# Development of an Ethics Survey Based on the Four-domain Development Diagram

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# Development of an Ethics Education Survey Based on the Four-Domain Development Diagram

## Abstract

This research paper presents the development of a survey for students based on the four-domain development diagram (4DDD) by Vanasupa and others [1]. There are many challenges for engineering faculty to successfully incorporate ethics education into their courses and programs. Lack of formal training in ethics among engineering faculty, limited space in overcrowded curricula, and difficulty with how to assess students on ethical development are just a few. This work seeks to address the third noted challenge through a student survey based on the 4DDD. The goal was to develop a survey for educators to assess the extent to which students perceived that their learning experience encompassed elements believed to foster ethical development.

This survey was distributed to targeted courses as part of a case study exploration of ethics education at 12 institutions in the 2017-2018 academic year. Courses varied from first-year to senior level from multiple disciplines. Some courses mixed engineering and non-engineering students. The ethics inclusion in the course ranged from a single activity to full 3-credit ethics courses. Student surveys that completed all items in a given construct were used in the statistical analysis, ranging from 313 to 393 responses. Preliminary evidence of reliability was explored through Cronbach's Alpha for internal consistency with strong evidence found for each of the six constructs. Evidence of validity based on survey content was examined through consensus building on construct items as they relate to ethics and ethics education. However, validity evidence based on internal structure as measured through Confirmatory Factor Analysis (CFA) was weak. Future work could remove items that showed weaker correlations with their construct, and responses to this revised survey might show improved reliability and/or validity.

## Introduction

Engineers' work has wide ranging impacts on communities and individuals, making it imperative that engineers. Broadly, ethics can be divided into two main foci; micro-ethics, which focuses on an individual's behavior, and macro-ethics, which focuses more on the social responsibilities of the profession as a whole. Creating learning environments in engineering programs is a critical step in developing engineers that practice in ethical ways. There are many challenges for engineering faculty, however, regarding the ethics education of engineering students. Previous work has highlighted barriers to effective ethics education including a lack of student engagement, working ethics into overcrowded curriculum, faculty with limited knowledge or training around ethics, difficulty in assessing ethical competency and fostering learning environments that effectively mirror "real world" applications [2,3,4]. Additionally, research has highlighted discrepancies between faculty perceptions of their ethics education and student experiences of those interventions [5]. This study found that while faculty thought they were presenting complex and nuanced ethical problems to students, students were perceiving the ethics situations being studied as simplistic, with black and white or right and wrong answers. Additionally, faculty believed that they modeled ethical behavior to their students as part of their ethics education, but students did not consider their professors as role models in this way.

These challenges point to the importance of fostering a learning environment that is conducive to effective ethics education and learning for students, in alignment with faculty goals and expectations. To this end, Vanasupa and others created the Four Domain Development Diagram (4DDD) [1]. The goal of the 4DDD is to guide the design of learning environments to foster students' holistic development. The authors described how moral and ethical development could result from learning environments that intentionally incorporates the cognitive, psychomotor, affective, and social domains. Drawing from self-determination theory, the core of the 4DDD is a motivational cycle that leverages student perceptions of value, interest and autonomy. Surrounding student motivation are the contextual elements that can be designed to help foster effective learning. These contextual elements include students' perception of connection with their classmates (relatedness), experiencing engagement through active learning, developing mastery of the material which includes understanding the broader context of the topic being discussed and using systems thinking tools to engage in more complex understandings of the topic. Finally, the 4DDD focuses on how these motivational and contextual elements can foster the moral and ethical development of students by looking holistically at student attitudes, the learning environment and exposure to ethics.

Student moral and ethical development can be broken down further into three constructs: knowledge of ethics, ethical reasoning, and ethical behavior [6]. Knowledge of ethics refers to a broad awareness and understanding of base ethical principles. This level of awareness parallels what is assessed by the NCEES Fundamentals of Engineering examination and traditionally focuses on micro-ethical behavior aligned with the engineering codes of ethics. Ethical reasoning reaches further to focus on students' ability to apply moral theories or logical arguments to reason through ethical situations. This construct focuses more on participants level of moral judgement than just their knowledge. Finally, ethical behavior focuses on realized or hypothetical responses to ethical situations. Relevant issues pertaining to ethical behavior for students may include cheating, volunteerism, or boundaries around shared work on course assignments.

