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VALIDATION OF A SITUATIONAL JUDGMENT TEST FOR ENGINEERING ETHICS DECISION MAKING

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Abstract
Ethical decision-making is an important skill for engineers to have because the work they do can have high stakes for social, environmental, and safety reasons. Despite the growing emphasis on ethics education in current engineering programs, there remains a lack of comprehensive, psychology-based tools that collect data on students' ethical reasoning in context. The purpose of this study was to validate a Situational Judgment Test (SJT) that was specifically designed to measure ethical decision-making in engineering students. The SJT presents respondents with difficult judgment scenarios that are relevant to their discipline, and draws from moral psychology and cognitive decision-making theory. We studied 150 undergraduate engineering students. The validation process consisted of content validation with expert panels, construct validation through exploratory factor analysis, and criterion-related validation correlating SJT scores with previous ethics training or courses and academic performance. We confirmed reliability based on high internal consistency (Cronbach's alpha = 0.82) and stable test-retest reliability. Results showed the SJT successfully captures moral reasoning variation across levels of experience, and also supports theoretical constructs associated with ethical sensitivity and decision-making. This validated SJT provides educators, researchers, and (hopefully) educational program administrators, a relatively simple, grounded-in-empirical research tool to assess and improve ethical reasoning in engineering courses. Its inclusion in formal training or educational program can help demonstrate both formative and summative evaluation of students' ethical reasoning. Its integration into ethics training programs can support both formative feedback and longitudinal tracking of moral development among future professionals.
Keywords: Situational Judgment Test (SJT), Engineering Ethics, Ethical Decision-Making, Moral Reasoning, Test Validation, Psychometrics, Cognitive Assessment, Ethics Education

I. INTRODUCTION

Engineers often face ethical dilemmas balancing the constraints of efficiency with public safety, environmental stewardship, and professional ethical standards. There are plentiful historical events, such as the Challenger explosion, the Volkswagen emissions scandal, and poorly designed and built infrastructure that collapsed due, in part, to ethics failures, that speak to the impact of ethics failures in engineering practice. Even though ethics education is part of the engineering program, current tools and methods of assessment, such as essays, case discussions, or multiple-choice tests, are limited and insufficient to define how real-world ethical decisions are made [1] [5].

Clearly, we need new approaches to assess how future engineers really think through ethical dilemmas in practice. Similarly, Situational Judgment Tests (SJTs) offer a more realistic alternative in assessing ethical situations by presenting respondents with realistic discipline-specific situated scenarios that sketch the pressures and ambiguities of reality [2]. SJTs have been used to assess behaviours and cognitive processes in other fields such as medicine, law enforcement, and business to assess non-cognitive traits such as empathy, integrity, and judgment [4].

Psychological frameworks support the use of SJTs as an assessment tool for ethics and include Rest's Four-Component Model, dual process theories, and moral schemas [3]. Psychological frameworks of ethical behaviour suggest that ethical behaviour is a combination of intention, behaviour, and context and would support the design logic of SJTs. Thus, validating an SJT tailored to engineering ethics fills a critical gap in both psychological assessment and professional education [3].

II. CONCEPTUAL BASIS AND TEST DESIGN

2.1. Theory Framework

The Situational Judgment Test (SJT) for engineering ethics is based on psychological theories of moral cognition and ethical action [13]. Specifically, the four-component model proposed by Rest, which cites moral sensitivity, moral judgment, moral motivation, and moral character, as the principal components of ethical action, served as a conceptual framework for the SJT [8]. Additionally, dual-process models of reasoning differentiated between two modes of thought: mostly automatic, intuitive responses (referred to as System 1) and more measured and analytical cognitive reasoning (referred to as System 2). This development process recognizes that ethical decision-making involves elements of forward and backward cognition acting in conjunction [7]. The incorporation of moral schemata theories suggested that moral models are often relied upon by representatives of each sector based upon their past experiences and the contexts of their decisions [10].

2.2. Scenario Development

Given these theories, the SJT includes representative scenarios depicting significant ethical dilemmas faced in engineering practice. The SJT scenarios include situations like conflicts of interest, irresponsibility for safety and ethical decision-making, resource allocation, plagiarism and data fabrication, and so on. Each scenario is presented as a brief description (250-word approximately) followed by 4–5 alternative responses that represent plausible but differ in extent, and moral appropriateness [14]. The respondents identify the most and least appropriate responses to the situation and are allowed flexibility in how to rank the responses.

A panel of experts (engineering educators, ethical scholarship researchers, and psychologists) were engaged to review the scenarios for content validity, relevance, and cultural neutrality. The collaborative process to develop the scenarios allowed richer representations of real life [6].

