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# The impact of different methods of increasing the intensity of compassion in engineering ethics cases

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**ABSTRACT**

Despite the growing interest in emotions in engineering education, empirical research on incorporating them into engineering ethics education is limited. Therefore, we designed this experimental study to assess how different methods for integrating compassion into engineering ethics cases influenced the intensity of compassion associated with the protagonists of the cases. We utilised modified versions of the Engineering and Science Issues Test (ESIT) cases, employing three methods to intensify compassion associated with the cases' protagonists: (i) implicit induction, (ii) explicit expression, and (iii) through the description of severe consequences. The participants ($n = 415$), predominantly engineering students (90%), were divided into one control group and three experimental groups. Results indicated that all three methods increased the intensity of compassion in the cases. However, the implicit method had a relatively weaker impact than the other two methods which had similar effects on the intensity of compassion. Other emotions did not seem to be impacted by the changes. This study provides valuable insights into effective methods to increase the intensity of compassion in engineering ethics cases without affecting other emotions.

## Introduction

Emotions are typically seen as external to engineering, which is often perceived as a rational and technocratic profession; however, over the last decade, there has been a growing focus on emotions in engineering education (Lönngren et al. 2023). An increasing interest in emotion is also evident in engineering ethics education (Hess et al. 2019; Roeser 2020; Sunderland 2014). However, there has been limited empirical research on integrating emotions into engineering ethics education. A possible way to integrate emotions into engineering ethics education might be through case studies that are commonly used in teaching engineering ethics (Martin, Conlon, and Bowe 2021).

There are good reasons to think including some degree of emotion in cases may be pedagogically productive. There is evidence that when protagonists in ethics cases are seen to experience emotions such as guilt and shame, this increases the perceived importance and urgency of cases (Higgs et al. 2020). Thiel et al. (2013) found that incorporating details about the protagonist's emotional state into ethics cases resulted in enhanced learning among participants. But Watts et al. (2017) found that low to moderate emotionality in cases was most linked to learning, and

that higher levels of emotional intensity may disrupt learning. This suggests it is also crucial to consider not only the presence but also the intensity of emotional content when incorporating emotions into engineering ethics cases.

It is important to note that empirical evidence shows that even engineering ethics cases that are presented as 'emotionally neutral' do seem to have an emotional character (Kotluk and Tormey 2023). The issue is then not about making cases emotional, so much as about increasing the intensity of an emotion in (already emotional) cases. When examining the ways of increasing emotional intensity associated with protagonists in ethics cases, existing literature identifies three methods: (i) implicit induction, which utilises the characteristics associated with the targeted emotion experienced by the case protagonists in the case content (for example, Kotluk and Tormey 2023), (ii) explicit expression, which highlights the name of the targeted emotion felt by the protagonist in the case content (as in Higgs et al. 2020), and (iii) the description of severe consequences, in which severe negative outcomes such as death and injury for individuals reliant on the case protagonist's decision are described (as in many of the engineering ethics cases in textbooks).

There is, however, limited empirical research on the effects of these methods in increasing emotion intensity in cases. While researchers identified that (i) implicitly inducing compassion does increase the intensity of compassion without affecting other related emotions (Kotluk and Tormey 2023), the effects on emotional intensity of (ii) explicitly expressing emotion and (iii) describing severe consequences, remain unknown. Considering the crucial role that compassion can play in ethical decision-making (Haidt 2003) in engineering ethics education (Roeser 2012), we focus on increasing the intensity of compassion in engineering ethics cases. Thus, this paper addresses this research question:

### Research question

How do different methods of including emotional content related to the compassion of protagonists in engineering ethics cases affect the intensity of emotions in the cases?

## Background

### Emotions

In Western philosophy, emotions were historically seen as distinct from and opposed to rationality, including moral reasoning (even if a minority, such as David Hume, examined the moral passions linking emotions to ethical considerations) (Barbalet 2001). This opposition between thinking and emotion is now largely discredited among emotion researchers, even if it still remains influential in public discourse. Emotion researchers generally define emotion as a multicomponent episode that prepares a person for a response to an object or event in the person's environment or context (Shuman and Scherer 2014). Different theories of emotions tend to emphasise various components of an emotion episode, but these components are often seen to include particular patterns of cognition, bodily changes, subjective experiences, culturally determined emotion display rules, and emotion words (Bericat 2016; Lindquist 2021). Emotions, therefore, integrate feelings, cognition, and social structures.

### The moral emotion of compassion

Emotions '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', are known as moral emotions (Haidt 2003, 853). Varied frameworks and labels are used for moral emotions (e.g. Haidt 2003; Moll et al. 2008; Rudolph and Tscharaktschiew 2014). For instance, Haidt (2003) frames four 'families' of moral emotions: (i) 'self-conscious' emotions such as embarrassment, guilt, and shame, (ii) 'other-condemning' emotions such

as anger, contempt, and disgust; (iii) 'other-praising' emotions such as awe, elevation, and gratitude, and (iv) 'other-suffering' emotions such as compassion/ sympathy, empathy, and distress.

Different moral emotions have been found to be linked to different ethical dispositions. Yang et al. (2022) suggests that, for example, guilt in ethical dilemmas increases sensitivity to ethical norms and standards, and, while guilt and shame have also been found to be linked to an increased sense of the urgency and importance of an ethical issue, embarrassment has not (Higgs et al. 2020). Anger has been found to be linked to pro-environmental personal behaviour (Stanley et al. 2021), but Kligyte et al. (2013) also found anger to be disruptive of ethical decision making. These examples show it is not sufficient to look at emotion in general, but we need instead to focus on specific emotions.