The challenge of creating effective learning environments for ethics education in engineering forms the motivation for this work. Drawing from the 4DDD model, this paper presents a description of the creation and reliability/validity measures of a survey instrument that faculty could use to assess their learning environments to promote positive ethical and moral development in students. The goal is that this instrument could not only provide assessment, but also guide the intentional creation of the learning environments from early on which draw from the 4DDD. With a focus on desired outcomes and confidence in an ability to assess then, these improved learning environments could promote better ethics education in engineering students.

**Instrument Development**

The development of this assessment tool is rooted in a modified version of the 4DDD model that is simplified and includes the three constructs of ethical and moral development from Finelli et al. [6]. A diagram of the modified 4DDD model is shown in Figure 1. Six constructs from the modified 4DDD were targeted in this survey including student's 1) *interest* in ethics, 2) perceptions of the *value* of ethics education, 3) feelings of *autonomy* in the classroom activities related to ethics, 4) feelings of connection or *relatedness* with their classmates, 5) perceptions of their own *competence* when it comes to ethical issues and 6) understanding of *systems thinking* as it relates to ethical issues.

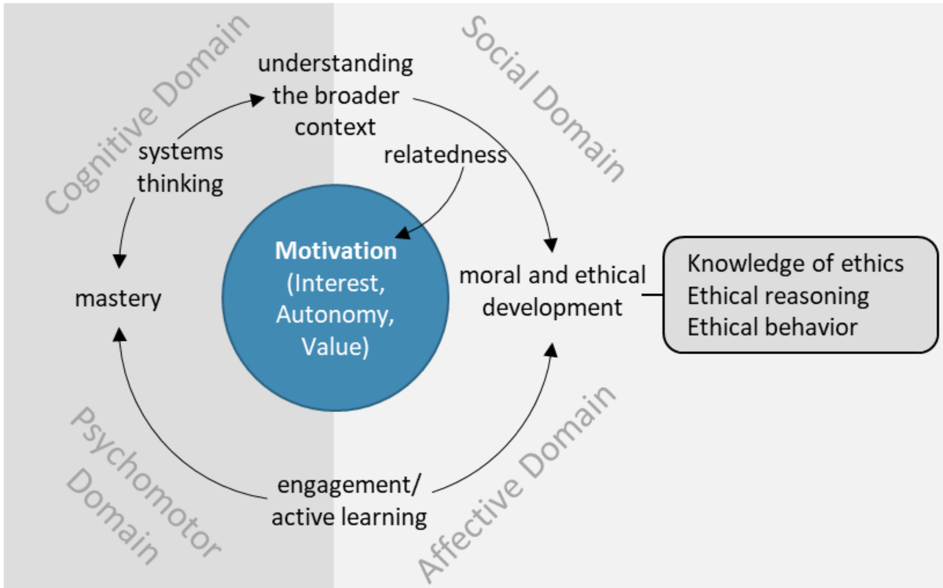


*Figure 1. Modified Four Domain Development Diagram (original diagram from [1])*

The survey included 33 items, 4 to 6 per construct, with about half of the items adapted from existing survey instruments and the other half developed by the research team. All items for this instrument and the associated constructs are given in the Appendix. All items for the *Interest* and *Value* constructs were developed collaboratively and iteratively by the research team. The items for the *Autonomy* and *Relatedness* constructs came entirely from the Work-related Basic Need Satisfaction scale [7]. The original scale was developed using data from students, researchers, human resources employees and call center agents, all from the Netherlands and draws from Self-Determination Theory as the theoretical framework. Structural Equation Modeling (EFA and CFA) was used to examine evidence of validity and showed three clusters (autonomy, competence and relatedness), two of which were used in their entirety for this survey (autonomy and relatedness). Evidence of reliability showed strong internal consistency with alpha values above 0.8 for all clusters. Subsequent studies used this scale with Italian psychology students [8] and Turkish workers from the private sector [9] and both found evidence of strong reliability and validity in those varied contexts. No studies were found that used this scale with engineers or engineering students.

