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[WIP] Baseline Results for The Impact of the Liberal Arts on the Ethical Development of Engineers

Joel R. TerMaat, Doane University

Joel R. TerMaat is an Associate Professor of Engineering and Chair of the Department of Engineering and Physics at Doane University.

Christopher D. Wentworth, Doane University

Dr. Chris Wentworth is Professor Emeritus of Physics at Doane University with research interests in physics education, engineering education, and biological physics.

Prof. Kristopher Williams, Doane University

Professor Williams holds a Ph.D. in Mathematics from the University of Iowa. He currently serves as an Associate Professor of Mathematics and Data Analytics and Director of Institutional Effectiveness at Doane University.

Work-in-Progress [WIP] Baseline Results for The Impact of the Liberal Arts on the Ethical Development of Engineers

Joel R. TerMaat (1), Kristopher J. Williams (2), and Christopher D. Wentworth (1)

(1) Department of Engineering and Physics, Doane University
(2) Director of Institutional Effectiveness, Doane University

Abstract

Previous research suggests that liberal arts institutions provide improved moral reasoning development in students compared with other types of institutions, but the reasons are not well understood. This work-in-progress paper presents initial data on a longitudinal study of moral reasoning development of both engineering and non-engineering students at a liberal arts institution.

We present the results of administering the Defining-Issues-Test Version 2 (DIT2) to engineering and non-engineering first-year students at a liberal arts institution. Descriptive statistics from the surveys are compared with national norms. Subpopulations of the survey respondents defined by demographic variables are compared and investigated for statistically significant differences. The variables explored include sex, political orientation, intended major, and co/extra-curricular activity participation. A regression analysis is used to examine relationships between DIT2 scores and selected variables.

Future work on this project will include a repetition of the DIT2 survey for the same respondents at the end of their second year in college, coupled with qualitative surveys and institutional data in a mixed-methods approach to facilitate identifying components of a liberal arts education that influence changes in the ethical reasoning scores over the course of their college experience.

Introduction

Student development of moral/ethical reasoning is now an established part of the undergraduate engineering curriculum due to the publishing of ethics codes by professional engineering organizations, ABET's Student Outcome 4, required for accreditation, and the complex ways engineering solutions interface with social concerns. This necessitates finding the curriculum and educational environments to develop this outcome effectively.

Previous research suggests that liberal arts colleges provide significant gains in moral reasoning compared to other institution types, but the reasons for this advantage are not well understood [1]. We are currently involved in a research project that seeks to better understand this advantage by addressing the following research questions:

1. What components of a liberal arts education contribute to the ethical development of engineering undergraduates?
2. How does the ethical development of engineering undergraduates compare to other students at the same institution?

One element of this research program involves a longitudinal study of moral reasoning development of both engineering and non-engineering students at a liberal arts institution. This paper will describe the first phase of this study, which is to specify the initial state of moral reasoning by incoming first-year students before any significant exposure to the curriculum and environment of the college. The moral reasoning of incoming students was assessed with the Defining Issues Test (DIT2) [2], a commonly used tool within the neo-Kohlbergian framework used by many studies in the field of moral reasoning development [3]. Descriptive statistics of the DIT2 P-score and N2-score were compared with national norms. Correlation studies were performed between the DIT2 scores and demographic variables, including sex, political orientation, intended major, and co/extra-curricular activity participation.

The Defining Issues Test

The Defining Issues Test (DIT) was introduced in the 1970s as a replacement for using interviews to measure moral reasoning development within the Kohlbergian framework of a strict developmental sequence [4]. The neo-Kohlbergian model, which this project assumes, is similar to the Kohlbergian model in that it focuses on cognition and recognizes growth occurs in a person's ability to execute moral reasoning. Both models hypothesize that a shift occurs from a conventional view to a post-conventional perspective. There are significant differences between the two models. The neo-Kohlbergian view rejects the strong stage model of Kohlberg in favor of there being multiple cognitive schemas available to a person depending on the specific situation they are considering, although there can be a preferred schema. Despite the shift in theoretical frameworks, the DIT remained a primary assessment tool for studying moral reasoning, although the interpretation of results changed.

