# Analysis of the Influential Factors of Students' Understanding of Professional Ethics


Wen Cheng
*Department of Civil Engineering*
*California State Polytechnic University, Pomona*
Pomona, USA
wcheng@cpp.edu

Bengang Li
*Department of Civil Engineering*
*California State Polytechnic University, Pomona*
Pomona, USA
bengangli@cpp.edu

*Menglu Cao*
*Department of Civil Engineering*
*California State Polytechnic University, Pomona*
Pomona, USA
menglucao@cpp,edu

Edwars R. Clay
*Department of Civil Engineering*
*California State Polytehcnic University, Pomona*
Pomona, USA
erclay@cpp.edu

Mankirat Singh
*Department of Civil Engineering*
*California State Polytechnic University, Pomona*
*Pomona, USA*
mankirats@cpp.edu



***Abstract*— The Research to Practice Full Paper focuses on the professional code of ethics which sets a standard for which each member of the profession can be expected to meet. It is a promise to act in a manner that protects the public's well-being. In the workplace, if we use shoddy materials or workmanship on the job, we can jeopardize the safety of others. Therefore, it is essential that all students shall fully understand the professional and ethical responsibility before they graduate for career development.**

**Unfortunately, there is a consistent lack of data measuring students' capabilities to understand their professional ethics due to the unmeasurable nature of moral reasoning. To address this issue and equip faculty with more tools to enhance students' comprehension of ethical engineering practice, the present research proposes a quantitative approach to measuring ethical behavior and exploring its contributing factors based on a somewhat long duration (years 2013-2019) of senior exit survey data consisting of more than 1000 survey responses. The senior exit survey questionnaire is made up of a set of questions to gauge the students' self-rated capabilities of student outcomes (e.g., ethical responsibility, communication skills, life-long learning, etc.), collect background information (e.g., admission year, transfer or first-time freshman, etc.) and quantity the level of extracurricular participation (e.g., number of student clubs participated, the amount of engagement for part-time work, etc.).**

**There is a broad range of statistical tools to deal with the multiple categorical responses (1- Poor; 2 – Fair; 3 – Average; 4 – Good; 5 – Excellent) to the understanding of professional ethics as implemented in the survey, which includes nominal, ordinal, logit, and probit, and so on. Given the strengths and weaknesses associated with various modeling techniques, the study uses different combinations containing multinomial logit, ordinal logit, and ordinal probit. The multiple combinations are employed for two reasons: First, the comparison of these models is rarely conducted based on the educational data. Second, the common results identified from the different models would lead to reliable findings with more confidence. Distinct data preparation tasks such as data-centering, scaling, outlier identification, and covariate correlation analysis, were used prior to modeling development to ensure result accuracy. The findings illustrate various statically influential factors to enhance students' professional ethics and therefore shed more insight into faculty who aims at improving student outcomes especially from the fact of ethics and morals.**



**Keywords— Senior exit survey, ordinal logistic regression model, Professional and ethical responsibility.**


## I. Introduction

Ethics is described as the moral principles that regulate one's actions, which can be said to be one of the factors that hold society together as it is, whether it's visible to everyone such as news media, [1] or in the form of professionalism in the work environment [2]. Every profession has a unique set of ethical codes to follow. If these ethic codes are not followed to the letter, disasters are not only likely to happen but are capable of resulting in the loss of human life [3].

When it comes to ethical understanding, especially in the professional workplace, it is necessary to introduce the ethical code early on. For professions that require an extensive amount of higher education, such as engineering, introducing the required ethical codes is imperative [4], not only in higher education in general, but having said introduction at the undergraduate level [5].

Despite having a code of ethics outlined, it is still necessary to perform an extensive analysis of the ethical understanding of professionals. This is because ethical codes vary from profession to profession, and even between individuals and their understanding of their respective codes [6]. To determine how structured and stout one's ethical understanding is, various experiments have been conducted to further understand how well-defined professionals' moral understanding is [7]. Research studies have been performed such as those that involve random people in a public survey [8]. In a more specific study, businesses have researched their consumers to understand their ethical standing [9]. In a professional environment, academic professionals have their code of ethics [10]. But through research, this code is questioned to the point of questioning said code and whether it is necessary to keep [11].