Among moral emotions, there is good reason to think compassion which is linked to pro-social behaviour is a fundamental emotion to focus on and explore in engineering ethics education. For example, Haidt (2003, 862) states that 'compassion makes people want to help, comfort, or alleviate the suffering of others' and motivates them to make 'good' moral decisions. According to Roeser, moral emotions, in general, can play an essential role in morally, socially, and responsibly engineering design, and in particular, 'sympathy, empathy and compassion can let us [engineers] be aware of our responsibility in a forward-looking sense' (2012, 110).

Compassion, as understood through various perspectives, encompasses a range of cognitive, affective, and behavioural elements. It involves being moved by another's suffering, desiring to help and requires an awareness of their distress, identification with their experience, and knowledge of their situation (Strauss et al. 2016). For Nussbaum (2013), compassion has three cognitive elements: the judgment of size (something terrible happened to someone), the judgment of non-desert (the person suffers undeservedly), and the eudaimonistic judgment (one must regard the suffering of another as important in some way in one's own life). Compassion is part of the other-suffering family of emotions and is thus closely linked to empathy, distress, and concern (Hess and Fila 2016). However, since the term empathy is multifaceted and can refer to several different phenomena (Batson 2009), we focused on the more tightly-defined emotion of compassion rather than on the more diffuse concept of empathy.

## Emotions and ethics learning in engineering ethics education

Emotions significantly influence human cognitive processes, shaping perception, attention, learning (Tyng et al. 2017), memory (Bower 2014), reasoning (Haidt 2001), and decision-making (Lerner et al. 2015). They are crucial in attention modulation, executive control, and efficient information processing (Tyng et al. 2017). Research in educational psychology indicates that emotions can notably impact students' learning, motivation, and academic achievement (Pekrun et al. 2002; Pekrun et al. 2017; Pekrun and Linnenbrink-Garcia 2012).

Until recently, emotion has generally been a marginalised consideration in teaching engineering ethics (Kim 2022; Newberry 2004; Tormey 2020). Roeser (2020), for example, argues that relying solely on rationalist approaches is insufficient for practical ethics learning; empirical knowledge, rationality, and emotions are all crucial for better ethical understanding. In this direction, for example, Sunderland (2014) examined how project-based learning may engage engineering students' emotions, stating that emotions gave engineering students a meaningful opportunity to engage in ethical learning. Another way to integrate emotion into engineering ethics education might be engineering ethics case studies.

## Engineering ethics cases and emotions

Teaching engineering ethics through case studies is among the most common pedagogical teaching methods in many countries (Bairaktarova and Woodcock 2017; Martin, Conlon, and Bowe 2021). Cases take different forms depending on, among other things, (a) their factual or fictional character,

(b) their level of detail, (c) whether or not a decision has already been taken in the case, and (d) whether or not the case recounts a well-known event (see Martin, Conlon, and Bowe 2021). In studies of the development of moral reasoning, however, dilemmas – defined as a situation which presents a difficult choice between two competing outcomes both of which are desirable (or undesirable) – have been found to be particularly powerful (Tormey forthcoming).

Although many empirical studies demonstrate that cognitive and emotional processes play essential roles in these kinds of ethical dilemmas and may interact differently in each case (Greene et al. 2008; Greene and Haidt 2002; Palmiotti et al. 2020), the emotional component is often not considered in mainstream textbooks in which engineering ethics cases are presented and analysed (Tormey 2020). This emotion may be associated with a case protagonist (e.g. someone who has to make a decision), but need not be: the Bhopal disaster, for instance; can evoke in readers feelings of horror and empathy for the victims, even without explicitly mentioning the names of the engineers (protagonists) or specifying the emotions involved.

These emotions are important because there is evidence that some emotional content in cases may positively affect engineering students' ethical learning, perspective-taking, and motivation. Thiel et al. (2013) found that describing emotions associated with the protagonist in a case made cases more realistic and memorable and increased ethical learning. In another study, Higgs et al. (2020) revealed that describing specific emotions of the protagonist in the case also increased ethical motivation. But all emotion appears not to be equal in this regard. For instance, a meta-analysis by Watts et al. (2017) found that, in training on responsible conduct of scientific research (i.e. research ethics) low to moderate realism and emotional content in cases are more associated with learning gains than more realistic, large-scale cases. While it is open to question as to whether this finding is directly transferable from research ethics instruction to engineering ethics instruction, it is nonetheless consistent with prior research which shows that higher levels of intensity of other-suffering emotions may lead people to become distracted by their own distress (empathetic overarousal, see Hoffman 2014 for a summary). Such distraction may in turn reduce attention on the case and thus impair learning.

## The different ways of integrating emotions into engineering ethics cases

Indeed, thus far, some moral emotions in engineering ethics education have been studied and intentionally included in ethics cases (Higgs et al. 2020; Kotluk and Tormey 2022; Thiel et al. 2013). Researchers have identified that, even in cases which are presented as emotionally neutral, students identify a number of emotions with case study protagonists, including compassion, embarrassment and guilt (Kotluk and Tormey 2023). Beyond this, the literature also shows three further methods that may increase the intensity of an emotion in the case.