The original DIT required test takers to read six stories concerning moral dilemmas and then rate and rank items related to the stories. In the 1990's, the DIT was revised, producing the DIT-2, with new stories that reflected the changing social context [2].

The original DIT used a numerical index, the P-score, that measured the percentage of post-conventional responses to a moral dilemma. The DIT-2 also uses the P-score, but adds another index, the N2-score, that measures not just a preference for post-conventional thinking but also a rejection of less sophisticated schemas. While the P-score and N2-score are correlated, the N2-score is now considered a better measure for older (post-high school) people [4].

Survey and Student Characteristics

The DIT2 was administered online using Qualtrics. All first-time first-year residential students were invited by email to participate in the survey in their initial Fall 2024 semester to establish a "pre-college" baseline of their moral reasoning skills. Table 1 summarizes demographics for the cohort. Respondents received a modest remuneration for completing the survey with a good faith effort. The DIT2 survey results were sent to the Center for the Study of Ethical Development at the University of Alabama for processing. Validated scored survey results (N=106) were combined with additional institutional data for analysis. All validated scores were included irrespective of citizenship or English as a primary language. This study was approved under the institutional IRB F24 001 DC IRB HS.

Table 1. Demographics of first-time first-year cohort respondents (N=106)

Variable	Profile/Characteristic	Mean±SD or % (n)
Age	Years	18.4±1.2 (106)
Sex	Male	41.5 % (44)
	Female	58.5 % (62)
Ethnicity	Hispanic	13.2 % (14)
	Non-Hispanic	82.1 % (87)
	Other/Not Received	4.7 % (5)
Race	White	79.2 % (84)
	Black	4.7 % (5)
	Other/Not Received	15.1 % (15)
Pell Recipient	Yes	38.7 % (41)
	No	61.3 % (65)
Residence	On-campus	91.5 % (97)
	Off-campus	8.5 % (9)
ACT Composite Score	Score, if reported	23.6±4.5 (38)
	Not reported	N/A (68)
High School GPA	Score, if reported	3.7±0.4 (88)
	Not Available	N/A (18)
Performing Arts	Theatre and/or Music scholarship	13.2 % (14)
	No	86.8 % (92)
Athletics Involvement	Athletics scholarship or on roster	83.0 % (88)
	No	17.0 % (18)
Activity Involvement	Yes	21.7 % (23)
	No	78.3 % (83)
Political Liberalism	Very liberal	8.5 % (9)
	Somewhat liberal	19.8 % (21)
	Neither liberal nor conservative	29.2 % (31)
	Somewhat conservative	31.1 % (33)
	Very conservative	11.3 % (12)

Results

DIT2 Results Overall and by Sex

Table 2 summarizes the means, standard deviations, and percentiles by Sex (as indicated by the DIT2 responses) and total survey responses. National norms of Undergraduate Freshman taken from Gungordu et al. from 2011-2020 are provided for reference [5].

Table 2. Selected DIT2 Means (M), standard deviations (SD), Medians (Med), and percentiles for the study.

	P-Score						N2-Score					
	N	**M**	**SD**	**25%**	**Med**	**75%**	**N**	**M**	**SD**	**25%**	**Med**	**75%**
Male	44	28.1	12.5	21.5	28.0	34.0	44	27.8	11.7	22.8	29.4	33.3
Female	62	30.0	15.4	20.0	30.0	41.5	62	28.3	14.0	18.1	26.7	39.4
TOTAL	**106**	**29.2**	**14.2**	**20.0**	**28.0**	**39.5**	**106**	**28.1**	**13.0**	**19.3**	**28.9**	**36.6**
Freshman Norm	*18985*	*31.1*	*15.3*	*20*	*30*	*42*	*18976*	*30.3*	*15.2*	*18.5*	*29.8*	*41.3*

No statistically significant results (two-sided equal variance assumption t-tests of two sample means) were found for the P-score, or N2-score means with respect to Sex. Analysis of the DIT2 Sex P-score responses demonstrated a t-statistic(104)= -0.673, p-value = 0.502. Analysis of the DIT2 Sex N2-score responses demonstrated a t-statistic(104)= -0.193, p-value = 0.847.However, it is noted that the average scores for males were slightly lower than female average scores, which is consistent with national norms [5].

