# PERSONALITY DIMENTIONS, GLOBAL AND ETHICAL PERSPECTIVES AND ENGINEERING STUDENTS'S ETHICAL DECISIONS

**S. A. Snyder**
Virginia Tech
Blacksburg, United States

**D. Bairaktarova** [1]
Virginia Tech
Blacksburg, United States

**E. Giménez Carbó**
Universitat Politècnica de València
València, Spain

***Conference Key Areas***: *Ethics in Engineering Education*
***Keywords***: *personality traits, global education, ethics education, case studies*

## ABSTRACT

Motivation is an important predictor of ethical awareness; however, it is not easy to assess. The goal of our study is to examine the relationship between motivation and ethical awareness in engineering students. We focus on two personality measures: person-thing orientation and spheres of control and test their association with ethical awareness using engineering scenarios that present ethical dilemmas. We predict that engineering students who score higher on the personality dimension of person-thing orientation will display more ethical awareness than those who score lower. We also predict that students with a higher level of personal control will also display more ethical awareness. Two groups of students were involved in the study. Group 1 was formed by fifty-three first-year engineering students from University in the United States and Group 2 was represented by sixty-four sophomore engineering students in Engineering School in Spain. Students worked individually on case studies that presenting ethical dilemmas; they were asked to write short essays describing how they would respond to each situation. Then the essays were analyzed using an ethical

[1] *Corresponding Author (All in Arial, 10 pt, single space)*
*D. Bairaktarova*
*dbairak@vt.edu*

doi:10.5821/conference-9788412322262.1345

reasoning and a global awareness rubric. Results revealed that 1) the context/nature of the students' responses to the case study varied greatly, 2) personality traits and global and ethical perspective, all correlate to students' ethical decisions as measured by their responses to the case studies scores, 3) there is an alignment between the SOC and the Global Perspective Inventory (GPI) dimensions that merits further exploration.

# 1 INTRODUCTION

## 1.1 Engineering students and ethical reasoning

Since its formalization nearly four decades ago, engineering ethics has made considerable progress, from creating communities of practicing scholars and journals partially devoted to the field, to obtaining recognition, increased emphasis, and formalized courses within the larger engineering community. One of the major goals of engineering education to date has been increasing the ethical sensitivity of students in engineering programs. However, Michael Davis emphasizes three components of the engineering ethics curriculum that are vital for the next generation of engineers that go beyond ethical sensitivity: the history and sociology of engineering, the ability to communicate the complexities and ethical issues of their work to other engineers, and the philosophical knowledge to ground the decisions they make in their work [1].

Codes of ethics, as outlined by many professional organizations of engineers such as ASME and ASCE, have become the commonplace method for introducing collegiate engineering students to ethics education. While the details of these codes of ethics differ across disciplines, some common themes across disciplines include 'acting in the best interests of your employer or client,' avoiding conflicts of interests, and ensuring public safety. In addition to examining codes of conduct, case studies have been the primary pedagogy utilized in ethics education. Case studies can take a complex situation allow students to explore and condense it down to the core issues within the case, which can range from issues of human error to examining competing interests between involved parties [2].

Utilizing codes of ethics, case studies, and various other pedagogical techniques, ethics education has been shown to have an impact of the moral outcomes of students. In a quasi-experimental study conducted on business students at a US university, May and Luth found that students, when exposed to ethics training, whether it was imbedded in other courses or in a stand-alone course, displayed higher levels of moral efficacy (the ability to make ethical decisions), moral courage (the motivation to act on the morally responsible decision), and perspective-taking than students did not have exposure to ethics education [3].

## 1.2 Personality dimensions and motivation of ethical awareness

Motivation is an important predictor of ethical awareness; however, it is not easy to assess. Multiple scales and theoretical frameworks have been created to examine how to predict ethical awareness and behaviour, with varying success. One framework for understanding how students think about ethical scenarios, presented by Magun-

Jackson, adapts Kohlber's Theory of Moral Development to implement ethics in engineering education. The framework highlights how students, as they develop morally, move from thinking of their own needs to thinking about those related to them (i.e. family) and eventually to how actions will affect society [4]. Another theoretical framework, presented by Bairaktarova and Woodcock, outlines a theoretical framework for predicting ethical awareness and behaviour based off Ajzen's theory of planned behaviour and Harding et al. inclusion of moral obligation [5], [6]. The revised framework included three personality scales to better predict student behaviour, Person Orientation, Thing Orientation, and the Spheres of Control.