For engineering, there outlined a code of ethics that all professional engineers must follow [12]. This code is introduced early in the education required to become a professional engineer. Likewise, engineers, like many professionals, are also put through rigorous courses to develop a better understanding of how this code of ethics affects their professional life [13]. Despite the various research performed on professional ethics and engineering alike, all research has been performed almost entirely on established professionals. There has not been any research involving the ethical understanding of current engineering students, either those beginning to go through the education process or those graduating. By conducting an ethical study on the suggested group, it is possible to potentially identify flaws in the code of ethics or to improve on how said ethical code is introduced to current students.

In summary, the study contributes to the field of higher education and provides a reference for educators to effectively improve undergraduates' understanding of professional ethics by identifying the significant factors of such comprehension.

Explicitly, based on students' academic status, participation in societies, and work experience during school, 15 variables that potentially affecting their understanding of professional and ethical responsibility were selected from Senior Exit Survey data for specific analysis. In the present study, the dependent variable, students' self-rated scores on their understanding of professional ethics, is a categorical variable with more than 2 levels. There are different types of generalized linear models which are suitable for this study, including nominal vs. ordinal, logit vs. probit. Using the rarely used educational data as an empirical comparison of the multiple models, this study used 3 models including the ordinal logistic model, the ordinal probit model, and the multinomial logistic model to find out the factors that affect students' professional ethics. The common results from the multiple models can also be used to draw conclusions with more assuredness. The fit of the three models was compared through the popularly used statistics, or, Akaike information criterion.

## II. Data Description

Senior Exit Survey is a survey conducted on civil engineering undergraduate students who have completed their senior project at the last stage of their programs. Compared with undergraduate students of other grades in the university, students who are about to obtain their bachelor's degree interviewed in the survey data should have a better understanding of their true capabilities during the entire undergraduate study. According to the seven years of data collected from 2013 to 2019, a total of more than 1000 students provided their responses to the exit survey. After data-cleaning which removed null or non-option responses, 511 responses were finally retained for this research analysis. The survey aims to collect feedback from undergraduate students and allows students to make self-assessments on their 11 different kinds of professional competencies and skills. Such as the ability to apply knowledge, the functional capabilities of interdisciplinary teams, the quality of presentations and communication, understanding of professional and ethical responsibility, and lifelong learning, and so on. Besides, the data also contains general information of students including the name and year of enrollment, as well as information on participation and attendance at various events, conferences, and social practices during the school. For the research purpose, only self-evaluation scores of students' professional ethics and some other related information were picked out from the original survey data for further analysis. The emphasis of this study is on students' understanding of professional and ethical responsibility. Among the 511 student responses, 321 students rated their professional and ethical responsibility as "Excellent", 169 students rated as "Good", 15 students rated as "Good", 5 students rated as "Fair", and only 1 student rated as "Poor". Thus, to build relatively balanced groups which are less subject to the impact of small size, the responses were regrouped into 3 groups as Excellent (a) with a total count of 321, Good (b) with a count of 169, Average or Poor (c) with a count of 21. The descriptions of the variables were shown in Table 1.

In this study, 15 variables were selected as explanatory factors of students' professional and ethical responsibility for analysis. The variables consisting of 2 numerical ones (Societies and Experiences), which are the total count of types of involvements in societies (D, E, F, G, H) or types of received professional experiences (I, J, K, L, M) for each student. The rest 13 variables are all categorical ones. The distribution and total count of student responses in each variable were listed in Table 2.

