Evidence-Based Practice: Looking Good When It Matters: How Engineering Students Regard the Virtue Ethics Framework

Dr. Natalie C.T. Van Tyne, Virginia Polytechnic Institute and State University

Natalie Van Tyne is an Associate Professor of Practice at Virginia Polytechnic Institute and State University, where she teaches first year engineering design in foundation courses for Virginia Tech's undergraduate engineering degree programs. She holds a Ph.D. in Engineering Education, along with masters degrees in chemical and environmental engineering, and in business administration, as well as bachelors degrees in chemical engineering and Russian language. Her research interests focus on the use of reflection in student learning, specifically for self-regulated learning and identity formation.

Evidence-Based Practice: Looking Good When It Matters: How Engineering Students Regard the Virtue Ethics Framework

Introduction

Our first-year engineering ethics unit contains an introduction to and guided practice in ethical decision making under each of four ethical frameworks: Deontology, Virtue Ethics, Consequentialism, and Utilitarianism. Students receive a briefing about each framework to learn about its basic features and how to apply them. Prior studies with first-year engineering students and these ethical frameworks revealed that rules-based Deontology and outcome-based Consequentialism and Utilitarianism were readily understood and applied. However, students had a difficult time with the application of Virtue Ethics. Clearly, additional guidance and a reframing of the in-class and homework exercises in Virtue Ethics were necessary to enable students to understand and be able to apply this framework more clearly.

As part of a feedback and assessment tool called an Exit Survey, we asked the students to describe a difficult situation in their own lives and how they resolved it, and then describe how their solution reflected upon their character and reputation as viewed by others. This approach embodies the essence of Virtue Ethics: how would a person act in a way that demonstrates virtue in the eyes of others? The survey question was as follows:

Think of a time when you made a decision that was influenced by how other people would think of you. Describe that decision and where you made it. What was the "virtue" that you wanted others to think that you showed?

This question is also framed by Flanagan's critical incident theory, wherein questions containing specific criteria prompt for the recall of "critical incidents. " Flanagan's respondents demonstrated greater and more accurate detail of incidents involving the traits being sought by the questions. The need for greater specificity and detail in recall arose during the early days of World War II, when pilots in training were evaluated for their ability to fly safely and effectively based on little direct evidence of what they could do under combat conditions. By asking trainers to recall certain types of "critical incidents" in pilot performance more closely related to what a pilot might see in combat, the trainers were able to identify competent pilots more easily and accurately. This method was also applied after the war to civilian settings such as the industrial workplace for the evaluation of supervisory personnel. Flanagan's critical incident method was later applied to a wide variety of professional fields in addition to its use in the military.

Our results revealed a focus on common virtues such as integrity, courage, conscientiousness, and empathy. Responses were also analyzed for the presence of positive or negative outcomes. The richness of the responses reflected desires for recognition in demonstrating care for others, acting with social or personal maturity, taking responsibility for more constructive actions, striving to appear socially adept, and going along with what peers were doing, all of which were relevant for this age group. There were relatively few responses that indicated a lack of concern with one's impression on others, which fails to support the impression that teenagers and young adults care little about how their actions affect others' impressions of their character.

Study Problem and Purpose

The purpose of this study is to address an observed problem with new and transfer engineering students in their lack of understanding of the Virtue Ethics framework, and to share our results and recommendations with the engineering ethics community. The problem is that we have observed that engineering students' understanding and ability to apply this framework is different from their understanding and application of Deontology, Consequentialism, and Utilitarianism to ethical problems in engineering. This assertion is based on prior studies in which students solved ethical problems using each of these four frameworks. Their responses under Virtue Ethics lacked both quality and depth when compared to responses under the other frameworks. One reason for the difficulty to understand and apply Virtue Ethics may be that it is based on acceptable traits of moral behavior or character as perceived by oneself and others, and is more generalized to all aspects of an individual's life rather than as a specific way to solve ethical problems [1], [2].

Virtue ethics has been described as a form of ethical reasoning based on what a virtuous person or a person of good character would do when faced with a difficult decision [3], [4]. There is also debate as to whether virtues can be taught, as well as whether they are exercised consistently or are dependent on circumstances or context [4], [5]. Therefore, the ambiguity surrounding the virtue ethics framework could provide evidence for students' difficulty in understanding and applying it.

By contrast, Deontology, or ethics by rules, is personified by the Code of Ethics of Engineers [6]. Our students become familiar with this code and study it because they know that it pertains to their professional conduct, and they are comfortable with rules and standards. Consequentialism is also easy to understand when described in terms of "the end justifies the means" , which is another way of saying that whether an action is ethical depends on its outcome [7]. Utilitarianism [8] is also more readily understood by students, as they devise solutions to ethical case studies with specific contexts, assumptions, and contingencies.

Based on this lack of understanding of the Virtue Ethics framework, our study question was framed as follows:

How do engineering students exhibit elements of Virtue Ethics when prompted to recall a past incident in which their behavior was influenced by how they perceived that others would view them?

