EMOTIONAL EMPATHY AND ENGINEERING STUDENTS' MORAL REASONING

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ABSTRACT

Although engineering education is often characterized as a principally rational activity, research suggests that emotions are vital for learning at all levels of education. In ethics education in particular, there is evidence that including mild emotional information in case studies can enhance learning. Evidence also suggests that specific emotions such as guilt and shame can impact on motivation to act in ethical scenarios. The place of emotions in ethics education remains controversial, however, since emotion can be perceived as a source of bias rather than as a valuable factor in learning and in motivating action. While some specific emotions have been explored in ethics research, there is a lack of empirical research addressing the relationship between ethical judgement and emotional empathy. In this research, therefore, we

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aimed to investigate the impact of mild emotional empathy on engineering students' ethical judgements. We conducted this study as an experimental design with 305 participants in two groups. Both groups took a modified version of the Engineering and Sciences Issues Test (ESIT) with an experimental group in which we induced a low level of emotional empathy and an emotionally neutral control group. Results show that a low level of emotional empathy does not impact participants' ethical decisions/judgments. Since the prior research evidence suggest that low level of emotional content improves learning, and given that it does not introduce biases in moral reasoning, we conclude it would make sense to include a low level of emotional content into ethics case studies.

1 INTRODUCTION

The role of emotions in engineering education has been the subject of increased research in recent years [1]. There is also a growing literature on the role of emotions in moral decisions in engineering and in ethical decision making more generally. Researchers even have latterly begun to focus on the various effects of some specific emotions which are called moral emotions such as empathy [2], shame [3], embarrassment, and guilt [4] in engineering and science education. However, given that emotions are vital for learning at all levels of education, the area is still under-researched.

In engineering ethics education, the importance and use of ethics cases, which are framed as a moral dilemma, is frequently highlighted [5, 6]. For example, Kerr, Brummel, and Daily stated that the use of case studies in engineering education is one of the most prominent methods of ethics training [7]. Some of this literature indicates that emotions can be important for the educational process related to using case studies to learn ethics. For example, Thiel et al., found that emotional case content stimulates the retention of cases and facilitates the transfer of ethical decision-making [6]. The researchers stated that emotions also make cases more realistic, an essential component for effective case-based instruction, and are an inherent part of ethical decision-making.

However, the place of emotions still remains controversial. There is evidence [8] that highly emotional cases can reduce student learning from case studies, and perhaps such cases should be avoided. This is an interesting finding given that many engineering ethics cases involve large scale death and destruction (Challenger and Columbia Space Shuttle disasters, Netherlands Flood Disaster of 1953, the Ford Pinto Case, Volkswagen emissions scandal, Hyatt Regency Walkway collapse, Chernobyl, the Bhopal Union Carbide disaster, and others). Indeed, it has frequently been argued that emotion may play a potentially harmful role in biasing rational judgement [9]. On the other hand, there is also evidence that experiencing no emotion during an ethical event may actually impede moral judgement [4] while some of the empirical literature also highlights emotion’s role in moral motivation [10]. This leads to our research question: If our goal is to enhance learning without biasing moral judgement, what is the appropriate degree of intensity of emotional content in engineering ethics case studies?

The literature thus far has explored some specific emotions. Johnson and Connelly, for example, found that feelings of guilt are positively related to making ethical decisions [11]. Higgs et al., supported the proposition that guilt, shame, and embarrassment exert differential effects when making ethical decisions [4].

Furthermore, Han et al., not only addressed the importance of moral emotions in all stages of the moral decision-making process but also indicated the effects of suppressing these emotions on ethical decisions. They argue that suppression of guilt and shame influences each of the three stages of the moral decision-making process; judgment, intention, and behavior differently [12].

While some specific emotions (guilt, shame, etc.) have been explored in ethics research, there is a need to look at emotional empathy. This provides a more focused research question: If our goal is to enhance learning without affecting moral judgement, what is the appropriate degree of intensity of emotional empathy in engineering ethics case studies? In this research, as a first step, therefore, we aimed to investigate the impact of mild emotional empathy on engineering students' ethical judgements by using the mild emotion-induced case studies.

2 METHODOLOGY

2.1 Method

We conducted this study as an experimental design with 305 participants in two groups. Both groups took a modified version of the Engineering and Sciences Issues Test (ESIT) with (a) an experimental group in which we induced a low level of emotional empathy and (b) an emotionally neutral control group.