The first such method is (i) implicit induction: instead of providing explicit information about the emotional responses of the case's protagonist, adding some features or emotional content related to the targeted emotion in the cases may allow readers to understand how the protagonist might feel. For example, since compassion is felt towards people who are experiencing some distress or pain and is often increased by similarity between people, researchers have found that including such features in a case study increases the intensity of compassion associated with case study protagonists (Kotluk and Tormey 2022). Furthermore, they found that other moral emotions were unaffected by this method for increasing the intensity of compassion.

A second method is (ii) explicit expression: including explicit statements of the emotions experienced by the protagonists in the cases. For example, Thiel et al. (2013, 271) included emotional content in cases to allow participants to understand how the protagonist felt (i.e. 'Robin feels less guilt and more anger. She is angry that … '). In another study, Higgs et al. (2020, 57) also explicitly mentioned the emotions experienced by the protagonists in the cases (i.e. 'you begin to feel disgusted with yourself … with intense feelings of shame'). While one might hypothesise that such an explicit expression of emotion would increase the intensity of emotion associated with the

protagonist, this has not yet been tested. Nor is it known if the explicit naming of, for example, compassion would have a knock-on effect on the intensity associated with other emotions.

A third method is (iii) the description of severe consequences into case content. The severe consequences form is widespread in mainstream engineering cases often in the form of well-known realistic engineering ethics cases which generally involve this kind of large-scale death and destruction (e.g. the Volkswagen Emissions Scandal, the Netherlands flooding, and the Chornobyl nuclear accident). Again, while it seems evident that attributing severe negative consequences to a decision would increase the intensity of compassion associated with a case protagonist, this has not been systematically evaluated, and the question as to whether this method might also increase the intensity of other emotions besides compassion is also unknown.

### The gap in the field

Existing research suggests a connection between emotions' intensity and ethical knowledge acquisition in ethics cases. Both excessive and insufficient emotional intensity have been found to have a negative impact on learning. Therefore, there is a need to investigate how emotions are incorporated into case studies and their effects on the intensity of the emotionality of cases. The importance of compassion as a pro-social moral emotion means that it is worth focusing specifically on this emotion.

Previous studies revealed that cases even assumed to be 'emotionally neutral' also contain some emotionality. Beyond this latent emotionality, emotions can be integrated into cases in three ways: implicitly, explicitly, and through the description of severe consequences. While researchers found that implicit induction increased the intensity of compassion associated with the case protagonist without impacting on the intensity of other moral emotions (Kotluk and Tormey 2023), the impact on the intensity of compassion of the other two methods, the explicit expression and the description of severe consequences, remains unknown. It is also unknown how the other emotions are affected by the method through which the intensity of compassion is regulated. This knowledge gap leaves case study writers and educators with a limited understanding of how different emotional content inclusion methods affect the emotionality of the cases. This leads us to the following research question:

### RQ

Do the methods of (ii) explicit expression and (iii) description of severe consequences change the level of compassion associated with protagonists in ethics cases, as compared to cases with only latent emotionality and to those which use the (i) implicit induction method?

> **H1.** The explicit expression of emotional content related to compassion within cases will result in a higher intensity of compassion associated with the protagonists compared to implicit induction.

> **H2.** The description of severe consequences method will result in a higher intensity of compassion associated with the protagonists compared to the explicit expression method.

### Supplemental RQ

Is there any effect of these methods on the intensity of other moral emotions associated with protagonists in the cases?

### Method

This experimental study was carried out with one control group and three experimental groups (Table 1).

**Table 1.** The research design.

| Research Design | | | |
|---|---|---|---|
| Groups | | | |
| Control | Experimental-1 | Experimental-2 | Experimental-3 |
| The cases used    Latent Emotionality | Implicit Induction | Explicit Expression | Description of Severe Consequences |

We used and modified a French version of the ESIT cases which was previously confirmed for validation, clarity, readability, and translation. The ESIT was developed by Borenstein et al. (2010) and comprises six cases on engineering and science issues that present ethical dilemmas. The control group was provided with a slightly modified version of the original cases, while the first experimental group received compassion-induced cases with implicit emotional elements. The data from Latent (Control) and Implicit (Experimental-1) conditions has already been reported in [Kotluk and Tormey 2023], but some of it is reproduced here for comparison purposes. The second experimental group was exposed to cases using the explicit expression method to increase the intensity of compassion, and the third experimental group was presented with cases including the description of severe consequences of the protagonists' decisions.

### Integrating compassion into ESIT's cases in three different ways

As we noted above, compassion can be induced implicitly by including features in a case which are known to be linked to the experience of that emotion. We modified the ESIT's cases by adding the following features to the three experimental groups' cases: (i) an **emotional target** (*people that compassion could be directed towards*), (ii) a **similarity** between the decision-maker and target group (*increasing in-group identification*), and (iii) **evidence of potential distress** of the emotional target (Nussbaum 2013). The first experimental group took this version.

For the second experimental group we explicitly expressed compassion using either the term 'compassion' or a recognized synonym of compassion, such as 'sympathy' (' … feels a lot of **sympathy** for her colleagues … ') in the case content.