TABLE I. DESCRIPTIONS OF VARIABLES SELECTED FROM SENIOR EXIT SURVEY DATA

| **Variable** | **Description** | |
|---|---|---|
| Status | Students' status upon admission | |
| | a | First-time Freshman |
| | b | Transfer with more than 2 years of college work |
| | c | Transfer with 2 years or less of college work |
| Involvement | The involvement had in student clubs or organizations during school | |
| | a | Held one or more offices |

| | | |
|---|---|---|
| | b | Actively involved in programs but never held and office |
| | c | Regularly attended meetings, but was not active in programs |
| | d | Occasionally attended meetings |
| | e | Little or none |
| Employed Hours | Weekly employed hours on average during the academic year | |
| | a | 30 or more hours |
| | b | 21 to 30 hours |
| | c | 11 to 20 hours |
| | d | 10 hours or less |
| Societies | Number of types of involvements in professional societies off-campus during school | |
| D | Whether attended one or more university-hosted student conferences | |
| E | Whether attended one or more student-led professional conferences or seminars | |
| F | Whether attended one or more professional society chapter meetings in the local area | |
| G | Whether attended one or more non-student led professional conferences or seminars | |
| H | Whether presented one or more papers or posters at a non-student led professional conferences or seminars | |
| Experiences | Count of types of professional experiences received while attending school | |
| I | Whether had or having a full-time summer engineering job or internship | |
| J | Whether had or having a part-time engineering job or internship during the school year | |
| K | Whether had or having a part-time non-engineering job during the school year | |
| L | Whether had participated in the student research program at the university | |
| Ethical | Understanding of professional and ethical responsibility | |
| | 3 | Excellent |
| | 2 | Good |
| | 1 | Average, Fair or Poor |

TABLE II. DISTRIBUTION OF STUDENT RESPONSES IN EACH VARIABLE

| **Integer Variable** | **Count and Percentage of Responses** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Societies** | **0** | **1** | **2** | **3** | **4** | **5** | **Count** |
| | 124 | 179 | 83 | 50 | 49 | 26 | 511 |
| | 24.27% | 35.03% | 16.24% | 9.78% | 9.59% | 5.09% | 100.00% |
| **Experiences** | **0** | **1** | **2** | **3** | **4** | **Count** | |
| | 75 | 211 | 143 | 68 | 14 | 511 | |
| | 14.68% | 41.29% | 27.98% | 13.31% | 2.74% | 100.00% | |
| **Categorical Variable** | **Count and Percentage of Responses** | | | | | | |
| **Status** | **a** | **b** | **c** | **Count** | | | |
| | 297 | 156 | 58 | 511 | | | |
| | 58.12% | 30.53% | 11.35% | 100.00% | | | |
| **Involvement** | **a** | **b** | **c** | **d** | **e** | **Count** | |
| | 197 | 46 | 46 | 128 | 94 | 511 | |
| | 38.55% | 9.00% | 9.00% | 25.05% | 18.40% | 100.00% | |

| Employed hours | a | b | c | d | Count |
|---|---|---|---|---|---|
| | 39 | 140 | 219 | 113 | 511 |
| | 7.63% | 27.40% | 42.86% | 22.11% | 100.00% |
| **D** | **Yes** | **No** | **Count** | | |
| | 168 | 343 | 511 | | |
| | 32.88% | 67.12% | 100.00% | | |
| **E** | **Yes** | **No** | **Count** | | |
| | 201 | 310 | 511 | | |
| | 39.33% | 60.67% | 100.00% | | |
| **F** | **Yes** | **No** | **Count** | | |
| | 188 | 323 | 511 | | |
| | 36.79% | 63.21% | 100.00% | | |
| **G** | **Yes** | **No** | **Count** | | |
| | 184 | 327 | 511 | | |
| | 36.01% | 63.99% | 100.00% | | |
| **H** | **Yes** | **No** | **Count** | | |
| | 80 | 431 | 511 | | |
| | 15.66% | 84.34% | 100.00% | | |
| **I** | **Yes** | **No** | **Count** | | |
| | 199 | 312 | 511 | | |
| | 38.94% | 61.06% | 100.00% | | |
| **J** | **Yes** | **No** | **Count** | | |
| | 320 | 191 | 511 | | |
| | 62.62% | 37.38% | 100.00% | | |
| **K** | **Yes** | **No** | **Count** | | |
| | 162 | 349 | 511 | | |
| | 31.70% | 68.30% | 100.00% | | |
| **L** | **Yes** | **No** | **Count** | | |
| | 76 | 435 | 511 | | |
| | 14.87% | 85.13% | 100.00% | | |
| **Ethical** | **1** | **2** | **3** | **Count** | |
| | 21 | 169 | 321 | 511 | |
| | 4.11% | 33.07% | 62.82% | 100.00% | |

Note: Refer to Table 1 for the descriptions of variables and levels.