2.2 The Engineering and Science Issues Test (ESIT)

In this study we used the ESIT test as a measure. In engineering ethics education, researchers have commonly used the Engineering and Science Test (ESIT), which is based on neo-Kohlbergian understandings of ethics [13]. The ESIT was developed by Borenstein et al., and includes six ethical dilemmas [14]. These dilemmas are related to engineering and science, in response to which participants are asked to make a choice. For each dilemma, participants rank the relevance of twelve considerations to their decisions. Then, they pick and rank the four most important considerations. Based on Kohlberg's theory [15], to assess engineering students' moral development, each of the twelve considerations corresponds to either the (a) pre-conventional, (b) conventional, or (c) post-conventional schema, or (d) a nonsense category, included as a check to ensure participants are considering and completing the ESIT in earnest. Rankings are analysed to determine the prevalence of post-conventional reasoning, measured by the P-score, and scores for conventional and pre-conventional moral reasoning can also be calculated. Another measure used is the N2 score which assesses the prevalence of post-conventional relative to pre-conventional reasoning [14].

2.3 Emotion Induction in the Case Studies

In this study, we induced emotional empathy into the six case studies of the ESIT to apply to the students. We have adapted these case studies to generate a mild feeling of emotional empathy. We did this by adding the following features to the experimental group's cases: (i) an emotional target (people that could be empathized with), (ii) a similarity between decision-maker and target group (since empathy is typically enhanced by perceived similarity), and (iii) evidence of potential distress of target (which might give rise to empathy). 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 study is as follow:

Case 1 (Stock)

> 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.

Firstly, we only added an "emotional target" (added in red) to this case for the control group as follow:

> 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], 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.

Then, we added "similarity between decision-maker and target group" and "potential distress of target group" for the experimental group as well as an "emotional target" as follows:

> 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]. 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]. Management and the other engineers in her division do not know that Jameson has a financial interest in one of the two vendors.

The 'Jameson has a lot of interaction with the main sales representative for his company's products in both RJ Industries and Pandora Products' here can be seen as an "emotional target". Being 'a similar age' and graduating from 'the same university' can be seen as a "similarity between decision-maker and target group". And, 'the decision could have a negative impact on the career of the sales representative affected' can be seen as an "emotional empathy of target group".

2.4 Participants and Data Collection Procedures

Participants were assigned to a control or experimental group randomly and they took either the standard (control) or modified (emotion induced-experimental) version of the ESIT. The tests were administered on-site in December 2021 at a large technical university in mainland Europe. The tests lasted 40 minutes. Participants were not asked for any identifiers (e.g. name or other ID). Basic demographic data were collected (e.g., age, gender, main field, work experiences in engineering or technical domains). An overview of the participants is included in Table 1.

2.5 Data Analysis

We excluded questionnaires from the analysis if they met one of several criteria below because they were either too nonsensical or had omitted too many questions to be considered reliable:

- Failed to complete 24 or more rating questions (equivalent to two dilemmas)
- Failed to complete 9 or more ranking questions (approximately two dilemmas)
- Received a “nonsense” score of 11 or more points.

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 groups and 150 experimental groups) questionnaires in the analysis. In our study, first, we performed the descriptive statistics for all data. Then we computed participants’ post-conventional score (Post-S), pre-conventional score (Pre-S), conventional score (Con-S), and N2Score (N2-S). Post-S is based on a participant's ranking of prototypic items written for Kohlbergian Stages 5 and 6 (Post-conventional level). The Post-S is interpreted as the relative importance participants give to principled moral considerations (Stages 5 and 6) in making a moral decision. Similarly, while Pre-S is interpreted for Kohlbergian Stages 1 and 2 (Pre-conventional level), Con-S is interpreted for stages 3 and 4 (Conventional level) moral reasoning. Since it uses both rating and ranking data than the Post-S, the developers of the original test prefer to use the N2-S. The N2-S assesses the prevalence of post-conventional relative to pre-conventional reasoning [14].We used specific calculations that Borenstein et al., (2010) formulated in their study for calculating Post-S, Pre-S, Con-S and N2-S scores. Then, we conducted two-sample t-tests or ANOVA on the differences in each mean and score for the groups. The results of these tests are provided in Table 2 across several groupings. We marked the results in the Table 2 that are significant at the 5% level or better.

3 RESULTS

Table 1. Descriptive statistics and scores of the groups

		Post-S	Pre-S	Con-S	N2-S
Group	Control (N:150; 50%)	0.47	0.14	0.30	4.81
	Experimental (N:150; 50%)	0.47	0.13	0.32	4.84
Gender	Male (N:163; 54.3%)	0.46	0.15	0.30	4.57
	Female (N:133; 44.3%)	0.48	0.12	0.33	5.06
Age	18-20 years old (N:157; 42.3%)	0.47	0.14	0.31	4.59
	21-23 years old (N:113; 47.6%)	0.48	0.13	0.31	5.23
	24-35 years old (N:30; 9.2%)	0.45	0.15	0.32	4.60
Level of Study	First Year Student (N:140; 46.7%)	0.47	0.14	0.32	4.73
	Second- & Third-Year Bachelor (N:89; 29.7%)	0.46	0.13	0.32	4.64
	Post Bachelor (N:59; 19.7%)	0.49	0.14	0.31	5.31
Main Field	Engineering (N:97; 32.3%)	0.46	0.15	0.31	4.73
	Natural Sciences (N:49; 16.3%)	0.52	0.12	0.28	5.32
	Social Sciences (N:53; 17.7%)	0.46	0.13	0.33	4.71
	Computer Sciences (N:21; 7%)	0.44	0.14	0.34	4.17
	Other (N:80; 26.7%)	0.47	0.13	0.31	4.90