Person and Thing Orientation have been used in recent literature to discuss potential reasons for the underrepresentation of women in various STEM fields, including engineering. Su and Rounds , in their meta-analysis of various studies examining gender differences across STEM professions found that women's interests lead to them choosing more people-oriented and less thing-oriented work environments when choosing their career in STEM [7]. Similar work discussing the usage of person and thing orientation in STEM, completed by Graziano, Habashi, and Woodcock (2011), who worked to remodel the PTO model, found that Thing Orientation differed across men and women, but that PO did not [8].

Highlighted in Bairaktarova and Woodcock's proposed framework for predicting ethical awareness and ethical behaviour is the Spheres of Control. Divided into three domains of control, Personal Control (PC), Interpersonal Control (IPC), and Socio-political Control (SPC), which each examine an individual's perceived control, or personal efficacy, within an environment [9]. Each of these Spheres represents an environment in which a student may feel they are in control of the decision-making process. This directly ties to the research of May and Luth which found that ethical teaching directly increased moral efficacy [3].

The goal of our study is to examine the relationship between motivation and ethical awareness in engineering students. We focus on two personality measures: person-thing orientation (Graziano et al.) and spheres of control (Paulhus) and test their association with ethical awareness using five engineering, scenarios that present ethical dilemmas. We predicted that engineering students who score higher on the personality dimension of person-thing orientation will display more ethical awareness than those who score lower. We also predicted that students with a higher level of personal control will also display more ethical awareness.

## 2 METHODOLOGY

### 2.1 Study settings & participants

Two groups of students were involved in the study. Group 1 was formed by fifty-three first-year engineering students from Virginia Tech in the United States and Group 2 was represented by sixty-four sophomore engineering students in the Engineering School the Universitat Politècnica de València. Students worked individually on case studies that presenting ethical dilemmas; they were asked to write short essays

describing how they would respond to each situation. Then the essays were analyzed using an ethical reasoning and a global awareness rubric.

### 2.2 Study measurements:

*Person and Thing Orientations*

We administered Graziano et al.'s Person-Thing Orientation Scale, which taps into the alignment of participants' interests with people and things. The scales consisted of 9 and 5 Likert-like questions for Person-Orientation and Thing Orientation, respectively, with reverse-coded questions. Participants took both the Person subscale (PO) and Thing subscale (TO), which had reliabilities of $\alpha = 0.76$ and 0.85, respectively.

*Spheres of Control*

The Spheres of Control (SOC) Scale was developed by Paulhus to measure perceived control in three domains - personal control (PC), interpersonal control (IPC), and socio-political control (SPC) [9]. Each subscale consists of 10 Likert-like questions (30 total), that contained 5 reverse-coded questions. The subscales have reliabilities of $\alpha = 0.80$, $\alpha = 0.83$, and $\alpha = 0.75$, respectively.

*Ethical Case Studies*

Students were provided with 4 ethical scenarios, each one paragraph long, that asked students to identify if there was an ethical issue within the scenario and to come to a decision based on the information provided. The scenarios described:

- *Scenario 1*: A Material Engineer faces a dilemma of using a cheaper polymer in a biomedical device that carries some risk of damaging human skin or choosing a more expensive polymer that has no known risks that will also take a much longer time to deliver.
- *Scenario 2*: A Mechanical Engineer is asked to by the CEO to change the data of a competitor's product listed on their company website to make their company's products look better.
- *Scenario 3*: After a time-intensive and expensive design process for a new microchip, a microchip testing engineer is asked to lie about a the new products output specifications to the client.
- *Scenario 4*: A Team Lead is left in charge of an underperforming new hire and tight deadlines and are left to decide if they need to be replaced with a hopefully better hire or given enough time will improve.

Each of the 4 scenarios was followed up by questions prompting students to describe the ethical dilemma within the scenarios and the course of action they would take if they were the engineer in the scenario. The student responses to the scenarios were then rated as either 'below competent (0),' 'competent (5),' or 'above competent (10)' across three criteria:

*Criteria 1*: Explain and contrast relevant ethical theories
*Criteria 2*: Identify ethical issues in a complex context
*Criteria 3*: Articulate and defend positions on ethical issues in a way that is both reasoned and informed by the complexities of those situations

Two members of the research team rated each of the student responses for the three criteria listed above. Across all three criteria and all four ethical scenarios, an interrater reliability of 0.8, which is suggests substantial agreement across raters [10].

## 3 RESULTS

### 3.1 Scale Reliability

While the results analyzed below only represent those of the students from Group A, the data has been collected for the students in Group B, and is currently being analyzed and will appear in the final version of this conference paper. Additionally, initial analysis of Group B's data corroborate the findings of Group A across many of the subscales scales, from both the PO-TO and SOC respectively. The two groups (VT international students and UPV, Spain) were not significantly different from each other on any of the variables except thing orientation (TO). The first group had higher TO (M = 3.44) than the second group (M = 3.13) and the difference was statistically significant ($p < .05$). This difference will be reflected and explored more in the final draft of the paper.