III. VALIDATION STRATEGY

3.1. Validation Framework

To validate both the Situational Judgment Test (SJT) on engineering ethics to establish reliability, a multi-step process of validation was followed. The sample size was 150 participants, and participants varied as undergraduate engineering students from various programs and year of study, as well as an early-career professionals [9]. This admitted the SJTs administration to evaluate along levels of experience and exposure to ethical training [12].

3.1.1. Cronbach's Alpha (Reliability Formula):

Measures internal consistency of the SJT

$$\propto = \frac{k}{k-1}\left(1 - \frac{\sum \sigma_i^2}{\sigma_t^2}\right)$$

3.1.2. Exploratory Factor Analysis (EFA):

Brief mention of factor loadings and eigenvalues (no formulas needed, just results or scree plot)

3.1.3. Content Validity Ratio (CVR):

$$CVR = \frac{n_e - (N/2)}{N/2}$$

Wheren_e = number of experts who rated the item as essential, N = total number of experts.

3.1.4. Correlation Coefficients (Criterion Validity):

Report Pearson's **r** value (e.g., SJT score vs. GPA, ethics course exposure)

Content validity was established through a highly structured review by a panel of 8 subject matter experts that included as part of the panel engineering faculty and ethics educators and organizational psychologists. Each scenario and responses set were rated for content, realism, ethical balance of response set, and clarity. A high content validity ratio (CVR) was established among items overall. Construct validity was evaluated throughout the exploratory factor analysis (EFA) of the data which seeked to evaluate any underlying dimension of ethical reasoning that may be evaluated by the SJT test. Results highlighted previously described considerations of moral sensitivity, rules adherence, and professional accountability as most evident in images [15].

Table 1: Participant Demographics and Background

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	90	60.0%
	Female	60	40.0%
Academic Level	2nd Year	45	30.0%
	3rd Year	55	36.7%
	4th Year	50	33.3%
Ethics Coursework Taken	Yes	72	48.0%
	No	78	52.0%
Internship Experience	Yes	63	42.0%
	No	87	58.0%

Table 1 outlines the participant sample from the validation study of the Situational Judgment Test (SJT) for engineering ethics. It reports key demographic identifiers like gender, level of academic qualification, and previous exposure to ethics course or internship experience. This contextualizing information is important to understand the diversity of the sample and the representativeness of it, as well as identifying if there were any group-level trends in test performance.

3.2. Statistical Approach

Criterion-related validity was assessed by correlating SJT scores with external criteria such as the students' academic performance (GPA), prior participation in ethics courses, and their involvement in professional activities or internships. SJT scores correlated positively moderate to strong, which provides support for the measure's predictive validity.Reliability was evaluated by using both internal consistency data (Cronbach's alpha = 0.82) and a test-retest approach two weeks later that indirectly determined score stability with a strong correlation (r = 0.87), attesting to the robustness of the tool.

IV. PSYCHOMETRIC PROPERTIES AND EDUCATIONAL IMPLICATIONS

4.1. Test Performance Metrics

The results of the analysis of the SJT provide evidence of strong psychometric properties and additional educational implications with respect to how engineering students approach ethical decision-making. The item analysis determined an appropriate mix of item difficulty, and sufficient discrimination values, indicating that the SJT successful discriminated between high and low performance on ethical reasoning. The reliability analysis produced consistently high values with a Cronbach's alpha of 0.82 which provided internal consistency evidence, and a test-retest reliability of r = 0.87 which indicated that the scores can be assumed to be stable over time.

The factor analysis suggested three underlying constructs: moral sensitivity, rule adherence, and ethical responsibility. These constructs can be aligned with a psychological perspective such as Rest's Four-Component Model and moral schematic theory/Schema; consistent with the factor-structures that support the belief that ethical reasoning is multidimensional in relation to the technical environment.

Table 2: SJT Item Analysis and Reliability Statistics

Item No.	Difficulty Index	Discrimination Index	Factor Loading
1	0.54	0.38	0.71
2	0.61	0.42	0.65
3	0.48	0.35	0.69
4	0.52	0.40	0.72
5	0.57	0.36	0.68

Table 2 reports the item-level psychometric analysis results, including the difficulty and discrimination indices for selected SJT items. These statistics describe how well each scenario is able to distinguish higher and lower ethical reasoning abilities. Factor loading values explain whether the various scenarios align with the requisite underlying psychological constructs, e.g., moral sensitivity and professional responsibility. The reliability statistics reported in this table show the overall reliability of the SJT; the Cronbach's alpha shows there is very high internal consistency; and the test–retest correlation shows that the tool was temporally stable. Collectively, Tables 1, and 2 demonstrate both the statistical strength and practical utility of the developed SJT in assessing ethical decision-making in engineering students.