Finally, for the third experimental group we added some severe consequences in the cases for the emotional targets that can be affected by the protagonists' decisions (' … health problems such as **cardiovascular disease, anxiety**, and **depression**'). Other examples of severe consequences described include pain and injury to people, risk of accidental death, and risk of brain damage in children.

In order to ensure comparability of control and experimental cases, the emotional target was also added to the control cases. As an example, in Table 2, we are sharing the modified versions of the ESIT's first case: the bolded words or sentences in the text show the changes we employed to the cases and these are described within square brackets – in the versions viewed by the participants, no text was bolded and the square bracketed text was not included. The same process was followed for all six case studies.

### Measuring the emotionality of the cases

After modifying the ESIT's six cases, each case was followed by a question that asked the participants to rate the extent to which the protagonist (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). The intention of using the different typologies was to create an inclusive list of both self-oriented and other-oriented moral emotions that are discussed in the literature. According to Haidt (2003), shame, for example, is one of the

**Table 2.** The different ways of integration of compassion into the ESIT's cases.

| | Compassion Integration into Case 1 |
|---|---|
| **Control: Latent Emotionality** | 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 Modernity'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. |
| **Experiment-1: Implicit Induction** | 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 Modernity's products in both RJ Industries and Pandora Products [*emotional target*], 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. |
| **Experiment-2: Explicit Expression** | 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 Modernity'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.** 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, and feels a lot of sympathy [*explicitly*] for her colleagues.** Management and the other engineers in her division do not know that Jameson has a financial interest in one of the two vendors. |
| **Experiment-3: Description of Severe Consequences** | 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 Modernity'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.** 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, and has recently attended a workshop which explained that the kind of workplace stress that this could generate for them is linked to health problems such as [*severe consequences*] cardiovascular disease, anxiety, and depression.** Management and the other engineers in her division do not know that Jameson has a financial interest in one of the two vendors. |

members of the 'self-conscious family' moral emotions, along with embarrassment and guilt. These three emotions are also called inner-directed negative (Rudolph and Tscharaktschiew 2014) or self-critical (Moll et al. 2008) emotions that generally motivate people to act ethically. Similarly, anger, contempt, and disgust are the members of the 'other-condemning family' (Haidt 2003) and are also called outer-directed negative (Rudolph and Tscharaktschiew 2014) or other-critical emotions (Moll et al. 2008) that are generally directed towards those who do not act ethically. As a result, the moral emotions that were on the final list were: guilt, shame, embarrassment, pride, anger, contempt, compassion/sympathy, gratitude, regret, awe, and distress. For example, in Case 1, 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 could add and rate other emotions they thought were not on the list.

### Participants, recruitment, and testing process

We recruited participants from a research subject pool consisting of more than 7000 students affiliated with a large technical university in mainland Europe where the students complete a 3-year Bachelor cycle before undertaking a consecutive Master. The subject pool permits recruitment based on various criteria, including age, gender, faculty, mother tongue, and educational level. Strong ethical standards are enforced for any research seeking to involve participants from this subject pool. Thus, the institutional research ethics committee granted ethical approval for the study.

The current research was promoted among pool members, who were subsequently invited to participate. Specifically, participants were sought whose mother tongue was French, and who were currently enrolled as engineering faculty students. Although all participants had a major in technical disciplines, some programs in more interdisciplinary fields do not lead to a recognized engineering qualification (e.g. digital humanities, architecture etc.) even if they share a large part of their education with those in engineering programs; these are listed as 'other'.

The instruments were administered in paper format and French. Participants did not complete the entire ESIT test but rather read each case and then rated the emotions of the protagonist in six distinct cases. The instrument was translated into French by a native speaker, followed by a reverse translation into English by a native English speaker. The comparison between the original and reverse-translated versions validated the translation. At each step, after incorporating emotional content into the French version of the cases in various ways, the instruments were piloted with at least 20 participants to revalidate language, assess readability, and ensure student comprehension.

Furthermore, the first author performed the entire data collection process in case participants had questions related to the instruments. However, no inquiries regarding language clarity were reported during or after the data collection process. In total, 28 sessions were scheduled for instrument administration, with 15–20 participants recruited for each session. The limited number of participants per session allowed the first author to scrutinize questionnaires for potential omissions and prevent incomplete responses, thereby maintaining an almost 100% response rate. The tests lasted 60 min and the participants were compensated for their time.

The recruitment process for this study was conducted in two parts. The first part involved recruiting participants for the control group and the first experimental group, which were previously reported on (Kotluk and Tormey 2023). Subsequently, the second part involved recruiting participants for the second and third experimental groups at a later date. The recruited participants were randomly assigned to one of the groups. The demographic information of the participants is presented in Table 3.

A total of 415 participants contributed to the study, with 42 of them being grouped under 'other' (i.e. other than engineering). Among 42 participants, 24 were in the field of architecture, while the others were master's students in interdisciplinary programmes. The number of participants in the control and experimental groups was roughly equal ([$N_{Latent}$ = 103]; [$N_{Implicit}$ = 104]; [$N_{Explicit}$ = 104]; and [$N_{Severe}$ = 104]). The groups were largely similar in gender distribution. In total, approximately 41% of participants identified themselves as women ($N_{Total}$ = 170), 59% as men ($N_{Total}$ = 244), and 0.2% as having another gender ($N_{Total}$ = 1). Based on the participants' major in the groups, the number of engineering students was nearly similar in the groups ([$N_{Latent}$ = 97, 94%]; [$N_{Implicit}$ = 97, 94%]; [$N_{Explicit}$ = 90, 87%]; and [$N_{Severe}$ = 89, 86%]). Those identifying as engineering students ($N_{Total}$ = 373) comprised 90% of the sample. The largest group by educational level were first-year engineering students ($N_{Total}$ = 140, 34%), while 28% of the sample were master students ($N_{Total}$ = 117).