Three of the four items for the *Competence* construct were adapted from the Intrinsic Motivation Inventory (IMI) which originally had six items associated with perceived competence. The other item was added by the research team. The IMI has been shown to have strong evidence of reliability and validity [10] and has been used in many studies across a diversity of contexts including with engineering students (ex. [11]).

The items for the *Systems Thinking* construct were written by the authors, but were rooted in information from documents highlighting the main characteristics of systems thinking including 1) understanding the system from multiple perspectives, 2) understanding systems without getting stuck on details – a tolerance for ambiguity and uncertainty, 3) understanding the implications of proposed changes, 4) identifying conflicts between social, environmental, and economic priorities, and 5) identifying and critiquing underlying values associated with possible solutions [12,13]. Drawing upon these base principles and assessment strategies for systems thinking, six items were developed by the research team and adapted to address systems thinking in the context of ethics and the societal impacts of engineering decisions.

All items were presented as Likert-type items, with a seven-point scale of agreement from "1=Strongly Disagree" to "7=Strongly Agree." Fourteen of the items were reverse worded in an attempt to minimize agreement bias, ensure fuller measurement of student attitudes, and combat students answering carelessly. The items were shuffled in the survey to distribute the constructs and reverse worded items. The order of the items as they appeared in the survey is provided in the Appendix. The survey also included two open ended questions ("How do you view your role in society as an engineer or computer scientist?" and "List the ethical issues that you think are relevant to engineers and/or computer scientists.") and three additional Likert-type items on a one to ten scale asking about 1) perceived importance of ethical issues to engineers, 2) perceived importance of consideration of societal impacts is to engineers, and 3) perceptions of preparedness to face ethical issues in their future work. These items were modified from [14]. Demographic information was obtained from a pre- survey given at the beginning of the course.

## Methods

The following section provides detail of the data set used in this examination of reliability and validity, the analysis methods used, including standard thresholds for statistical values, and a discussion of limitations based upon the survey instrument and the survey population.

### *Data Set*

The data used in the examination of reliability and validity came from a multi-site case study of exemplar ethics education in the 2017-2018 academic year. Thirteen ethics education contexts were chosen from 11 universities across the country. Three more courses were used from home institutions of two of the authors in order to increase the sample size and to add more first-year students to the set. A breakdown of the different contexts that contributed to this sample set is provided in Table 1. Surveys were distributed in some courses electronically and in others as hard copies (also noted in Table 1). The courses represented a variety of academic levels from first-year to graduate students, a variety of schools (public, private, religiously affiliated, military affiliated, large, small, etc.) and a variety of engineering disciplines. Some courses also included a mixture of engineering and non-engineering students. The collective demographic breakdown of the participants is shown in Table 2.

### *Analysis*

Evidence of reliability and validity were approached using the American Educational Research Association, American Psychological Association and National Council on Measurement in Education guidelines [15]. Reliability relates to "the consistency of the scores across instances of the testing procedure" (p. 33). Cronbach's alpha was used as a measure of internal consistency for the items within each construct. "Validity refers to the degree to which evidence and theory supports the interpretations of the test scores for the proposed uses of tests…" (p. 11). The intention of this instrument is to measure environmental factors which may contribute to effective ethics education in engineering. Evidence of validity presented in this paper includes evidence based on test content and evidence based on internal structure. Evidence based on test content focuses on the relationship between the content of the test (the questions) and the construct it is intended to measure, which is discussed in the formation of the instrument and the presentation of instruments used to source questions. Evidence based on internal structure addresses "the degree to which the relationship among test items and test components conform to the construct on which the proposed test score interpretations are based" (p.15). Evidence based on internal structure was examined through the use of Confirmatory Factor Analysis using AMOS.

