01519-8

21689830, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20538 by Bibliotheque De L'Epfl-, Wiley Online Library on [20/06/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Matsumoto, D., & Hwang, H. S. (2013). Cultural display rules. In K. D. Keith (Ed.), *The encyclopedia of cross-cultural psychology* (pp. 303). John Wiley & Sons. https://doi.org/10.1002/9781118339893.wbeccp126

Merseth, K. K. (1994). *Cases, case methods, and the professional development of educators*. ERIC Digest. https://eric.ed.gov/?id=ED401272

Mesquita, B., & Walker, R. (2003). Cultural differences in emotions: A context for interpreting emotional experiences. *Behaviour Research and Therapy*, *41*(7), 777–793. https://doi.org/10.1016/S0005-7967(02)00189-4

Moll, J., Oliveira-Souza, R. d., Zahn, R., & Grafman, J. (2008). The cognitive neuroscience of moral emotions. In W. Sinnott-Armstrong (Ed.), *Moral psychology, Vol. 3. The neuroscience of morality: Emotion, brain disorders, and development* (pp. 1–17). MIT Press.

Morrison, L. A. (2020). Situating moral agency: How post-phenomenology can benefit engineering ethics. *Science and Engineering Ethics*, *26*(3), 1377–1401. https://doi.org/10.1007/s11948-019-00163-7

Narvaez, D., & Rest, J. (1995). The four components of acting morally. Moral behavior and moral development: An introduction. *Handbook of Moral and Character Education*, *1*(1), 385–400. https://www3.nd.edu/~dnarvaez/documents/NARVAEZREST.pdf

Nussbaum, M. C. (2001). *Upheavals of thought: The intelligence of emotions*. Cambridge University Press.

Nussbaum, M. C. (2013). *Political emotions*. Harvard University Press.

Pantazidou, M., & Nair, I. (1999). Ethic of care: Guiding principles for engineering teaching & practice. *Journal of Engineering Education*, *88*(2), 205–212. https://doi.org/10.1002/j.2168-9830.1999.tb00436.x

Pawley, A. L. (2009). Universalized narratives: Patterns in how faculty members define "engineering". *Journal of Engineering Education*, *98*(4), 309–319. https://doi.org/10.1002/j.2168-9830.2009.tb01029.x

Pekrun, R., Lichtenfeld, S., Marsh, H. W., Murayama, K., & Goetz, T. (2017). Achievement emotions and academic performance: Longitudinal models of reciprocal effects. *Child Development*, *88*(5), 1653–1670. https://doi.org/10.1111/cdev.12704

Pekrun, R., & Linnenbrink-Garcia, L. (2012). Academic emotions and student engagement. In S. Christenson, A. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 259–282). Springer. https://doi.org/10.1007/978-1-4614-2018-7_12

Prinz, J. J. (2011). Is empathy necessary for morality. In A. Coplan & P. Goldie (Eds.), *Empathy: Philosophical and psychological perspectives* (pp. 211–229). Oxford University Press.

Rest, J., Narvaez, D., Bebeau, M., & Thoma, S. (1999). A neo-Kohlbergian approach: The DIT and schema theory. *Educational Psychology Review*, *11*(4), 291–324. https://doi.org/10.1023/A:1022053215271

Rest, J., Thoma, S. J., Narvaez, D., & Bebeau, M. J. (1997). Alchemy and beyond: Indexing the defining issues test. *Journal of Educational Psychology*, *89*(3), 498–507. https://doi.org/10.1037/0022-0663.89.3.498

Rest, J. R., Narvaez, D., Thoma, S. J., & Bebeau, M. J. (1999). DIT2: Devising and testing a revised instrument of moral judgment. *Journal of Educational Psychology*, *91*(4), 644–659. https://doi.org/10.1037/0022-0663.91.4.644

Riley, D., Pawley, A. L., Tucker, J., & Catalano, G. D. (2009). Feminisms in engineering education: Transformative possibilities. *NWSA Journal*, *21*(2), 21–40. http://www.jstor.org/stable/20628172

Roeser, S. (2010). Emotional reflection about risks. In S. Roeser (Ed.), *Emotions and risky technologies* (pp. 231–244). Springer. https://doi.org/10.1007/978-90-481-8647-1_14

Roeser, S. (2012). Emotional engineers: Toward morally responsible design. *Science and Engineering Ethics*, *18*(1), 103–115. https://doi.org/10.1007/s11948-010-9236-0

Roeser, S. (2020). Risk, technology, and moral emotions: Reply to critics. *Science and Engineering Ethics*, *26*(4), 1921–1934. https://doi.org/10.1007/s11948-020-00196-3

Rosen, J. B., Brand, M., & Kalbe, E. (2016). Empathy mediates the effects of age and sex on altruistic moral decision making. *Frontiers in Behavioral Neuroscience*, *10*, 67. https://doi.org/10.3389/fnbeh.2016.00067

Rudolph, U., & Tscharaktschiew, N. (2014). An attributional analysis of moral emotions: Naïve scientists and everyday judges. *Emotion Review*, *6*(4), 344–352. https://doi.org/10.1177/1754073914534507

Scherer, K. R. (2005). What are emotions? And how can they be measured? *Social Science Information*, *44*(4), 695–729. https://doi.org/10.1177/0539018405058216

Shuman, V., & Scherer, K. R. (2014). Concepts and structures of emotions. In R. Pekrun & L. Linnenbrink-Garcia (Eds.), *International handbook of emotions in education* (pp. 13–35). Taylor and Francis.