Note: To protect anonymity, we do not present data for groups with a small number of participants

Table 1 breaks down the participants' demographic statistics for the study. The number of participants in both the experimental and control groups was roughly equal; there were 165 males (54.3%) and 133 females (44.3%). The vast majority of participants were between either 18 and 20 years old (42.3%) or 21 and 23 years old (47.6%); whereas, only 9.2% of the participants were between 24 and 35 years old. Most participants were either first-year students (46.7%) or second- and third-year bachelor students; whereas, 19.7% of the participants were Post-Bachelor. The largest group of participants were those from the engineering faculty (32.3%); 17.7% of the participants were social sciences majors; 16.3% were natural sciences majors (most of these also graduate with an engineering degree); while 7% were computer sciences majors (again, these all also graduate with an engineering degree); whereas, 26.7% of the participants reported that their majors were as other.

Table 2. t-Test statistics of the experiment and control groups

	Scores		t-test for Equality of Means						
	Experiment	Control	t	df	Sig (2-tailed	Mean Difference	Std. Error Difference	95% Confidence	
								Lower	Upper
Post-S	.472	.479	-.44	298	.656	-.006	.014	-.035	.022
Pre-S	.132	.140	-.78	298	.434	-.008	.010	-.029	.012
Con-S	.320	.304	1.30	298	.192	.016	.012	-.008	.040
N2-S	4.84	4.81	.110	298	.912	.033	.299	-.556	.622

To analyze the effect of emotion-induced content on the participants' moral reasoning, we looked at the Post-S, Pre-S, Con-S, and N2-S scores for each of these measures (Table 2). Significant differences were not found between experiment and control groups scores; Post-Conventional Scores [Experiment (M=.472, SD=.12) and control (M=.479, SD=.12) groups; t(298)=.44, p=.656, d=.05)], Pre-Conventional Scores [Experiment (M=.132, SD=.08) and control (M=.140, SD=.09) groups; t(298)=.78, p=.434, d=.09)], Conventional Scores [Experiment (M=.320, SD=.11) and control (M=.304, SD= 10) groups; t(298)=1.30, p=.192, d=.15] and N2-Scores [Experiment (M= 4.84, SD=2.62) and control (M=4.81, SD=2.56) groups; t(298)=.11, p=.912, d= .01]. In other words, there is no evidence that including emotion content biases participants' moral reasoning.

Table 3. t-Test statistics of the males and females

	Scores		t-test for Equality of Means						
	Females	Males	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Upper	Lower
Post-S	.489	.460	-1.9	294	.048*	-.02909	.01464	-.0579	-.00028
Pre-S	.117	.154	3.5	294	.000*	.03743	.01056	.0166	.05821
Con-S	.326	.302	-1.9	294	.052*	-.02415	.01235	-.0484	.00016
N2-S	5.06	4.57	-1.6	294	.098	-.49767	.30024	-1.088	.09323

Although some researchers [14] did not find significant difference in the scores between male and female participants, we found significant differences between the scores of males and females except for N2-scores (Table 3). Significant differences were found between females and males Post-Conventional Scores [Females (M=.489, SD=.11) and males (M=.460, SD=.13); t(294)=1.9, p=.048, d=.24)], Pre-Conventional Scores [Females (M=.117, SD=.07) and males (M=.154, SD=.09); t(294)=3.5, p=.000, d=.45)], Conventional Scores [Females (M=.326, SD=.10) and males (M=.302, SD= 10); t(294)=1.9, p=.005, d=.24]; while a significant difference was not found for N2-Scores [Females (M= 5.06, SD=2.49) and males (M=4.57, SD=2.62); t(294)=1.6, p=.098, d=.19]. However, the effect size was found to be small almost in all scores.