The first step of the analysis was to ensure the reliability of the various subscales for the Person-Thing Orientation and the Spheres of Control. From these two scales, the PO, TO, PC, and IPC subscales all had acceptable fits, ranging from $0.7<\alpha<0.8$. However, the SPC scale had an unacceptable fit ($\alpha=0.342$), which may be due to small sample size.

As seen below in Table 1, independent sample t-tests found no significant difference between the Total Ratings (all ratings combined) of the four case studies between males and females. Similarly, for many of the personality scales, there was no significant difference between males and females in all the variables except in the Thing-Orientation (TO) variable. Females had a significantly lower score (M = 2.95, SD = 3.20) compared to males (M = 3.57, SD = 3.60) on Thing Orientation. This was not expected as previous work by Graziano et al. (2012) found that females in STEM reported similar TO scores to their male counterparts while also reporting higher PO scores [8]. This difference may be due to the smaller sample size, which when the data from Group 2 is analyzed may align with previous works.

*Table 1. Independent Sample t-tests for all variables by gender*

| | Statistic | df | p | Mean difference | SE difference | Effect Size |
|---|---|---|---|---|---|---|
| PC_Mean | -0.3576 | 50.0 | 0.722 | -0.0949 | 0.265 | -0.1214 |
| IPC_Mean | -0.5900 | 50.0 | 0.558 | -0.1594 | 0.270 | -0.2003 |
| SPC_Mean | 0.2982 * | 50.0 | 0.767 | 0.0563 | 0.189 | 0.1012 |
| TO_Mean | 2.4978 | 53.0 | 0.016 | 0.6273 | 0.251 | 0.8420 |
| PO_Mean | -0.6424 | 52.0 | 0.523 | -0.1897 | 0.295 | -0.2171 |
| Case1_Total | 0.9645 | 52.0 | 0.339 | 1.5433 | 1.600 | 0.3259 |
| Case2_Total | -0.6695 | 52.0 | 0.506 | -1.4271 | 2.132 | -0.2262 |
| Case3_Total | 0.5770 | 49.0 | 0.567 | 1.1341 | 1.966 | 0.2035 |
| Case4_Total | 0.0762 | 49.0 | 0.940 | 0.1585 | 2.080 | 0.0269 |

* Levene's test is significant ($p < .05$), suggesting a violation of the assumption of equal variances

A Pearson Correlation Matrix found that with cases 1, 3, and 4 the Total Ratings (all ratings combined) was not significantly related to PC, IPC, SPC, TO, or PO, which is depicted below in Table 2. However, Case Study 2 total score (the sum of a student's scores for the three ethics criteria for a given case study) was significantly related to Interpersonal Control (positive relationship; $r = .315$) and Thing Orientation (negative relationship; $r = -.269$). A positive relationship with IPC indicates that feeling in control of a situation with other people leads to better ethical decision making, which is consistent with the idea of moral courage described by May and Luth [3]. The negative relationship between the case study ratings and TO indicates that students may not have been thinking about how the results of fudging company data would affect other people, and simply saw the issue as a technical one of fixing an error.

Table 2. Pearson Correlation Matrix for all variables

| | PC_Mean | IPC_Mean | SPC_Mean | TO_Mean | PO_Mean | Case1_Total | Case2_Total | Case3_Total | Case4_Total |
|---|---|---|---|---|---|---|---|---|---|
| PC_Mean | — | | | | | | | | |
| IPC_Mean | 0.272 * | — | | | | | | | |
| SPC_Mean | 0.288 * | -0.050 | — | | | | | | |
| TO_Mean | 0.166 | -0.076 | -0.034 | — | | | | | |
| PO_Mean | 0.089 | 0.076 | 0.065 | 0.358 * | — | | | | |
| Case1_Total | 0.224 | 0.259 | 0.034 | -0.015 | 0.123 | — | | | |
| Case2_Total | 0.064 | 0.315 * | 0.024 | -0.269 * | 0.157 | 0.483 *** | — | | |
| Case3_Total | 0.038 | 0.181 | 0.031 | -0.089 | 0.054 | 0.570 *** | 0.212 | — | |
| Case4_Total | 0.121 | 0.249 | 0.001 | -0.205 | 0.155 | 0.502 *** | 0.435 *** | 0.479 *** | — |

Note. * p < .05, ** p < .01, *** p < .001

Linear regression examinations of Case Study 2 found that both TO and PO were significant in predicting Case 2 total score. Thing Orientation was found to be negatively related to case study rating total score (β=-2.953, p=0.016). Students with higher scores on TO would be expected to have a lower score on the Total Rating on Case Study 2. Dissimilarly, Person Orientation was found to be positively related to case study rating total score (β=2.144, p=0.054). Students who have higher scores on PO would be expected to have a higher score on the have a higher Total Rating on Case Study 2. It is important to note that these trends did not exist for the other case studies. While it may be due to low sample size, which will be remedied with the addition of data from Group 2, it may be that Case Study 2 is unique in and of itself. This may have to do with the fact that Case 2 is the least lengthy of the four, and therefore may not have as much context surrounding it that students needed to identify ethical issues. Regarding the regression scores for TO and PO, Case Study 2 described interactions with people the least, instead focusing on the actor making up false schematics, which might be why people who had higher Thing Orientation scores had lower scores on this Case Study.