The overall survey P-scores (mean = 29.2) were also compared to the national freshman norm (mean = 31.1) using a single sample t-test and the latter mean assumed as the population mean, and found a difference with t(105) = -1.34, p =0.183. Likewise, the N2-score survey mean (mean = 28.1) compared to the national freshman norm (mean = 30.3) yielded t(105) = -1.78, p = 0.078. Additional analysis of Pell recipient status and campus residence showed no statistical significance at a 0.05 level.

DIT2 Results by Political Orientation

The survey results were analyzed with respect to the Conlib variable of the DIT2, in which participants are asked to characterize themselves in terms of their political views [6].

Table 3. DIT2 Means (M) and standard deviations (SD) by DIT2 Political Liberalism response.

		P-Score		N2-Score	
	N	**M**	**SD**	**M**	**SD**
1-Very Liberal	9	34	16.5	31.1	14.9
2- Somewhat Liberal	21	32.3	16.2	31.2	15.2
3- Neither Liberal nor Conservative	31	30.1	15.0	28.1	13.2
4- Somewhat Conservative	33	27.5	11.2	26.5	10.5
5- Very Conservative	12	22.8	14.0	24.5	13.8

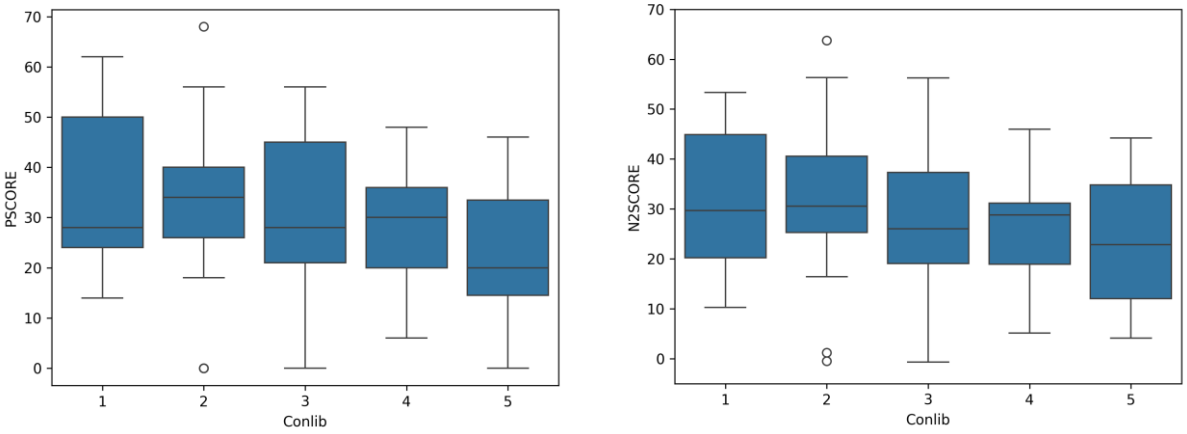

Figure 1. Box and whisker plots of P-score and N2-score vs DIT2 political liberalism response.

A one-way ANOVA was performed to investigate the relationship of political orientation (1-5 as categorized scores) to the DIT2 scores. The results were not statistically significant for either the P-score ($F = 1.261$, $p = 0.29$) or the N2-score ($F = 0.760$, $p = 0.554$), indicating that no significant difference of any of the means was found. Linear regression analysis was then performed using the 1-5 Conlib variables as numerical scores, resulting in statistical significance at the 0.05 level for the P-score ($F=4.919$, $p = 0.029$, $R^2=.045$) but not for the N2-Score ($F=2.946$, $p=0.089$, $R^2=0.028$).

One is referred to the DIT2 guide [6] and its citations [7], [8] for detailed discussions regarding interpretation of DIT2 results with respect to political orientation. Consistent with the survey results herein, other researchers typically find that respondents classifying themselves as conservative tend to have higher maintaining norms (MN) scores whereas respondents classifying themselves as liberal tend to have higher P scores [6]. However, while a relationship exists between political orientation and DIT2 scores, they are not considered reducible to or simply proxies of each other [7].