**Table 3.** The participants' demographics.

| | | | Control | | Experiment-1 | | Experiment-2 | | Experiment-3 | | | |
| | | | Latent Emotionality ($N_{Latent} = 103$) | | Implicit Induction ($N_{Implicit} = 104$) | | Explicit Expression ($N_{Explicit} = 104$) | | Description of Severe Consequences ($N_{Severe} = 104$) | | Total ($N_T = 415$) | |
| | Groups | | N | % | N | % | N | % | N | % | N | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gender[a] | Men | | 63 | 61.2 | 55 | 53.0 | 61 | 58.7 | 65 | 62.5 | 244 | 58.8 |
| | Women | | 40 | 38.9 | 49 | 47.1 | 42 | 40.4 | 39 | 37.5 | 170 | 41.0 |
| | Another gender | | 0 | 0.00 | 0 | 0.00 | 1 | 0.96 | 0 | 0.00 | 1 | 0.24 |
| Majors | Engineering | | 97 | 94.2 | 97 | 93.6 | 90 | 86.5 | 89 | 85.6 | 373 | 89.9 |
| | Other | | 6 | 5.80 | 7 | 6.70 | 14 | 13.5 | 15 | 14.4 | 42 | 10.1 |
| Educational Level | Bachelor | 1st Year | 39 | 37.9 | 39 | 37.5 | 28 | 26.9 | 34 | 32.7 | 140 | 33.7 |
| | | 2nd Year | 15 | 14.6 | 18 | 17.3 | 23 | 22.1 | 28 | 26.9 | 84 | 20.2 |
| | | 3rd Year | 19 | 18.4 | 23 | 22.1 | 17 | 16.4 | 15 | 14.4 | 74 | 17.8 |
| | Master | | 30 | 29.1 | 24 | 23.1 | 36 | 34.6 | 27 | 26.0 | 117 | 28.2 |

[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'.

## Results

Before performing comparisons, we conducted normality tests (e.g. skewness and kurtosis values and Q-Q plots) to assess the assumption of normal distribution for the data. The results indicated that the assumption of normality was reasonable, satisfying the assumptions for parametric tests. Therefore, we proceeded with the analysis using ANOVA for group comparisons. Also, we addressed concerns about spurious results from repeated testing by using the Bonferroni's post hoc test. We also report effect sizes, specifically Cohen's d, to provide a deeper understanding beyond statistical significance.

Since we assessed the scores obtained on a scale ranging from 0 to 7, to categorise the intensity of emotions, we established four general levels: scores ranging from 0.00 to 1.74 were considered as 'Low Intensity', those from 1.75 to 3.49 were categorised as 'Moderate Low Intensity', scores between 3.50 and 5.24 fell into the 'Moderate High Intensity' range, and scores from 5.25 to 7.00 were identified as 'High Intensity'. Across the groups, for example, the intensity of compassion ranged from 'moderate low' to 'moderate high'.

In these preparatory steps, we compared the intensity of each moral emotion concerning participants' demographics. In terms of gender, major, and level of education, there was no significant difference between the means.

As is the norm with the ESIT, the data is not presented here for each case separately; instead, the aggregate score across all six cases is reported. For each group, then, we conducted descriptive statistics (Table 4).

Considering the aggregate scores, as Table 4 shows, while the ESIT's compassion intensity is the highest in the explicit expression group ($M = 4.60$, Sd = 1.25), it is the lowest in the latent emotionality group ($M = 2.45$, Sd = 1.36). Also, the severe consequences group ($M = 4.41$, Sd = 1.36) has a higher intensity than the implicit induction group ($M = 3.74$, Sd = 1.33). The rating of emotions the participants thought the protagonists across all six case studies felt are presented visually in Figure 1.

We conducted ANOVA tests on the groups' scores to reveal whether there were statistically significant differences (Table 5). Although compassion, embarrassment, guilt, distress, anger, and shame had relatively higher scores and variability among the cases, ANOVA results showed that the only moral emotions that differed among the control and three experimental groups were compassion ($F$ [3, 414] = 55.8, $p < .001$) and pride ($F$ [3, 414] = 3.20, $p = .023$).

**Table 4.** The aggregate scores (M) and standard deviations (Sd) for each emotion by groups, on a 0 ('not at all') to 7 ('very strong') scale.