We conducted our data collection using Flanagan's critical incident technique [9], [10], [11], and our data analysis using Chun's virtue ethics model [12], [13]. While these conceptual frameworks were developed and applied in the military and the business world, respectively, we wanted to assess their transferability to an engineering educational context.

Conceptual Frameworks and Background

Flanagan's Critical Incident Technique

By prompting our students to recall a "critical incident" [9] in which they described how they did or did not practice one or more traits of a person of virtue, we expected to receive more meaningful responses based on real-life situations. The critical incident protocol contains carefully-worded questions that are intended to reveal examples of human behavior to address specific problems [9]. Responses may reveal either positive, negative, or both types of behavior with respect to the incident descriptions, contexts, or circumstances [14].

In addition to Flanagan's experience with military personnel, the critical incident technique has also been applied to the customer service sector in order to identify customer service from the customer's point of view [15] [16]. It has also been applied within the health care and health sciences industries over a large number of years [10], [14], [17]. Additional fields that have found this technique to be valuable to problem solving include counselling and industrial psychology, communication, job analysis, social work, and education [11].

Flanagan's original approach employed direct observation of what people did that may have contributed to a specific problem, although recalling a past incident was also recognized as potentially useful [9], [11]. Direct observation of what people are doing that may be constructive or problematic often yields authentic data, but it is labor-intensive and expensive [11]. This is one reason why critical incident studies in later years relied largely on the recall of past incidents, provided that recall is clear and sufficiently detailed [9], [11].

Chun's Ethical Character and Virtue Framework

Chun was primarily concerned with the ethical character of businesses in the United Kingdom, drawing on established theories of business ethics [12]. Later on, she expanded her work to consider the virtue or character that global firms presented of themselves [13]. The foundation for Chun's work lay grounded in Kantian and utilitarian approaches, where the Kantian approach was moral-based, and the utilitarian approach focused on cost-benefit relationships [12]. She also drew on the insight provided by Solomon, who asserted that personal integrity could be beneficial to business, and from Shanahan and Hyman, who adapted Solomon's principles into their own model [2], [18], [19].

In order to develop Chun's framework, ethical values statements from Fortune Global 500 firms were subjected to content analysis in two studies approximately 14 years apart [12], [13]. These results contained 34 distinct elements of virtue ethics. A survey of employee and customer participants representing British firms was then conducted to confirm and validate the virtue themes identified by the content analysis, which resulted in a reduction of virtue items from 34 to 24 and the identification of 6 themes [12]. Finally, the 24 items and 6 themes were tested for validity and reliability using factor analysis and Cronbach's alpha [12]. The six themes and their corresponding elements are listed in Table 1 in the Data Analysis section.

Research Methods

This is an evidence-based study for which the participants completed a four-question Exit Survey containing one question relating to the exercise of virtues or character traits associated with virtue ethics, using Flanagan's critical incident method to prompt for the recall of past incidents with these virtues. Responses were classified as to whether the described virtue prompted for a positive or a negative action, such as honesty vs. dishonesty, or "the right thing to do" vs. personal advantage at the expense of others.

Study Context and Participants

A one-semester version of the two-semester engineering foundations course sequence is offered to first-year engineering students with advanced placement due to prior attainment of college-level course credits in first-year science, mathematics, and English composition requirements. The course is also made available to transfer students who have completed the same requirements. This study population consisted of approximately 80% male and 20% female students.

The course contained two lessons in engineering ethics, one of which delivered instruction and practice in four ethical frameworks: Deontology, Virtue Ethics, Consequentialism, and Utilitarianism. After applying a practical description of each of the ethical frameworks during an in-class exercise, students completed a homework assignment in which they applied two of the four frameworks to possible solutions to an ethical problem. A subsequent Exit Survey was also administered after the ethical frameworks lesson and during the homework time frame, containing this free-response question along with three additional questions about that week's course material:

Think of a time when you made a decision that was influenced by how other people would think of you. Describe that decision and where you made it. What was the "virtue" that you wanted others to think that you showed?

Data Collection

The qualitative data were collected as a convenience sample from the responses to the Exit Survey provided by 82 participants [20]. This sample excluded additional participants who claimed that they never made ethical decisions based on how others would think. The sample contained 61% first-time-in-college (FTIC) students and 39% transfer students.

While the data were not labeled by gender, it was segregated by time in college. This means that the FTIC data were collected and analyzed separately from the transfer student data. The most important reason for the segregation of data was the fact that transfer students have a different first-time-in-this-institution experience than FTIC students at the same institution, according to the literature [21], [22], [23]. Specific difficulties faced by transfer students in adjusting to a new four-year institution include increased anxiety and/or stress, adjustments to a different social environment in a larger or smaller space, and a lack of expected mastery of foundation course material [21]. The transfer students may also need more time than FTIC students to attain their degrees, whether from adjustment issues or transfer credit limitations [22]. Institutions, for their

part, devote fewer resources to the support of transfer students than to FTIC students, expecting the former to adjust on their own because they have been admitted largely by convenience in order to fill classroom space [22]. These are the results from transfer students could differ from those of FTIC students to a sufficient extent to warrant segregation.