*Table 1. Course Descriptions for Survey Distribution*

| ID | Institution Carnegie Classifications* | Course, Student Rank, Majors% | Home department** | Topics / Pedagogy | Post n |
|---|---|---|---|---|---|
| Eth-Rel | Relig, Lg, R1 | Ethics, So-Sr, ME[58] EE[20]Bm[8] | Engr. | Elective; Explores relationship between society, engr. & tech. | 60 |
| FY-Rel | Relig, Sm, Bac | Intro, FY, all eng | FY | Req'd; ethics through case studies & project | 34[e] |
| SrDsn-Env | Public, Lg, MS | Capstone Dsn, Sr, Env | CEE | Req'd; professional, academic and lifelong learning skills | 15[e] |
| Elect-sci | Public, Lg, R1 | Elective, FY-Grad, science | Chem | Elective; contemporary issues related to tech. and energy | 35[e] |
| Eth-gen | Public, Lg, R2 | EthIssues, FY-Sr, eng[32] | Philosophy | Elective; Examines modern ethical issues through discussion and critical writing | 25 |
| EngSci | Public, Lg, R1 | EngSci, Soph/Jr, ChE[70] Bio[22] | Chem | Req'd; Core engr. technical course | 21[e] |
| Prf-all | Public, Lg, MS | ProfIssues, Jr/Sr | Engr. | Req'd; covers strengths, professional, academic & lifelong learning skills | 11[e] |
| EthPrf-Rel | Relig, Lg, MS | EthProf, Sr, ME[52] EE[24]Bm[24] | Engr. | Req'd; professional preparation and ethical decision making | 9[e] |
| SustEl | Public, Lg, R1 | Sust., Jr/Sr, Chem, Bm | Chem | Elective; covers global energy systems | 19[e] |
| Prf-Sr-priv | Private, Lg, MS | ProfIssues, Sr, Civ[69] EE[25] | Engr. | Req'd; covers legal and ethical aspects of engr. profession | 16 |
| ICC | Public, Med, R2 | Intercultural Communication, Jr-Sr, eng[81%] | Humanities, Arts & Social Sciences | Elective; Cross-cultural communication | 16 |
| CostRisk | Public, Lg, R1 | Cost/Risk, So-Grad, Ind[3] Cv[25] CS[25] | Engr. | Elective; covers risk and ethics through case studies and current events | 8 |
| EWB | Public, Lg, R1 | EWB, all, all | N/A | Student EWB chapter | 23[e] |
| *FY-Cv* | *Public, Lg, R1* | *Intro (1cr), FY, Cv[100]* | *CEE* | *Ethics, sustainability, design* | *32* |
| *Prf-Sr-Cv* | *Public, Lg, R1* | *ProfIssues (2cr), Sr, Cv[100]* | *CEE* | *Ethics, sustainability* | *56* |
| *FY* | *Private, Lg, R1* | *Intro, FY* | *CEE* | | *8* |

[*] http://carnegieclassifications.iu.edu/lookup/lookup.php;
[**] CEE = Civil and/or Environmental Engineering, Engr. = General Engineering, Chem = Chemical Engineering, FY = First-year (general), Bm = Biomedical
[e] distributed electronically.  If not noted, survey was distributed by paper in class.

*Table 2. Response Population Demographic Information*

| Demographic Classification | Demographic Category | n (%)** |
|---|---|---|
| **TOTAL** | | **403** |
| | | |
| Gender | Female | 130 (32%) |
| | Male | 208 (52%) |
| Academic Rank | First-Year | 69 (17%) |
| | Sophomore | 32 (8%) |
| | Junior | 72 (18%) |
| | Senior+ | 170 (42%) |
| | Graduate | 4 (1%) |
| Major* | CE | 132 (33%) |
| | ME | 61 (15%) |
| | ECE | 39 (10%) |
| | Bio | 27 (7%) |
| | Chem | 39 (10%) |
| | Other Engr. | 36 (15%) |
| | Other Non-Engr. | 52 (7%) |
| Grew up Primarily in the US | Yes | 314 (78%) |
| | No | 31 (8%) |