DIT2 Results by High School GPA and ACT score

To investigate any relationship between students' prior academic performance and their DIT2 scores, survey results were additionally analyzed by respondents' reported high school GPA and ACT composite score. For high school GPA, students whose scores were readily available from institutional data were included, while missing GPA or those whose scores were reported as a straight percentage (e.g. 95.3%) were excluded. Of scores included in the analysis (N=88, mean=3.70, SD=0.40, range=2.53 to 4.45), it is noted that scores may be a mixture of unweighted (4.0 max) and weighted (above 4.0) values. As ACT composite scores are not required for admission to the institution, a smaller number (with possible self-selection considerations) of ACT composite scores were available (N=38, mean=23.6, SD=4.5, range=15 to 35). The paired correlations between DIT2 P-score, DIT2 N2-score, high school GPA, and ACT composite score are shown in Table 4. Both Pearson's r and Spearman's rho correlation

coefficients were calculated. The pair of P-score and N2-score is not reported since the N2-score is simply a derived/modified index based on the P-score [6].

Table 4. Correlation coefficients between DIT2 scores, high school GPA, and ACT composite score.

Paired Comparison	Pearson's r coefficient (r^2)	Pearson r p-value	Spearman's rho coefficient	Spearman's rho p-value
P-score and GPA	0.450 (0.202)	$p < .001$	0.410	$p < .001$
N2-score and GPA	0.396 (0.157)	$p < .001$	0.383	$p < .001$
P-score and ACT	0.060 (0.004)	$p = 0.719$	0.007	$p = 0.966$
N2-score and ACT	0.283 (0.080)	$p = 0.085$	0.240	$p = 0.146$
GPA and ACT	0.654 (0.427)	$p < .001$	0.562	$p < .001$

Both P-score and N2-score exhibited correlation with high-school GPA. Interestingly, neither score demonstrated correlation with ACT composite score, despite the strong correlation between ACT and GPA. As a cognitive moral development model, DIT2 scores are correlated with other measures of cognitive capacity such as the SAT at the student level but interestingly not at the institutional level [9]. These study results appear to additionally support the notion that the DIT2 measures something more/different than cognition. The ACT is arguably a more direct measure (than perhaps GPA) of cognitive ability and can be an accurate predictor of IQ [10]. However, ACT was not found to be correlated with the DIT2 scores in this limited study. The N2-score and ACT paired relationship was somewhat more distinct than the P-score and ACT relationship. This possibly suggests that the N2-score (as designed with rejection of low-level moral arguments) may be more susceptible to general cognition factors (e.g. reading comprehension and logical consistency) aligned with the ACT score. At the same time, high school GPA was significantly correlated with higher P-score and N2-score—if valid, why? GPA is itself a broad indicator with many underlying factors. At a surface-level, GPA could be hypothesized as related to one's engagement/commitment to their educational opportunities (attendance, participation, timely completion of assignments, along with the more cognition-dependent summative assessments). It is well accepted that DIT2 scores increase with education level and interventions [5]. Therefore, it is perhaps reasonable that more engaged students (leading to generally higher GPAs) will benefit more from the provided educational interventions, leading to generally higher DIT2 scores for a given education level. The confluence of high impact education practices with engaged learners may provide some basis for DIT2 difference in institutional types. For example, a lower student:faculty ratio was found to be positively related to moral development [9].

DIT2 Results by Activity Involvement

Involvement in co/extra-curricular activities is possibly a factor in promoting moral development. For example, engaging with others as part of a student group or team may facilitate moral development outside of curricular interventions. The survey results were analyzed by looking at students' involvement in either performing arts (music/theatre scholarship), athletics (scholarship and/or on roster), or Activity Credit (academic programming team, music ensemble, dance team, literary magazine, college newspaper, campus magazine, theatre productions). The assumption was that current involvement in the first semester at the institution reflected previous involvement in high school. Table 5 shows the P-Score and N2-Score for each grouping.