## III. METHODOLOGY

The main purpose of this research is to demonstrate how to improve student understanding of professional and ethical responsibility by exploring the relationship between some common influential factors and self-assessed understanding of professional ethics. The research was able to successfully determine these factors using the statistical software package R. With the desire to determine whether the dependent variables have importance ranking, we decide to use three methods to show the factors influence on students' understanding which are ordinal logistic model, ordinal probit regression, and multinomial logistic model. These models have the same null hypothesis, that is, there is no relationship between the dependent variable professional ethics and a series of independent variables. By detecting the results of p-values, we can estimate the variables that have a significant relationship with professional ethics the research data.

### *A. Ordinal Logistic Model*

The ordinal logistic regression is just an extension of logistic regression for ordered outcomes with more than two categories. Ordinal regression is used to predict the dependent variable with 'ordered' multiple categories and independent variables. In other words, it is used to facilitate the interaction of dependent variables (having multiple ordered levels) with one or more independent variables

Ordinal regression can be performed using a generalized linear model (GLM) that adopts both coefficient vectors and thresholds to a data set. If there has a set of observations, represented by length-p vectors $x_1$ through $x_n$, with associated responses $y_1$ through $y_n$, where each $y_i$ is an ordinal variable on a scale 1, ..., K. For simplicity, and no loss of generality, we assume y is a non-decreasing vector, that is, $y_i \leqq y_{i+1}$. To this data, one fits a length- p coefficient vector w and a set of thresholds $\theta_1, ..., \theta_{K-1}$ with the property that $\theta_1 < \theta_2 < ... < \theta_{K-1}$. This set of thresholds divides the real number line into K disjoint segments, corresponding to the K response levels. [14]

The model can now be formulated as

$$\Pr(y \le i \mid x) = \sigma(\theta_i - w \cdot x) \tag{1}$$

Ordered logistic regression-Let Y be an ordinal outcome with JJ categories. Then P(Y≤j) is the cumulative probability of Y less than or equal to a specific category j=1, …, J−1. The odds of being less than or equal a particular category can be defined as

$$\frac{P(Y \le j)}{P(Y > j)} \quad (2)$$

for j=1, …, J−1.

In the equation, P(Y>J) = 0. The zero cannot be used as a denominator. Thus, the log odds are also known as the logit, so that

$$\log\frac{P(Y \le j)}{P(Y > j)} = \log it(P(Y \le j)) \quad (3)$$

In R's 'polr' function, the ordinal logistic regression model is parameterized as

$$\log it(P(Y \le j)) = \beta_{j0} - \eta_1 x_1 - \cdots - \eta_p x_p \quad (4)$$

### B. Ordinal Probit Model

The correlations among observations resulting from the multilevel structure of the data make the outcome of individuals of the same region more homogeneous than those of a random sample of individuals drawn from the whole population. This greater homogeneity is naturally modeled by a positive within-region correlation among individual levels of evaluation for every student, which is formally equivalent to a variance component model.[15]

The probability that observation i will select alternative j is:

$$p_{ij} = p(y_i = j) = p(a_{j-1} < y_i^* \le a_j) = F(a_j - x_i'\beta) - F(a_{j-1} - x_i'\beta) \quad (5)$$

For the ordered logit, F is the logistic cumulative density function. For ordered probit, F is the standard normal cumulative distribution function. The marginal effect of an increase in a regressor or on the probability of selecting alternative j is:

$$\frac{\partial p_{ij}}{\partial x_{ri}} = \{F'(a_{j-1} - x_i'\beta) - F'(a_j - x_i'\beta)\}\beta_r \quad (6)$$

The marginal effects of each variable on the different alternatives sum up to zero. Marginal effects interpretation: each unit increase in the independent variable increases/decreases the probability of selecting alternative j by the marginal effect expressed as a percent.