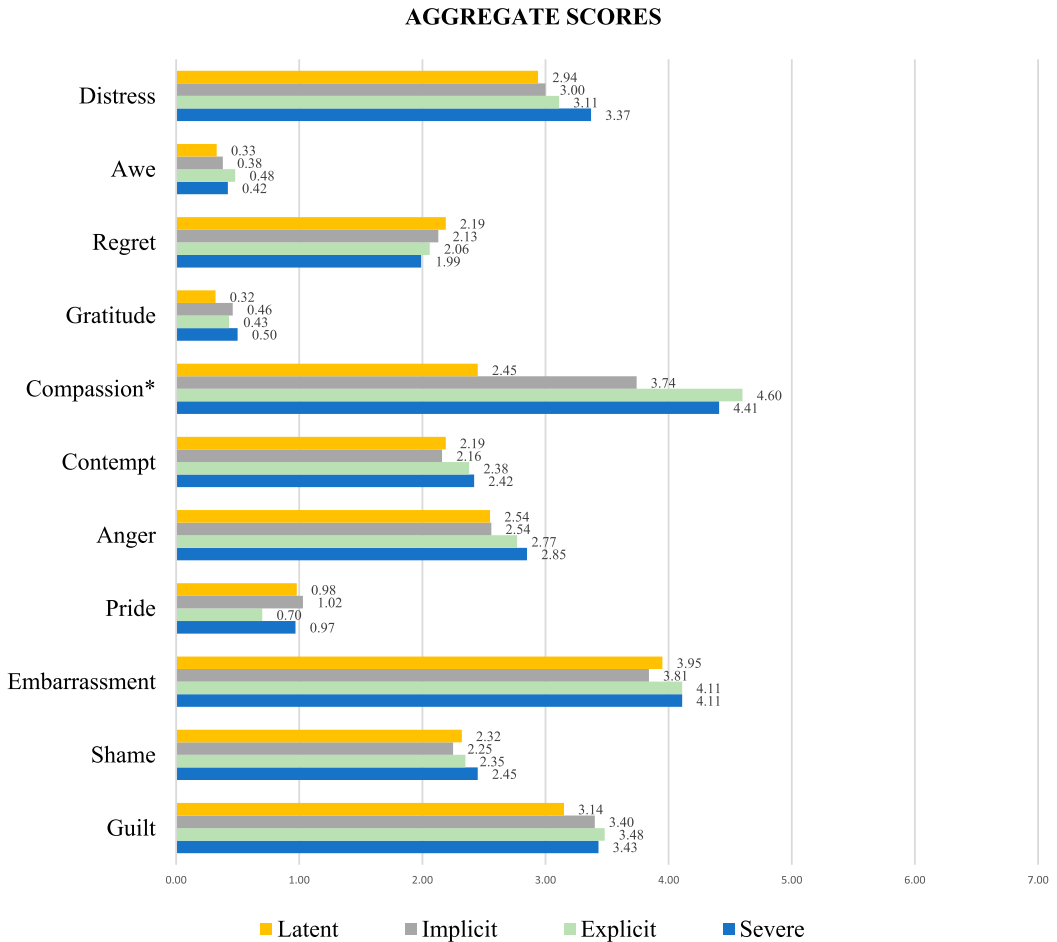| | Groups | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Control | | Experiment-1 | | Experiment-2 | | Experiment-3 | |
| | Latent Emotionality | | Implicit Induction | | Explicit Expression | | Description of Severe Consequences | |
| Emotions | M | Sd | M | Sd | M | Sd | M | Sd |
| Guilt | 3.14 | 1.36 | 3.40 | 1.38 | 3.48 | 1.32 | 3.43 | 1.38 |
| Shame | 2.32 | 1.27 | 2.25 | 1.33 | 2.35 | 1.25 | 2.45 | 1.23 |
| Embarrassment | 3.95 | 1.62 | 3.81 | 1.53 | 4.11 | 1.56 | 4.11 | 1.61 |
| Pride | 0.98 | 0.75 | 1.02 | 0.94 | 0.70 | 0.66 | 0.97 | 0.95 |
| Anger | 2.54 | 1.10 | 2.54 | 1.06 | 2.77 | 0.98 | 2.85 | 1.02 |
| Contempt | 2.18 | 1.13 | 2.16 | 1.20 | 2.38 | 1.07 | 2.42 | 1.23 |
| Compassion | **2.45** | **1.36** | **3.74** | **1.33** | **4.60** | **1.25** | **4.41** | **1.36** |
| Gratitude | 0.32 | 0.56 | 0.46 | 0.66 | 0.43 | 0.50 | 0.50 | 0.61 |
| Regret | 2.19 | 1.29 | 2.13 | 1.45 | 2.06 | 1.35 | 1.99 | 1.48 |
| Awe | 0.33 | 0.75 | 0.38 | 0.58 | 0.48 | 0.64 | 0.42 | 0.68 |
| Distress | 2.94 | 1.60 | 3.00 | 1.72 | 3.11 | 1.61 | 3.37 | 1.65 |

## AGGREGATE SCORES



**Figure 1.** Aggregate scores for each emotion by groups. Each emotion was rated using an 8-point scale (from 0 to 7; 0 = not at all to 7 = very strong).

To determine which group means differ, then, we performed the *post-hoc* test analysis: *Bonferroni*'s tests showed a statistically significant difference in compassion but not pride. Crucially, regarding the aggregate scores, compassion was the only moral emotion that differed between the control and experimental groups (for the emotion of pride, the difference was that the explicit expression group had a notably lower intensity of pride than all three other groups, including the latent emotionality group). Finally, we calculated the effect size (Cohen's *d*): we have interpreted Cohen's *d* value as 0.20 to suggest a small effect size, 0.50 indicates a medium effect, and 0.80 represents a large effect in the observed outcomes. *Bonferroni*'s tests showed a significant difference between the latent emotionality ($M = 2.45$, Sd = 1.36) and implicit induction ($M = 3.74$, Sd = 1.33) groups ($p < .001$, $d = 0.96$); between the latent emotionality and explicit expression ($M = 4.60$, Sd = 1.25) groups ($p < .001$, $d = 1.65$); between the latent emotionality and description of severe consequences ($M = 4.41$, Sd = 1.36) groups ($p < .001$, $d = 1.45$) with the large effect size. There was also a significant difference between the implicit induction and explicit expression groups ($p < .001$, $d = 0.67$); and between the implicit induction and description of severe consequences groups ($p < .001$, $d = 0.50$) with the medium effect size. However, there was no significant difference between the explicit expression and description of severe consequences groups.