Table 5. Selected DIT2 Means (M), standard deviations (SD), Medians (Med), and percentiles for extracurricular groupings.

	P-Score						N2-Score					
	N	**M**	**SD**	**25%**	**Med**	**75%**	**N**	**M**	**SD**	**25%**	**Med**	**75%**
Perf Arts	14	34.4	16.0	22.5	29.0	48.0	14	30.7	15.2	23.7	29.9	38.6
Non-Perf Arts	92	28.5	13.9	20.0	28.0	36.5	92	27.6	12.7	19.1	27.0	36.2
Athlete	88	28.8	14.0	20.0	28.0	38.0	88	27.9	12.7	19.1	28.9	36.2
Non-athlete	18	31.4	15.8	20.5	27.0	46.0	18	29.0	14.9	20.7	28.2	38.0
Activity	23	37.5	13.8	27.0	40.0	48.0	23	33.6	13.2	27.5	33.2	42.7
No Activity	83	27.0	13.6	18.0	28.0	34.0	83	26.5	12.6	18.4	26.0	33.1

No statistically significant results (two-sided equal variance assumption t-tests of two sample means) were found for the P-score or N2-score means for either Performing Arts or Athletic involvement. Analysis with respect to Performing Arts (vs. none) P-score demonstrated a t-statistic(104)= 1.469, p-value = 0.149. Analysis of Performing Arts (vs. none) N2-score demonstrated a t-statistic(104)= 0.828, p-value = 0.410. Analysis with respect to Athletics (vs. none) P-score demonstrated a t-statistic(104)= -0.717, p-value = 0.475. Analysis of Performing Arts (vs. none) N2-score demonstrated a t-statistic(104)= -0.346, p-value = 0.730.

The analysis with respect to Activity Credit was statistically significant for both P-score (t(104)=3.273, p-value=0.001) and N2-Score (t(104)=2.376, p-value=0.019). Students in activity credits earn 0 or 1 credit as part of the academic programming team (4), music ensemble (11), dance team (4), literary magazine (0), college newspaper (0), campus magazine (0), or theatre productions (8). (Note that 4 students were in music ensembles and theatre productions.) The number of students in each category was too small for meaningful analysis, but indicates an area of further research. It is interesting that once the performing arts students are combined with other students involved in some co-curricular activities, that the averages scores become statistically significantly different.

DIT2 Results by Intended Major

The curriculum experienced by a student differs according to the chosen major. We are interested in whether this choice creates a difference in moral reasoning ability; therefore, we measured DIT2 scores for students grouped by their intended major area (division) coming into college to determine if any pre-existing differences were present. To increase the numbers for each major, we grouped them into Business (BusD), Computer Science & Engineering (CSEgrD), Education (EduD), Humanities (HumD), Natural Science and Mathematics (NSMD), Social Science (SSD), and Undecided (UNDD) divisions. Table 6 gives the P-Score and N2-Score grouped by incoming intended major division. Figure 2 and Figure 3 show box plots for these scores.

Table 6. Selected DIT2 Means (M), standard deviations (SD), Medians (Med), and percentiles for incoming major division groupings.

	P-Score						N2-Score					
	N	**M**	**SD**	**25%**	**Med**	**75%**	**N**	**M**	**SD**	**25%**	**Med**	**75%**
BusD	15	29.3	9.5	24.0	28.0	34.0	15	28.9	10.2	20.8	29.1	33.5
CSEgrD	19	28.3	13.2	23.0	28.0	33.0	19	26.5	11.3	23.6	25.3	33.5
EduD	10	26.0	15.1	16.5	20.0	39.5	10	25.4	11.9	17.1	26.2	32.5
HumD	14	31.0	14.7	23.5	33.0	41.5	14	29.4	12.5	22.7	29.8	40.8
NSMD	22	31.6	16.9	20.0	27.0	47.5	22	31.7	15.5	21.6	31.1	44.1
SSD	8	27.3	12.6	23.5	31.0	34.5	8	23.9	12.2	17.5	28.2	30.7
UNDD	18	28.6	16.4	18.5	28.0	37.0	18	26.8	15.2	17.4	23.4	36.8