### C. Multinomial Logistic Model

In statistics, multinomial logistic regression is a classification method that generalizes logistic regression to multiclass problems, i.e. with more than two possible discrete outcomes. That is, it is a model that is used to predict the probabilities of the different possible outcomes of a categorically distributed dependent variable, given a set of independent variables. There has a dependent variable to be predicted that comes from one of a limited set of items that cannot be meaningfully ordered, as well as a set of independent variables that are used to predict the dependent variable. [16]

$$\log_e\left(\frac{pr(y_{ij})}{pr(y_{i1})}\right) = f_j(x) \quad (7)$$

for j=2, ..., m.

In the equation, i represents the specific category and j represents the category referenced; the denominators j remains constant as it is the reference level. The function f(x) represents the logit function and is the log-odds.

### D. Akaike Information Criterion (AIC)

It is a standard for measuring the goodness of statistical model fitting [18]. In general, AIC can be presented as:

$$AIC = \frac{(2k - 2L)}{n} \quad (9)$$

It assumes that the model's errors follow an independent normal distribution. Where: k is the number of parameters in the fitted model, L is the log-likelihood value, and n is the number of observations. The size of the AIC depends on L and k. The smaller the value of k, the smaller the AIC; the larger the value of L, the smaller the AIC value. Small k means that the model is concise, and large l means that the model is accurate. Therefore, the AIC and the modified coefficient of determination are similar, and both the simplicity and accuracy are considered in the evaluation model. [19]

## IV. RESULTS

Probability value (p-value) is an important reference value for determining the statistical significance of independent and dependent variables. The smaller the p-value calculated, the greater the significance between that independent variable and the dependent variable. In this study, the dependent variable was the score of students' self-rated understanding of professional and ethical responsibility, and the rest 15 variables were independent variables.

Each of these variables was examined in 3 methods including the ordinal logistic model, the ordinal probit model, and the multinomial logistic model. If the p-value outcome is less than 0.05, it means that the null hypothesis is rejected at a 95% confidence level, the examined variable has a statistically significant impact on the dependent variable. Also, if the p-value is between 0.05 and 0.1, then the null hypothesis is rejected at a 90% confidence level, the independent variable and the dependent variable were moderately significant correlation. Finally, if the p-value is greater than 0.1, it means that the independent variable has no significant statistical correlation with the dependent variable.

Through the first run of three models in R, only 4 variables with p-values less than 0.1 showed significance for students' ethical understanding. These variables were "Status", "Involvement", "Employed Hours", and "Societies". After removed independent variables that showed no significance in the first run, p-values of variables were slightly different from the previous ones. This time, only 2 variables "Employed Hours", and "Societies" have test results with p-values less than 0.1. in the ordinal models. The results of the three models included coefficients and p-values for each level of the variables were listed in the following Tables 3~5. Besides, the goodness of fits judged by residual deviance and AIC value for each model were listed in Table 6. According to the comparison of AIC values of 3 models, two ordinal models were better than the multinomial logistic model and the ordinal logistic model was slightly better than the ordinal probit model.

This study included the interpretation of the logistic method for the ordinal model since the results of the ordinal logistic model and the ordinal probit model were very similar, and also because the fit of the ordinal logistic model was better than the ordinal probit model. For the ordinal logistic model, based on the p-values outcome shown in Table 4, the factors that the count of types of society attended and weekly employed hours had significant impacts on students' understanding of professional and ethical responsibility among all the variables. According to the odds ratio values in Table 5, for every one-unit increase in the types of society attended (Societies), the odds of being more understanding ethical (Good or Excellent) is multiplied 1.18 times (i.e., increases 18%), holding constant all other variables. And for students working 30 or more hours weekly on average (Employed Hours (a)), the odds of being more understanding ethical (Good or Excellent) is 2.13 times [i.e., 1/0.47] that of students working 10 hours or less weekly (Employed Hours (d)), holding constant all other variables. The estimated ordinal logistic model can be written as the following two equations,