**Table 5.** Comparison (ANOVA) for moral emotions by groups.

| | | Sum of Squares | df | Mean Square | F | Significance |
|---|---|---|---|---|---|---|
| Guilt | Between Groups | 7.06 | 3 | 2.35 | 1.27 | .286 |
| | Within Groups | 764 | 411 | 1.86 | | |
| | Total | 771 | 414 | | | |
| Shame | Between Groups | 2.17 | 3 | .724 | .450 | .718 |
| | Within Groups | 662 | 411 | 1.61 | | |
| | Total | 664 | 414 | | | |
| Embarrassment | Between Groups | 6.64 | 3 | 2.21 | .888 | .447 |
| | Within Groups | 1024 | 411 | 2.49 | | |
| | Total | 1030 | 414 | | | |
| Pride [a] | Between Groups | 6.66 | 3 | 2.22 | 3.20 | .023 |
| | Within Groups | 285 | 411 | .693 | | |
| | Total | 291 | 414 | | | |
| Anger | Between Groups | 7.93 | 3 | 2.64 | 2.45 | .063 |
| | Within Groups | 444 | 411 | 1.08 | | |
| | Total | 451 | 414 | | | |
| Contempt | Between Groups | 5.77 | 3 | 1.92 | 1.43 | .234 |
| | Within Groups | 553 | 411 | 1.35 | | |
| | Total | 559 | 414 | | | |
| Compassion [b] | Between Groups | 294 | 3 | 98.0 | 55.8 | <.001 |
| | Within Groups | 722 | 411 | 1.76 | | |
| | Total | 1016 | 414 | | | |
| Gratitude | Between Groups | 1.94 | 3 | .647 | 1.91 | .128 |
| | Within Groups | 139 | 411 | .340 | | |
| | Total | 142 | 414 | | | |
| Regret | Between Groups | 2.26 | 3 | .752 | .386 | .763 |
| | Within Groups | 800 | 411 | 1.95 | | |
| | Total | 803 | 414 | | | |
| Awe | Between Groups | 1.27 | 3 | .425 | .963 | .410 |
| | Within Groups | 181 | 411 | .441 | | |
| | Total | 183 | 414 | | | |
| Distress | Between Groups | 11.4 | 3 | 3.81 | 1.41 | .240 |
| | Within Groups | 1113 | 411 | 2.71 | | |
| | Total | 1125 | 414 | | | |

[a]Statistically significant difference $p < .05$; [b]Statistically significant difference $p < .01$.

## Discussion

In this study, the empirical research question was: 'Do different methods for including com-passion in cases give rise to different levels of intensity of compassion associated with protago-nists?' Additionally, since previous research showed that different emotions may have a range of different effects on moral reasoning and behaviour, our supplemental research question was: 'Is there any effect of these methods on the intensity of other moral emotions associated with protagonists?'

As presented in Table 4 and Figure 1, the clear finding is that in each method we included, the emotional content related to compassion increased the compassion intensity and emotionality of the cases above the level found in the latent emotionality (Control) condition. However, compassion intensity varied depending on how the related emotional content was included in the cases. Overall, the differences in intensity between the conditions was significant ($F$ [3, 414] = 55.8, $p < .001$). While explicitly expressing compassion in the cases was associated with a slight and non-statistically sig-nificantly higher level of compassion than when compared to the description of severe conse-quences condition, both methods resulted in statistically significant and moderate (ranging from $d = 0.50$ to $d = 0.67$) increase in intensity of compassion when compared to implicit induction. Post hoc tests results showed that all three methods we used to include compassion seem to have a statistically significant impact on the compassion intensity compared to the control group. Consequently, based on our findings related to the intensity of compassion (Description of Severe Consequences = Explicit Expression > Implicit Induction > Latent Emotionality) in the cases, we do

not reject Hypothesis 1 (H1: Explicit Expression > Implicit Induction); but reject Hypothesis 2 (H2: Description of Severe Consequences > Explicit Expression).

A look at Table 4 and Figure 1 shows that the increase in compassion across the four conditions was accompanied by small increases in the intensity of other emotions, including embarrassment, guilt, anger, shame, and distress. However, these differences are all small and none of them are consistently statistically significant. While pride does appear to show a statistically significant difference, this is not found in *post-hoc* testing. Furthermore, the difference found (explicit expression of pride showing lower intensity than all other conditions including the latent emotionality control condition) is not in line with any logical explanation. Thus, it seems likely that this reflects only a random variation rather than a true difference. In other words, it seems likely that we induced compassion in engineering ethics cases in three different ways without evidence of having altered the intensity of other emotions.