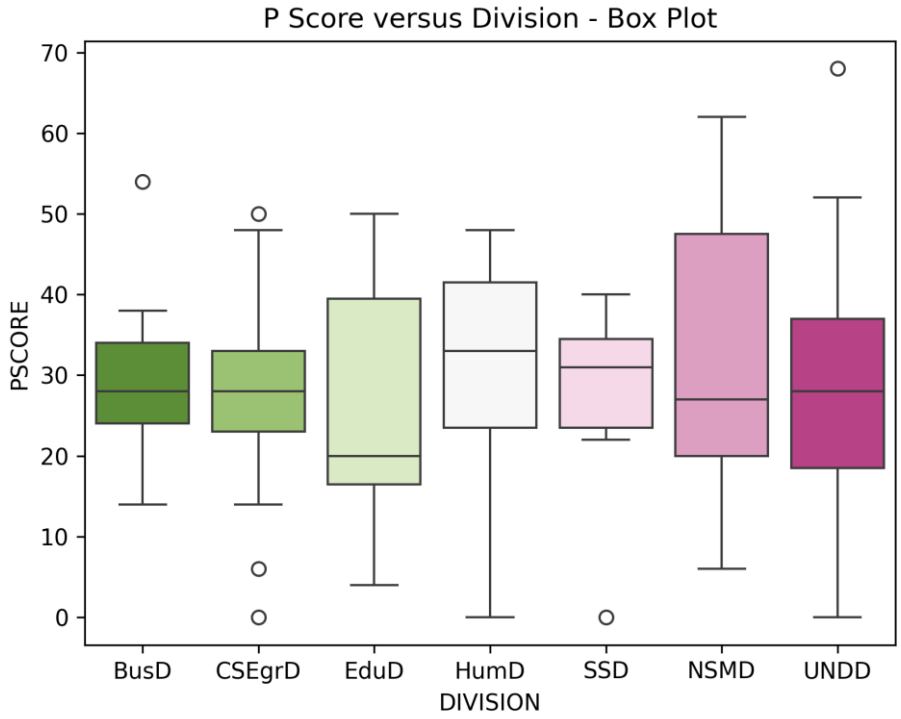

Figure 2. Box plot for P-Score grouped by incoming intended major division.

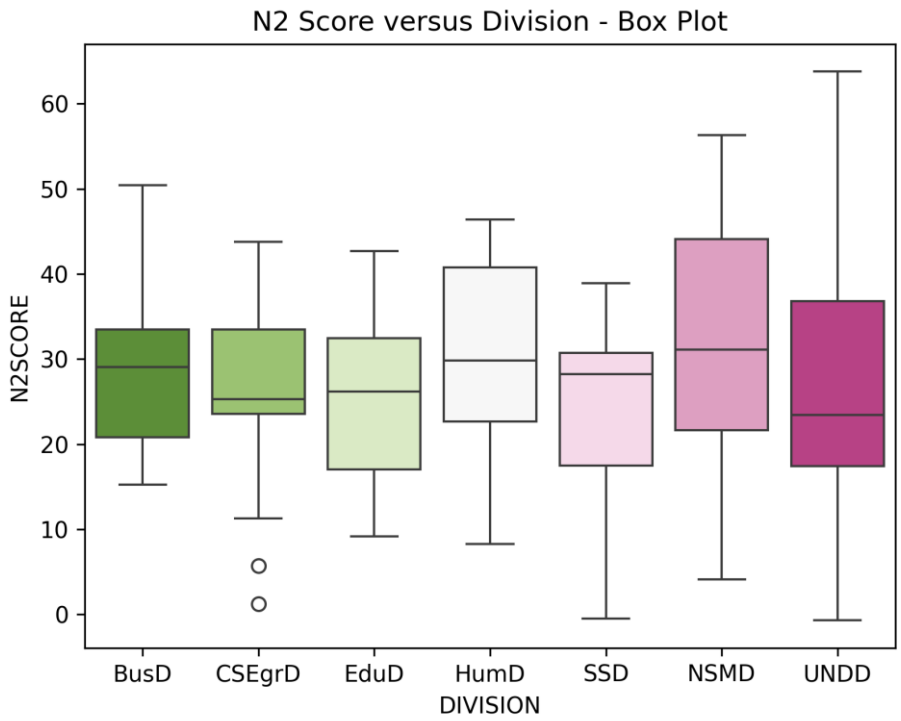

Figure 3. Box plot for N2-Score grouped by incoming intended major division.