* CE = Civil and/or Environmental Engineering, ME = Mechanical Engineering, ECE = Electrical and/or Computer Engineering/Science, Chem = Chemical Engineering, Bio = Biological Engineering

** Note that some students did not fill out demographic information, so percentages will not add up to 100%

*Limitations*

This instrument has been developed and distributed solely within the context of universities and colleges in the United States, therefore evidence of reliability and validity in other cultural contexts may vary. Additionally, cultural understandings of personal and professional ethics may vary, so too may the learning environment, and therefore this instrument is primarily intended for educational cultures that align with the 4DDD. Finally, this presentation of reliability and validity evidence is preliminary. Future work would need to examine these results with other measures that focus on concretely student's ethical and moral development. At this point, only the instrument as a stand-alone piece has been examined, but evidence of validity through relation to other variables such as student interviews or alumni perspectives on the effectiveness of the course would be useful.

## Results

*Reliability Evidence*

Cronbach's alpha values were used to provide evidence of reliability through the use of reliability coefficients. Guidelines for internal reliability alpha thresholds of 0.7 to show "acceptable" reliability and 0.8 to show "good" reliability were used [16,17]. Alpha values are presented in Table 3. All constructs showed acceptable reliability or better with all 33 items except for the *system thinking* construct. When one item was removed from this construct (S5), the alpha value increased from 0.686 to 0.728, making the results acceptable. This item was removed from the instrument for the examination of validity evidence using internal structure that follows. Other forms of reliability evidence, such as parallel forms or test-retest, were not conducted as part of this study, but would be useful for future development of this instrument.

*Table 1. Instrument Construct Descriptions and Cronbach's Alpha Values*

| Construct | No. of items* | No. of responses | Average | SD | Cronbach's Alpha based on standardized items |
|---|---|---|---|---|---|
| Interest | 6[3] | 313 | 5.28 | 1.62 | 0.826 |
| Value | 6[3] | 392 | 5.56 | 1.62 | 0.820 |
| Autonomy | 6[3] | 393 | 4.88 | 1.63 | 0.808 |
| Relatedness | 6[3] | 392 | 4.93 | 1.75 | 0.831 |
| Competence | 4[1] | 366 | 5.26 | 1.38 | 0.744 |
| Systems Thinking | 5[1] | 375 | 5.15 | 1.46 | 0.686** |

*Superscript denotes number of items that were negatively worded and reversed in reliability analysis
** Cronbach alpha increases to 0.728 when item S5 (see table in Appendix) is removed

*Validity Evidence based on Test Content*

Validity evidence based on test content was developed through the collaborative and iterative selection of items for each construct by the research team, all of whom have experience as engineering educators and ethics researchers. Moreover, the selection of items from preexisting instruments with strong evidence of reliability and validity in different contexts, described above, provides further validity evidence based on test content.

*Validity Evidence based on Internal Structure*

Structural Equation Modeling (SEM) was used to explore evidence of validity based on internal structure. Specifically, Confirmatory Factor Analysis (CFA) using the AMOS software was used for the SEM approach. CFA is used to examine the underlying structures of the relationship between latent and observed variables. Specifically, CFA was used in this preliminary analysis to explore the separation of items into six constructs and to examine the degree of correlation between constructs. The 32-items that showed reasonable clustering based on Cronbach's alpha were included in the model (1 item omitted). The standardized regression weights (SRWs) for each item from the maximum likelihood model are shown in the appendix. By convention, SRWs should be 0.7 or higher [18]; in our model, 21 of 32 items fail that criteria. Relaxing the SRW criteria to 0.6, 8 survey items are poor.