4.2. Educational Impact

Across the group, there was a slight difference by class level: the seniors tended to perform better than the juniors, due to increased learning in and about real life as well as increased attention to ethics, which is to be expected. There were no statistically significant differences by gender; for example, there were no trends to favour male or female participants. In addition, the students who reported taking at least one ethics course (or similar course) and/or ethics-related internship tended to do better, which emphasizes the importance of actually doing something in regards to engaging ethically.

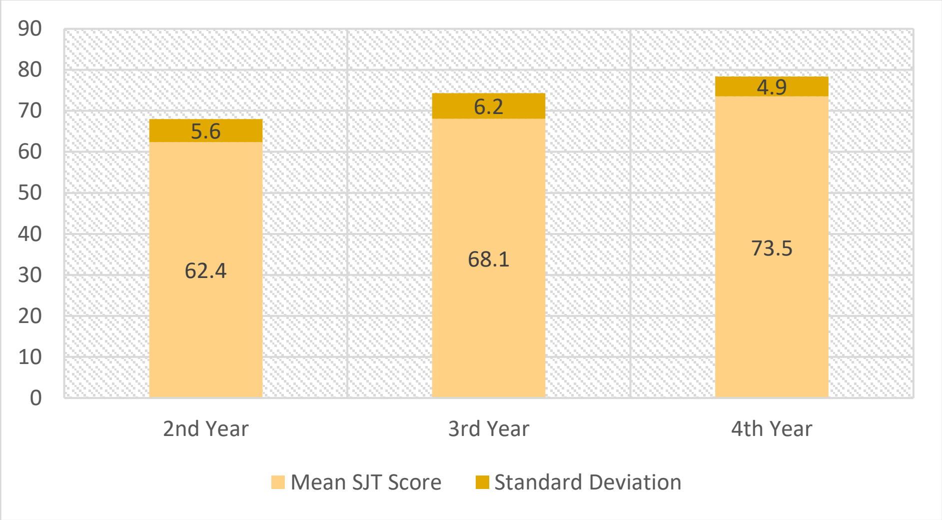

Figure 1: Mean SJT Scores by Academic Level of Engineering Students

Figure 1 presents the average scores on the Situational Judgment Test (SJT) for engineering students at 2nd year, 3rd year, and 4th year. This graph is highlighted in this way to show how students' competencies in making ethical decisions (measured via the SJT) can improve as students increase their academic levels and undergo more ethics education and experience ethics education through solving real-life problems. The average scores trend positively, confirming that students becoming more senior are performing better on ethical reasoning tasks, which is helpful to the tool's construct validity and potentially tracking the moral development of students throughout their engineering education.

Taken from an educational perspective, the SJT is a non-static, context-based device to stimulate critical thinking and self-reflection. This is useful as an assessment tool in the context of an engineering ethics course, and could be used for ongoing feedback and assessment based on longitudinal analysis of moral development, and, post hoc analyses based on interventions implemented on the basis of feedback. Overall, these results serve as further validation for SJTs and their reliability as a psychological measure for complex decision making in the context of engineering education.

V. CONCLUSION AND FUTURE DIRECTIONS

This research was able to verify a Situational Judgment Test (SJT) specified to measure ethical decision-making in engineering applications based on established psychological theory and designed collaboratively with experts. The SJT was capable of strong psychometric reliability and construct validity, adhering to key components of moral reasoning processes, including: ethical issue sensitivity; professional standards adherence; and context on decision making.The validated SJT fills a gap in engineering education: while theories would usually examine ethical decision-making, this is a realistic psychologically based measurement based on situations and theoretical knowledge. Given this particularity, the validated SJT will allow educators to identify ethical strengths and gaps for students, leading to intentional feedback and curricular improvement. In addition, the situational method allows for a decision-making experience akin to the types of dilemmas that practitioners face, and creates a bridge experience between students' course expectations and the applied world using situations.Future versions of the SJT will also benefit from adaptive testing formats that adjust the difficulty based on the student individual performance, and long-term usage, tracking ethical development over time. Furthermore, we also see the potential of extending the use of the test to professionals in the industry, where it might contribute to ongoing ethics education and integrity assessments of organizations. As engineers will continue to face ethical expectations, tools, such as the SJT, will be useful to train students and practitioners to encounter moral challenges of contemporary engineering problems without missing a beat or cause unnecessary anxiety.

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