The box plots shown in Figure 2 and Figure 3 suggest that there are no significant differences in the means across major divisions for P and N2 scores. To test this hypothesis, we created a linear regression model with the DIT2 score as the dependent variable and the major division as a categorical independent variable and a one-way ANOVA. Table 7 gives the relevant statistics for accepting or rejecting the hypothesis. The small R^2 values for the linear regression models suggest that the student's intended major division is not a good explanatory variable for either DIT2 score. The large p-values from the ANOVA strongly suggest that we cannot reject the hypothesis that the DIT2 scores are all equal.

Table 7. Linear regression model and ANOVA results for DIT2 scores versus major division.

	P-Score Model	N2-Score Model
R^2	0.016	0.035
F-statistic	0.26	0.59
p-value	0.95	0.74

Conclusion & Future Work

The wide variance in DIT2 index scores (for example, P-scores in this study ranged from 0 to 68) presented challenges in observing statistical significance of study subgroup comparisons. The

relationship of high school GPA, but not ACT, to increased DIT2 scores does draw some interest in further investigation. The messiness of a GPA indicator, particularly at the high school level including different high school systems, makes further analysis of root causes difficult. However, it does perhaps provide some research direction at the undergraduate level for further study, such as measures of student curricular engagement and student-faculty interaction. Additional exploration of extracurricular activity involvement outside of the classroom will also be a focus of further analysis. A liberal arts education, which we believe reaches beyond a set of formal course requirements to include the learning environment, institutional norms, and student experiences, presents significant complexity in understanding the factors that may influence moral development.

Expectedly so, the initial "pre-college" cross-sectional results of this work-in-progress paper provide little in the way of conclusions above existing literature. Rather, these results establish the baseline for the planned longitudinal study that will track the moral development of the freshmen cohort through their time at the liberal arts institution, alongside curricular and co/extra-curricular variables. An important aspect of the study, given wide DIT2 score variances in cross-sectional studies, is the longitudinal design to track individual student growth. The DIT2 is planned to be repeated as 1) a "mid-college" survey in sophomore spring semester survey since growth is typically observed by that time, and 2) an "end-college" survey at the final semester of senior year. Modest to no growth is expected for those students already with high (e.g. 40+) P-score and N2-scores; however, the moral reasoning development (and underlying factors) of those incoming students with lower scores (e.g. 0-20) will be of particular interest. More specifically, the moral development growth of engineering majors will be compared with other majors, to better understand the factors influencing moral development of the different disciplines and their potential divergence.

Quantitative analysis of the DIT2 scores and institutional data alone likely will not provide explanatory evidence as to the why of moral development at the liberal arts institution (if observed). A key design of the longitudinal study is a mixed methods approach which will complement the quantitative data by inclusion of 1) a qualitative mid-college questionnaire, and 2) senior year interviews of a selected group of students. Both the custom survey and interviews will seek to provide additional explanatory context into liberal arts components that may possibly be associated with promoting ethical development. Grounded theory [11] will be used to develop an explanatory theory of the social processes predominant at liberal arts institutions that influence undergraduates' ethical development.

The current research project is somewhat limited as a single institution study. The relatively modest available cohort is also relatively homogenous demographically although there is heterogeneity in academic performance (see ACT scores). The institutional constraint and high participation rates in extracurricular activities, including the engineering subgroup, may also limit contrasting of student experiences to identify factors that may be important to moral development. For example, the effect of class size may be difficult to analyze without a large class experience comparison. We are interested in expanding the research into a multi-institution study to obtain a more diverse set of student demographics and undergraduate experiences. The larger study would help better understand the contextual and pedagogical factors that might be leveraged more broadly to improve engineering ethics education.

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