Table 4. ANOVA statistics in terms of participants' level of study for all participants

		Sum of Squares	df	Mean Square	F	Sig.
Post-S	Between Groups	.030	3	.010	.629	.59
	Within Groups	4.782	296	.016		
	Total	4.813	299			
Pre-S	Between Groups	.010	3	.003	.399	.75
	Within Groups	2.529	296	.009		
	Total	2.539	299			
Con-S	Between Groups	.078	3	.026	2.329	.07
	Within Groups	3.294	296	.011		
	Total	3.372	299			
N2-S	Between Groups	18.584	3	6.195	.923	.43
	Within Groups	1987.524	296	6.715		
	Total	2006.108	299			

Note: Levels of study are "first year", "second and third year", and "post-bachelor".

Some researchers have also found a relationship between measures of moral reasoning on the DIT-2 and other factors such as age, level of study, or main field. In our study, dividing the students into groups based on their age and level of study yielded no significant results with respect to the scores (Table 4). No significant differences were found between participants in scores for level of study; Post-Conventional Scores [F (3,296) = .629, p= .59], Pre-Conventional Scores [F (3,296) = .399, p=.75], Conventional Scores [F (3,296) = 2.329, p=.07] and N2-Scores [F (3,296) = .923, p=.43]. This suggests that age and level of study of the participants do not impact moral reasoning.

Table 5. ANOVA statistics for engineering programs' students only in terms of participants' level of study

	Groups	N	Mean		Sum of Squares	df	Mean Square	F	Sig.
Post-S	First Year Student	78	.462	Between Groups	.044	3	.015	.840	.474
	Second- & Third-Year Bachelor	45	.497	Within Groups	2.850	163	.017		
	Post Bachelor	39	.491	Total	2.894	166			
Pre-S	First Year Student	78	.140	Between Groups	.009	3	.003	.342	.795
	Second- & Third-Year Bachelor	45	.130	Within Groups	1.484	163	.009		
	Post Bachelor	39	.137	Total	1.494	166			
Con-S	First Year Student	78	.310	Between Groups	.016	3	.005	.441	.724
	Second- & Third-Year Bachelor	45	.300	Within Groups	2.004	163	.012		
	Post Bachelor	39	.305	Total	2.021	166			
N2-S	First Year Student	78	4.54	Between Groups	18.768	3	6.256	.846	.471
	Second- & Third-Year Bachelor	45	4.80	Within Groups	1205.305	163	7.395		
	Post Bachelor	39	5.36	Total	1224.073	166			

The literature thus far has also found that engineering education did not lead to increases in moral reasoning over years [16,17,18]. We wanted to check if we have a similar pattern in our data. For this purpose, considering our findings presented in Table 4., we also performed data analysis only looking at those who will graduate with an engineering qualification (those from the engineering faculty, natural science, or computer science) and excluded those from social sciences and others. The results did not show significant differences between the groups' scores in terms of their background; Post-Conventional Scores [F (3,163,166) = .840, p= .47], Pre-Conventional Scores [F (3,163,166) = .342, p=.79], Conventional Scores [F (3,163, 166) = .441, p=.72] and N2-Scores [F (3,163,166) = .836, p=.47]. (Table 5).

4 CONCLUSIONS

In this study we aimed to investigate the impact of mild emotional empathy on engineering students' ethical reasoning by using mild emotion-induced case studies. It is known that some emotional content can improve students learning from engineering and science ethics case studies, however it is also feared by some that including emotional content may give rise to bias. Our study found no evidence at all that including emotional evidence biases moral reasoning: the overall results showed very little differences between the experimental and control groups' scores–any differences were not statistically significant. In other words, a low level of emotional empathy in case studies does not impact participants' moral reasoning.

Engineering ethics case studies often involve large scale death and destruction. This represents a high level of emotional content (even if emotions are not made explicit). Evidence from prior studies [8] suggests this should be avoided as it can reduce student learning from case studies. Our study focused on mild level 'emotional empahty'. We addressed this by (a) identifying people/a person who was potentially impacted by an ethical decision and (b) identifying a source of empathy for them. Since empathy is linked to in-group relationships, we also sought to (c) increase an in-group relationship within the case study. This method could be used by others who are seeking to enhance a mild level of emotional content in case studies. Other methods used in other studies include explicitly identifying an emotion felt ("X feels guilty…").

Numerous studies have found that engineers are somewhat unusual in that they do not seem to show much growth in moral reasoning over the course of their engineering education – this is at odds with the normal pattern of development in other professional domains [16,17,18]. We found a similar pattern here – there is little evidence that our student moral reasoning improved over the course of their studies. Hence our data reconfirms an imperative need to improve the quality of engineering ethics education.

The results of this study showed no impact on students' moral reasoning as a result of the inclusion of low to moderate levels of emotional empathy in case studies. Since the evidence [6] suggests that emotion inclusion can facilitate retention and transfer of the case's knowledge content it would make sense for case study designers to include emotional information. Since low to moderate emotion does improve learning, and since we now know it does not impact moral reasoning, we recommend the inclusion of mild to moderate emotional empathy in case studies.

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