### Implications

This research has notable implications for the engineering ethics education community. Prior research has shown that there are multiple reasons for including emotion in ethics cases. A low to moderate level of emotional information associated with case participants has been found to increase learning from cases (Thiel et al. 2013) and to make cases more urgent and important (Higgs et al. 2020). Although some authors express concerns about whether emotion could bias ethical decisions, researchers have found that low to moderate levels of compassion does not have any negative impact on the use of post-conventional moral reasoning in learners (Kotluk and Tormey 2023). Indeed, compassion is an important emotion in pro-social behaviour and there are good reasons to want to include it as part of engagement with an ethics case. In this paper we have shown, for the first time, how different methods for including compassion give rise to different levels of intensity associated with the case protagonists. This research should therefore help researchers or teachers writing ethics cases to be able to effectively regulate the intensity of compassion with some confidence that this will not affect other emotions.

This research may also enable a rethinking of how engineering ethics cases are designed and practically used in engineering ethics education. In particular, most ethics cases in engineering ethics education are designed, presented, and analysed without considering the emotional component. However, many cases commonly used in teaching engineering ethics often involve large-scale death and destruction (the Netherlands Flood Disaster of 1953, the Challenger and Columbia Space Shuttle disasters, the Bhopal Union Carbide disaster, and others). These cases are most similar to the third experimental condition in our study (which involved the description of significant negative – severe – consequences including pain and potential death), although the cases we used were small in scale when compared to these famous engineering disaster cases. In our study this kind of description of significant negative consequences was associated with some of the highest levels of emotionality. It seems likely that this intensity could be even higher for such disaster cases. At a minimum, the findings of this study should give teachers cause to pause and think before using such disaster cases, perhaps especially given the risks of empathetic overarousal (Hoffman 2014).

### Limitations

This study does not address emotions in general: it intentionally studied compassion as a targeted moral emotion in the cases' protagonists and across different intensity levels. Further research is needed to see how other moral emotions can be included in different ways in cases and the impacts on their emotionality. We want to note that the data presented here is not about research participants' emotions about the cases. There are studies conducted in other disciplines where the participants were asked to report if they felt emotion during exposure to ethical dilemmas, and to identify the emotions they experienced and rate them (Hutcherson and Gross 2011). There are

also studies where participants were asked to report on the emotion experienced by the protagonists in the cases (Gubbins and Byrne 2014).

Our study focused on the protagonists' emotions rather than the participants'. Although the method of focusing on the protagonists' emotions rather than the participants' was tested and found to benefit case-based learning (Thiel et al. 2013) in similar studies in science and engineering ethics, research evidence in moral psychology shows that variations may emerge in case studies (moral dilemmas) depending on whether participants are asked about the emotions of the protagonists or their own emotions (Kaplan and Tivnan 2014). Therefore, obtaining direct insights into participants' emotions could yield different outcomes. Also, participants' cognitive empathy towards the protagonist was not assessed in this study. Another limitation is linked to the way in which emotional intensity is measured here. Because the intensity of each emotion is assessed with a single question in each case, we cannot construct a scale which might enhance reliability and validity of the measure. While our approach is commonly used in other emotion studies (e.g. Hutcherson and Gross 2011) and has been found to be economic and useful in experimental situations, there may be other approaches that could improve the reliability of the measure (Pekrun et al. 2002). Hence, these limitations should be explored further in future studies.

We conducted this study at a large technical university in mainland Europe. Most of our participants had similar cultures and languages. The research instrument used a questionnaire format, assuming respondents understood the emotional and ethical terms similarly. We acknowledge that there can be linguistic variations in expressing emotions. Although we did not observe significant interpretation difficulties during data collection, we are cautious about assuming that the identified patterns would be the same in other languages and cultures. Therefore, further investigation is needed in different cultural and linguistic contexts to explore potential pattern variations (Jackson et al. 2019; Lindquist 2021; Mesquita and Walker 2003).

## Conclusion

We started this research by recognising that emotion matters in engineering ethics education, with prior research suggesting emotion can improve learning and motivation. But emotion should not be taken as a generic category; rather we need to explore the different impacts of different specific emotions (compassion, anger, guilt, embarrassment) and their impacts across a range of different intensity levels. Doing this required (a) being able to regulate the level of a specific emotion (such as compassion) in ethics cases while (b) effectively distinguishing that emotion from others. How to do this was an empirical question to be answered. This paper provides some of the answers to this question.

Our methods for inducing a specifically targeted emotion succeeded: we showed how teachers and researchers can increase the intensity of compassion in engineering ethics cases in three ways without apparently altering other emotions. We hope this research will help teachers to better understand the way in which the information in cases is impacting on the emotional content of the cases. This will allow teachers and case study writers to make more informed choices when developing and using cases. We would also see these findings as being of value to researchers who want to explore how other emotions in engineering ethics cases can be regulated. In particular, while prior research has looked at the impact of including emotional information on motivation, engagement and learning, the approach which we have tested here would allow researchers to look at the impacts of different emotional intensities on learning, which might allow us to identify if, and at what intensity level, increased engagement flips over into overarousal and distraction. This study can also perhaps provide a roadmap for other researchers to similarly explore the intensity of other emotions in ethics cases.

Emotions are a part of ethics cases, and as we have written elsewhere (Kotluk and Tormey 2023), ignoring emotions will not make them go away. This study can help teachers and researchers to engage in a more reflective and intentional way with the emotionality of engineering ethics education.

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## Disclosure statement

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