$$logit(\hat{P}\ (Y\leq 1)) = -3.34 - 0.2*Status(b) - 0.42*Status(c) - (-0.54)*Involvement(b) - 0.25*Involvement(c) - 0.13*Involvement(d) - (-0.16)*Involvement(e) - (-0.51)*Employed\ Hours(b) - (-0.36)*Employed\ Hours(c) - (-0.75)*Employed\ Hours(d) - 0.16*Societies \quad (10)$$

$$logit(\hat{P}\ (Y\leq 2)) = -0.66 - 0.2*Status(b) - 0.42*Status(c) - (-0.54)*Involvement(b) - 0.25*Involvement(c) - 0.13*Involvement(d) - (-0.16)*Involvement(e) - (-0.51)*Employed\ Hours(b) - (-0.36)*Employed\ Hours(c) - (-0.75)*Employed\ Hours(d) - 0.16*Societies \quad (11)$$

In the multinomial logistic model, different from the ordinal models, the two variables that are most significant with students' understanding of ethics were status upon admission and weekly employed hours. The log odds of a good understanding of ethics than average or poor will increase by 14.33 if changing the status from a (First-time Freshman) to c (Transfer with 2 years or less of college work). On the other hand, log odds of an excellent understanding of ethics than average or poor will increase by 14.53 if changing the student's status in the same way. Compared with the ordinal models, one independent variable (Status) in the multinomial logistic model had too much influence on its dependent variable (Ethnic) compared to other independent variables. This could make the model obtain more contingency, which might cause predictions to be excessively dependent on one specific variable.

Based on the results of AIC values in Table 6, among the 3 selected models, the ordinal logistic model was the model that worked best for the students' survey data with an AIC value outcome of 812.12. The ordinal probit model was slightly worse than the ordinal logistic model, which indicates that the logistic regression is more suitable for the students' data. And the multinomial logistic model performed the worst because it is mainly used to analyze unordered variables while the dependent variable of our data has an intrinsic ordering.

TABLE III. SUMMARY OF ORDINAL LOGISTIC MODEL

| Ordinal Logistic Model | | | | | |
|---|---|---|---|---|---|
| **Variable** | **Value** | **Std. Error** | **t-value** | **p-value** | **Odds Ratio (2.5% - 97.5%)** |
| Status (b) | 0.20 | 0.21 | 0.93 | 0.35 | 1.22 (0.81 - 1.85) |
| Status (c) | 0.42 | 0.31 | 1.33 | 0.18 | 1.52 (0.83 - 2.85) |
| Involvement (b) | -0.54 | 0.34 | -1.59 | 0.11 | 0.58 (0.30 - 1.14) |
| Involvement (c) | 0.25 | 0.36 | 0.68 | 0.50 | 1.28 (0.64 - 2.65) |
| Involvement (d) | 0.13 | 0.28 | 0.46 | 0.64 | 1.14 (0.66 - 1.95) |
| Involvement (e) | -0.16 | 0.31 | -0.53 | 0.59 | 0.85 (0.47 - 1.55) |
| Employed Hours (b) | -0.51 | 0.41 | -1.22 | 0.22 | 0.60 (0.26 - 1.32) |
| Employed Hours (c) | -0.36 | 0.41 | -0.88 | 0.38 | 0.70 (0.30 - 1.51) |
| **Employed Hours (d)** | -0.75 | 0.42 | -1.78 | **0.07** | **0.47 (0.20 - 1.05)** |

| | | | | | |
|---|---|---|---|---|---|
| **Societies** | 0.16 | 0.08 | 2.07 | **0.04** | **1.18 (1.01 - 1.37)** |
| 1\|2 | -3.34 | 0.50 | -6.66 | 2.74e-11 | - |
| 2\|3 | -0.66 | 0.46 | -1.44 | 0.15 | - |

Note: Statistically significant variable (p-value less than 0.05) and moderately significant variable (p-value between 0.05 to 0.1) were shown in font bold.