Snieder, R., & Zhu, Q. (2020). Connecting to the heart: Teaching value-based professional ethics. *Science and Engineering Ethics*, *26*(4), 2235–2254. https://doi.org/10.1007/s11948-020-00216-2

Sunderland, M. E. (2014). Taking emotion seriously: Meeting students where they are. *Science and Engineering Ethics*, *20*(1), 183–195. https://doi.org/10.1007/s11948-012-9427-y

Sunderland, M. E., Taebi, B., Carson, C., & Kastenberg, W. (2014). Teaching global perspectives: Engineering ethics across international and academic borders. *Journal of Responsible Innovation*, *1*(2), 228–239. https://doi.org/10.1080/23299460.2014.922337

Sutton, R. E., & Wheatley, K. F. (2003). Teachers' emotions and teaching: A review of the literature and directions for future research. *Educational Psychology Review*, *15*(4), 327–358. https://doi.org/10.1023/A:1026131715856

Thiel, C. E., Connelly, S., Harkrider, L., Devenport, L. D., Bagdasarov, Z., Johnson, J. F., & Mumford, M. D. (2013). Case-based knowledge and ethics education: Improving learning and transfer through emotionally rich cases. *Science and Engineering Ethics*, *19*(1), 265–286. https://doi.org/10.1007/s11948-011-9318-7

Thoma, S. J., & Dong, Y. (2014). The defining issues test of moral judgment development. *Behavioral Development Bulletin*, *19*(3), 55–61. https://doi.org/10.1037/h0100590

21689830, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20538 by Bibliothèque De L'Epfl-, Wiley Online Library on [20/06/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Tormey, R. (2020, September). *Towards an emotions-based engineering ethics education*. Paper presented at the Engaging Engineering Education Proceedings of the European Society for Engineering Education 48th Annual Conference, Enschede, the Netherlands. https://www.sefi.be/wp-content/uploads/2020/11/Proceedings-DEF-nov-2020-kleiner.pdf

Turner, J. H., & Stets, J. E. (2005). *The sociology of emotions*. Cambridge University Press.

Tyng, C. M., Amin, H. U., Saad, M. N. M., & Malik, A. S. (2017). The influences of emotion on learning and memory. *Frontiers in Psychology*, *8*, 1454. https://doi.org/10.3389/fpsyg.2017.01454

Van de Poel, I., & Royakkers, L. (2011). *Ethics, technology, and engineering: An introduction*. John Wiley & Sons.

Villanueva, I., Campbell, B. D., Raikes, A. C., Jones, S. H., & Putney, L. G. (2018). A multimodal exploration of engineering students' emotions and electrodermal activity in design activities. *Journal of Engineering Education*, *107*(3), 414–441. https://doi.org/10.1002/jee.20225

Walling, O. (2015). Beyond ethical frameworks: Using moral experimentation in the engineering ethics classroom. *Science and Engineering Ethics*, *21*(6), 1637–1656. https://doi.org/10.1007/s11948-014-9614-0

Walther, J., Brewer, M. A., Sochacka, N. W., & Miller, S. E. (2020). Empathy and engineering formation. *Journal of Engineering Education*, *109*(1), 11–33. https://doi.org/10.1002/jee.20301

Walther, J., Miller, S. E., & Sochacka, N. W. (2017). A model of empathy in engineering as a core skill, practice orientation, and professional way of being. *Journal of Engineering Education*, *106*(1), 123–148. https://doi.org/10.1002/jee.20159

Watts, L. L., Medeiros, K. E., Mulhearn, T. J., Steele, L. M., Connelly, S., & Mumford, M. D. (2017). Are ethics training programs improving? A meta-analytic review of past and present ethics instruction in the sciences. *Ethics & Behavior*, *27*(5), 351–384. https://doi.org/10.1080/10508422.2016.1182025

Yadav, A., & Barry, B. E. (2009). Using case-based instruction to increase ethical understanding in engineering: What do we know? What do we need? *International Journal of Engineering Education*, *25*(1), 138–143. https://www.ijee.ie/latestissues/Vol25-1/s17_Ijee2114.pdf

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