Parameters that relate to the overall fit showed a marginal model. It is preferable to have scales with a Root Mean Square Error of Approximation (RMSEA) of lower than 0.1; our model is right on the threshold at 0.100. The comparative fit index (CFI) compares our default model to the null model (covariances among latent variables zero; assumes the dimensions or factors of a construct are unrelated). It is best to have a CFI above 0.90; our value 0.732 is low. Hoelter's critical N is used to judge if sample size is adequate. By convention, the sample size is adequate if Hoelter's N > 200 and a Hoelter's N under 75 is considered unacceptably low; we have a Hoelter N of 86 at 0.05 significance, which is very close to the minimum. This implies that more responses should be gathered and the CFA repeated. Covariances are shown in Table 4. The covariances among all of the scales are statistically significant (P), with the greatest covariance for value with the other dimensions.

*Table 4. Covariance among dimensions from CFA model*

| | | | Estimate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|---|---|
| Value | <--> | Autonomy | .706 | .109 | 6.474 | *** | |
| Autonomy | <--> | Systems | .367 | .079 | 4.654 | *** | |
| Value | <--> | Systems | 1.274 | .144 | 8.821 | *** | |
| Autonomy | <--> | Related | .813 | .117 | 6.923 | *** | |
| Systems | <--> | Related | .723 | .114 | 6.339 | *** | |
| Value | <--> | Related | 1.065 | .150 | 7.104 | *** | |
| Value | <--> | Competence | .697 | .100 | 6.995 | *** | |
| Autonomy | <--> | Competence | .311 | .059 | 5.244 | *** | |
| Related | <--> | Competence | .391 | .075 | 5.207 | *** | |
| Systems | <--> | Competence | .650 | .091 | 7.140 | *** | |
| Interest | <--> | Value | .855 | .134 | 6.357 | *** | |
| Interest | <--> | Autonomy | .395 | .072 | 5.481 | *** | |
| Interest | <--> | Competence | .310 | .059 | 5.286 | *** | |
| Interest | <--> | Related | .442 | .085 | 5.187 | *** | |
| Interest | <--> | Systems | .482 | .084 | 5.745 | *** | |

*** P<0.001

## Conclusions and Future Work

This study has explored preliminary evidence of reliability and validity for a new instrument designed to assess learning environments for effective ethics education in engineering. The 4DDD model was used as theoretical grounding for the development of a six-construct instrument. These constructs focus on student perceptions of *interest* in and *value* of ethics in engineering, *autonomy* in the educational setting, connection or *relatedness* with peers in the learning environment, *competence* with respect to ethical issues and skills in *systems thinking* around ethical or societal impact issues in engineering. Cronbach's alpha values supported the internal consistency of the six-constructs. Structural Equation Modeling provided weak evidence, however, of internal structure around a six-construct model and clustering of the items into the constructs they were intended to measure. This work is preliminary and there are opportunities for further refinement of this instrument using fewer items and by exploring validity evidence with other sources and with larger sample sizes.

The intention of this instrument is to guide engineering educators in the intentional formation, execution, and assessment of ethics education in engineering contexts, specifically around addressing macro-ethical issues. Using the 4DDD model, faculty could design ethics modules or courses around specific constructs and then use this instrument to see if their execution is matching with their intentions. The larger goal is to provide more resources for faculty toward the effective education of engineering students toward a deeper understanding of ethical issues in engineering and a recognition of the societal impacts of their work.