Table 3. Linear Regression for Case Study 2 Total Ratings

| Predictor | Estimate | SE | t | p |
|---|---|---|---|---|
| Intercept | -3.494 | 9.31 | -0.375 | 0.709 |
| PC_Mean | 0.152 | 1.16 | 0.131 | 0.896 |
| IPC_Mean | 2.099 | 1.10 | 1.907 | 0.063 |
| SPC_Mean | -0.417 | 1.60 | -0.260 | 0.796 |
| TO_Mean | -2.935 | 1.17 | -2.507 | 0.016 |
| PO_Mean | 2.144 | 1.08 | 1.979 | 0.054 |

## 4 SUMMARY AND ACKNOWLEDGMENTS

This research has found that for Case Study 2, Interpersonal Control is a positive predictor and Thing Orientation was a negative predictor of the student scores on Case Study 2. This aligns with previous research and the framework presented by Bairaktarova and Woodcock [6]. However, the research team is continuing to examine why IPC and TO correlations existed for Case Study 2 that did not exist for the other Case Studies and in future iterations may revise the Case Studies to be of similar length, description, and ask similar probing questions to the students. Future research will more closely examine the differences in scores between the first-year students from Group 1 and the sophomore students from Group 2, both in experience within the program as well as cultural differences that may exist.

## REFERENCES


[1] R. A. Burgess *et al.*, “Engineering Ethics: Looking Back, Looking Forward,” *Sci. Eng. Ethics*, vol. 19, no. 3, pp. 1395–1404, 2013, doi: 10.1007/s11948-012-9374-7.

[2] A. Colby and W. M. Sullivan, “Ethics Teaching in Undergraduate Engineering Education,” *J. Eng. Educ.*, vol. 97, no. 3, pp. 327–338, Jul. 2008, doi: 10.1002/j.2168-9830.2008.tb00982.x.

[3] D. R. May and M. T. Luth, “The Effectiveness of Ethics Education: A Quasi-Experimental Field Study,” *Sci. Eng. Ethics*, vol. 19, no. 2, pp. 545–568, 2013, doi: 10.1007/s11948-011-9349-0.

[4] S. Magun-Jackson, “A psychological model that integrates ethics in engineering education,” *Sci. Eng. Ethics*, vol. 10, no. 2, pp. 219–224, 2004, doi: 10.1007/s11948-004-0017-5.

[5] T. S. Harding, M. J. Mayhew, C. J. Finelli, and D. D. Carpenter, “The Theory of Planned Behavior as a Model of Academic Dishonesty in Engineering and Humanities Undergraduates,” *Ethics Behav.*, vol. 17, no. 3, pp. 255–279, 2007, doi: 10.1080/10508420701519239.

[6] D. Bairaktarova and A. Woodcock, “Engineering Student’s Ethical Awareness and Behavior: A New Motivational Model,” *Sci. Eng. Ethics*, no. 0218, pp. 1–29, 2017, doi: 10.1007/s11948-016-9814-x.

[7] R. Su and J. Rounds, “All STEM fields are not created equal: People and things interests explain gender disparities across STEM fields,” *Front. Psychol.*, vol. 6, no. FEB, pp. 1–20, 2015, doi: 10.3389/fpsyg.2015.00189.

[8] W. G. Graziano, M. M. Habashi, D. Evangelou, and I. Ngambeki, “Orientations and motivations: Are you a ‘people person,’ a ‘thing person,’ or both?,” *Motiv. Emot.*, vol. 36, no. 4, pp. 465–477, 2012, doi: 10.1007/s11031-011-9273-2.

[9] D. Paulhus, “Sphere-specific measures of perceived control,” *J. Pers. Soc. Psychol.*, vol. 44, no. 6, pp. 1253–1265, 1983, doi: 10.1037/0022-3514.44.6.1253.

[10] P. F. Brennan and B. J. Hays, “Focus on psychometrics the kappa statistic for establishing interrater reliability in the secondary analysis of qualitative clinical data,” *Res. Nurs. Health*, vol. 15, no. 2, pp. 153–158, 1992, doi: 10.1002/nur.4770150210.