TABLE IV. SUMMARY OF ORDINAL PROBIT MODEL

| **Ordinal Probit Model** | | | | |
|---|---|---|---|---|
| **Variable** | **Value** | **Std. Error** | **t-value** | **p-value** |
| Status (b) | 0.13 | 0.13 | 1.04 | 0.35 |
| Status (c) | 0.29 | 0.19 | 1.58 | 0.18 |
| Involvement (b) | -0.30 | 0.20 | -1.47 | 0.11 |
| Involvement (c) | 0.15 | 0.21 | 0.71 | 0.50 |
| Involvement (d) | 0.08 | 0.17 | 0.46 | 0.64 |
| Involvement (e) | -0.14 | 0.18 | -0.75 | 0.59 |
| Employed Hours (b) | -0.23 | 0.24 | -0.97 | 0.22 |
| Employed Hours (c) | -0.15 | 0.23 | -0.63 | 0.38 |
| **Employed Hours (d)** | -0.40 | 0.24 | -1.65 | **0.07** |
| **Societies** | 0.09 | 0.05 | 1.87 | **0.04** |
| 1\|2 | -1.80 | 0.28 | -6.50 | 2.74e-11 |
| 2\|3 | -0.35 | 0.27 | -1.34 | 0.15 |

Note: Statistically significant variable (p-value less than 0.05) and moderately significant variable (p-value between 0.05 to 0.1) were shown in font bold.

TABLE V. SUMMARY OF MULTINOMIAL LOGISTIC MODEL

| **Multinomial Logistic Model** | | | | |
|---|---|---|---|---|
| **Variable** | **Coefficients** | | **p-values** | |
| **Ethical** | **Good - 2** | **Excellent - 3** | **Good - 2** | **Excellent - 3** |
| (Intercept) | 1.23 | 2.14 | 0.21 | 0.01 |
| Status (b) | 0.85 | 0.92 | 0.14 | 0.11 |
| **Status (c)** | 14.33 | 14.53 | **< 2e-16** | **< 2e-16** |
| Involvement (b) | -0.06 | -0.61 | 0.95 | 0.49 |
| Involvement (c) | 0.24 | 0.50 | 0.82 | 0.65 |
| Involvement (d) | -0.04 | 0.11 | 0.97 | 0.88 |
| **Involvement (e)** | -1.39 | -1.25 | **0.06** | **0.08** |
| **Employed Hours (b)** | 1.80 | 0.81 | **0.04** | **0.28** |
| **Employed Hours (c)** | 1.47 | 0.71 | **0.08** | 0.32 |
| Employed Hours (d) | 0.59 | -0.29 | 0.48 | 0.63 |
| Societies | -0.21 | -0.04 | 0.29 | 0.95 |

Note: Statistically significant variable (p-value less than 0.05) and moderately significant variable (p-value between 0.05 to 0.1) were shown in font bold.

TABLE VI. THE GOODNESS OF FITS FOR 3 TYPES OF MODEL

| **Goodness of Fit** | **Ordinal-Logistic** | **Ordinal-Probit** | **Multi-Logistic** |
|---|---|---|---|
| Residual Deviance | **788.12** | 788.16 | 796.39 |
| AIC | **812.12** | 812.16 | 817.39 |

Note: The best model with the smallest values of AIC and residual deviance shown in font bold.

## V. CONCLUSION

In sum, the ordinal logistic model fits the need of our research better than the competing ones including ordinal probit model and multinomial logistic model. As a result, only one independent variable, which is the number of types of professional societies attended by students, had a significant impact on the dependent variable, or, students' self-rated understanding of professional and ethical responsibility. In the Senior Exit Survey data, society types were integrated into 5 categories, including Pacific Southwest Regional ASCE Student Conferences, professional society chapter meetings in the local area, student-led professional conferences or seminars, and non-student led professional conferences or seminars. The study showed that students who are involved in more types of societies had a better understanding of ethics. In addition, students with more working time understood ethics better as well. The weekly employed hours of students also showed moderately significance in the ordinal model.