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## Appendix

| Construct | ID | Question Order in Survey | Question | Source | Mean (Std.Dev.) | Standardized Regression Weight |
|---|---|---|---|---|---|---|
| Interest | I1 | 21 | Engineering ethics is interesting to study | | 5.11 (1.52) | 0.432 |
| | I2 | 28 | Studying ethics in [insert class name/#] is boring | | 4.84 (1.77) | 0.774 |
| | I3 | 27 | I enjoy looking at the societal impacts of engineers' work in [insert class name/#] | | 5.34 (1.50) | 0.791 |
| | I4 | 25 | I think ethics in [insert class name/#] is an uninteresting distraction from more important content | | 5.23 (1.76) | 0.743 |
| | I5 | 11 | Examining how engineers impact society is not interesting to me | | 5.40 (1.71) | 0.675 |
| | I6 | 1 | The impact on society that engineers can have enhances my interest in studying engineering | | 5.66 (1.29) | 0.572 |
| Value | V1 | 15 | I believe that it is important to learn about ethics as an engineering student | | 5.93 (1.40) | 0.742 |
| | V2 | 24 | I will face ethical dilemmas as a practicing engineer | | 5.67 (1.44) | 0.665 |
| | V3 | 13 | Learning about ethics in school will not help me address ethical dilemmas at work | | 5.32 (1.84) | 0.570 |
| | V4 | 10 | Studying the societal impacts of engineering aligns with my personal goals of studying engineering | | 4.95 (1.72) | 0.785 |
| | V5 | 20 | Engineers have little impact on larger societal issues | | 5.83 (1.61) | 0.623 |
| | V6 | 31 | Studying ethics and societal impacts in [insert class name/#] is a waste of my time | | 5.69 (1.49) | 0.512 |
| Autonomy | A1 | 14 | I feel like I can be myself in [insert class name/#] | [7] | 5.34 (1.43) | 0.712 |
| | A2 | 5 | In [insert class name/#], I often feel like I have to follow other people's commands. | | 4.93 (1.59) | 0.583 |
| | A3 | 7 | If I could choose, I would do things in [insert class name/#] differently | | 4.46 (1.71) | 0.606 |
| | A4 | 4 | The tasks that I have to do in [insert class name/#] are in line with what I really want to do | | 4.34 (1.62) | 0.628 |
| | A5 | 9 | I feel free to do my work in [insert class name/#] the way I think it could best be done | | 5.09 (1.44) | 0.658 |
| | A6 | 12 | In [insert class name/#], I feel forced to do things that I do not want to do | | 5.15 (1.59) | 0.747 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Relatedness | R1 | 3 | I don't really feel connected with other students in [insert class name/#] | [7] | 4.74 (1.76) | 0.724 |
| | R2 | 23 | In [insert class name/#], I feel part of the group | | 4.45 (1.81) | 0.678 |
| | R3 | 17 | I don't really mix with other students in [insert class name/#] | | 5.14 (1.66) | 0.729 |
| | R4 | 19 | I often feel alone when I am with my classmates in [insert class name/#] | | 5.53 (1.58) | 0.687 |
| | R5 | 16 | Some people in [insert class name/#] are close friends of mine. | | 4.88 (1.99) | 0.644 |
| | R6 | 8 | In [insert class name/#], I can talk with people about things that really matter to me. | | 4.82 (1.51) | 0.593 |
| Competence | C1 | 32 | I think I did pretty well at the ethics content in [insert class name/#] | [10] | 5.47 (1.18) | 0.643 |
| | C2 | 29 | After working on the ethics module in [insert class name/#], I feel pretty competent. | | 4.96 (1.43) | 0.804 |
| | C3 | 26 | I am satisfied with my performance on the ethics module in [insert class name/#]. | | 5.40 (1.27) | 0.529 |
| | C4 | 30 | The ethics activities in [insert class name/#] were difficult for me. | | 5.47 (1.18) | 0.603 |
| Systems Thinking | S1 | 33 | When examining the societal impacts of engineering in [insert class name/#], I feel confident that I can identify possible conflicts between social, environmental and economic priorities. | Based on [12, 13] | 5.59 (1.26) | 0.643 |
| | S2 | 2 | I feel prepared to identify and critique the underlying values in engineering design solutions | | 4.98 (1.49) | 0.736 |
| | S3 | 6 | I find it easy to understand the implications of engineering solutions from an ethical and societal impact perspective. | | 5.24 (1.25) | 0.546 |
| | S4 | 18 | I am comfortable dealing with ambiguity and uncertainty when considering the ethical and societal impacts of engineering work. | | 4.79 (1.54) | 0.669 |
| | ~~S5~~ | ~~22~~ | ~~It is difficult for me to see ethical or societal impact issues from multiple perspectives~~ | | ~~5.11 (1.59)~~ | |