Overall, students participating in more types of societies or devoting more time to work tend to have a better understanding of professional and ethical responsibility than those who had attended fewer societies and spend less time at work. Therefore, it is recommended for educators to encourage students to take part in more societies to enhance their understanding of ethics and professionalism. However, regardless of the results determined, there does exist limitations to research conducted and the results produced. As the assessment is rated by the students themselves, they may have an insufficient understanding of their own ability, which results in very small sample sizes for average and low scores in the survey data, which could also lead to the deviation in the results.

For the future study of our research, increasing the sample size of the original data can be a good way to improve the research accuracy. This can be achieved by collecting more students' data from other departments or universities. Meanwhile, in order to increase the samples in different score levels, it's also helpful for the analysis to strengthen the rigor of assessment and make students follow the specified standards and requirements when doing self-evaluation. Another limitation is that this study did not distinguish the different types of social activities students have participated in. Some societies may emphasize the importance of professional ethics more than others. Taking this comparison into the study in the future, the contribution of research will be better for higher education.

## ACKNOWLEDGMENT

The authors are beholden to all teachers and students who participated in the senior exit survey.

## REFERENCES

[1] Berry, David. Journalism, ethics and society. Routledge, 2016.

[2] Banks, Sarah. "Everyday ethics in professional life: Social work as ethics work." Ethics and Social Welfare 10.1 (2016): 35-52.

[3] Mitrović, Veselin L., Dónal P. O'Mathúna, and Iskra A. Nola. "Ethics and floods: a systematic review." Disaster medicine and public health preparedness 13.4 (2019): 817-828.

[4] Robert F. Harvanek SJ (1982) Ethics Teaching in Higher Education, The Journal of Higher Education, 53:3, 360-362, DOI: 10.1080/00221546.1982.11780461.

[5] Joseph J. Schwab (1982) Ethics in the Undergraduate Curriculum, The Journal of Higher Education, 53:3, 380-381, DOI: 10.1080/00221546.1982.11780469.

[6] Smith, K. (2010). In research ethics, one size doesn't fit all: [1]. Times Higher Education, (1931), 30.

[7] Gold, N. (2008). Experiments in ethics. Times Higher Education, (1838), 48.

[8] Inglis, F. (2008). Trouble with strangers: A study of ethics. Times Higher Education, (1874), 46.

[9] Vitell, S.J. Consumer Ethics Research: Review, Synthesis and Suggestions for the Future. Journal of Business Ethics 43, 33–47 (2003). https://doi.org/10.1023/A:1022907014295.

[10] Elias Baumgarten (1982) Ethics in the Academic Profession, The Journal of Higher Education, 53:3, 282-295, DOI: 10.1080/00221546.1982.11780454.

[11] Daniel Callahan (1982) Should There Be an Academic Code of Ethics?, The Journal of Higher Education, 53:3, 335-344, DOI: 10.1080/00221546.1982.11780458.

[12] National Society of Professional Engineers. Code of Ethics for Engineers. 2019

[13] Turner, J. D. (2010). Putting the world back in working order. Times Higher Education, (1945), 36.

[14] McCullagh, Peter (1980). "Regression models for ordinal data". Journal of the Royal Statistical Society. Series B (Methodological). 42 (2): 109–142.

[15] Aitkin, Murray & Longford, Nicholas. (1986). Statistical Modelling Issues in School Effectiveness Studies. Journal of the Royal Statistical Society. Series A (General).

[16] Greene, William H. (2012). Econometric Analysis (Seventh ed.). Boston: Pearson Education. pp. 803–806. ISBN 978-0-273-75356-8.

[17] Imai, K., & Dyk, D. A. V. (2005). MNP:RPackage for Fitting the Multinomial Probit Model. Journal of Statistical Software, 14(3). doi: 10.18637/jss.v014.i03

[18] Burnham, K. P.; Anderson, D. R. (2002), Model Selection and Multimodel Inference: A practical information-theoretic approach (2nd ed.),

[19] Akaike, H. (1974), "A new look at the statistical model identification", IEEE Transactions on Automatic Control, 19 (6): 716–723, doi:10.1109/TAC.1974.1100705