Data Analysis

The data were *a priori* coded using Chun's Virtue Ethics Character Scale, as shown in Table 1 below [12], [13] :

Table 1: Virtue Ethics Character Scale

Themes	***Elements of Each Theme***
Integrity	Honest, Sincere, Socially Responsible, Trustworthy
Empathy	Concerned, Reassuring, Supportive, Sympathetic
Courage	Ambitious, Achievement-Oriented, Leading, Competent
Warmth	Friendly, Open, Pleasant, Straightforward
Zeal	Exciting, Innovative, Imaginative, Spirited
Conscientiousness	Reliable, Hardworking, Proud, Secure

The data were sorted according to positive vs. negative outcomes prior to coding. A "positive" outcome was one in which the results of the action were beneficial to oneself and/or other members of the incident, and a "negative" outcome had a detrimental effect in the same ways. This was done in order to compare the elements of virtue indicated by either type of response, as well as to compare the number of positive and negative responses by first-year vs. transfer students. One theme and three codes were applied to each response for uniformity in coding, although additional themes and codes might have been applied to one or more responses.

Limitations to This Study

This study was limited in its time frame and institutional space, due to the scope of the engineering ethics unit within the two-credit first-year engineering foundations course and the academic maturity of the student participants. Participation in this study was voluntary, and the survey instrument was not required for the course nor graded. In addition, response bias on the part of the students could have influenced their responses, although we expected that the recall of critical incidents relating to the exercise of virtue ethics could have mitigated this effect. Researcher bias could also have been present, due to limitations in the opportunity for alternate rating.

The history and traditions of the virtue ethics framework were also omitted from the engineering ethics unit due to limitations in what could be adequately explored among all of four ethical frameworks. However, Chun had included two of Aristotle's cardinal virtues in the development of her framework: courage and justice [12], [13], [24]. Chun identified courage as a theme, while justice was implied among the elements of the integrity theme [12], [13].

One major difference between Flanagan's 1954 method and our use of it lies in the study context and participants [9], [11]. For example, Flanagan and others applied this method to adult participants in the military, industrial, and medical fields, while our study involved engineering students [9], [10], [11]. Another important limiting factor is the quest to demonstrate credibility and trustworthiness in the use of this qualitative approach [11]. A review of the evolution of the critical incident method over the 1954-2004 period resulted in the conclusion that there was a lack of a standardized method to prove credibility, since different researchers might have either disregarded it completely, or used combinations of triangulation, face validity, inter-rater reliability, member checking, category formation, and even content analysis as checks for credibility [11].

Results and Discussion

From a total of 150 responses by advanced-placement first-year students, 90% described critical incidents with positive outcomes and 10% described negative outcomes. For the 96 responses from transfer students, 69% indicated positive outcomes, and 31% contained negative outcomes. For all of the positive outcomes, the distribution between first-year and transfer students was 67% for first-year and 33% for transfer students. The combination of negative outcomes for both groups yielded 33% for first-year and 67% for transfer students. Therefore, it would seem that the first-year students were more likely to recall critical incidents involving virtue ethics in which they acted for the benefit of others rather than to the detriment of others. The transfer students seemed to exhibit the opposite effect, although these results might have been different with a sample containing a larger number of transfer students.

The distribution of responses containing elements of Chun's six themes for virtue ethics is shown below:

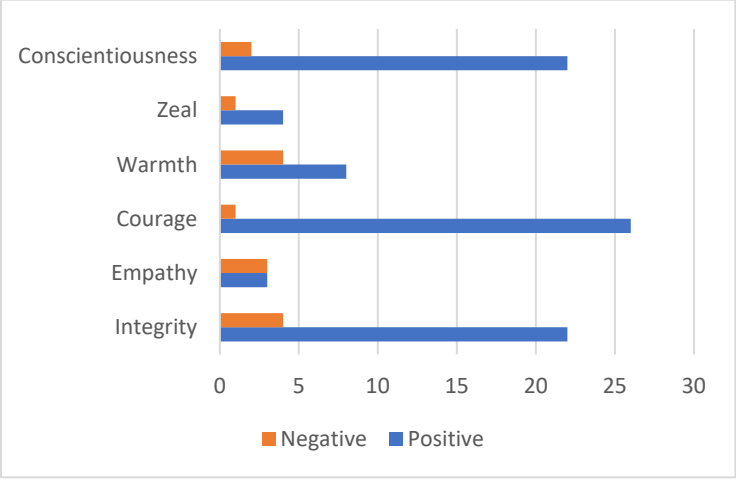

Figure 1: Chun's virtue ethics elements for first-year students

Similarly, the distribution of transfer students' responses appears in Figure 2:

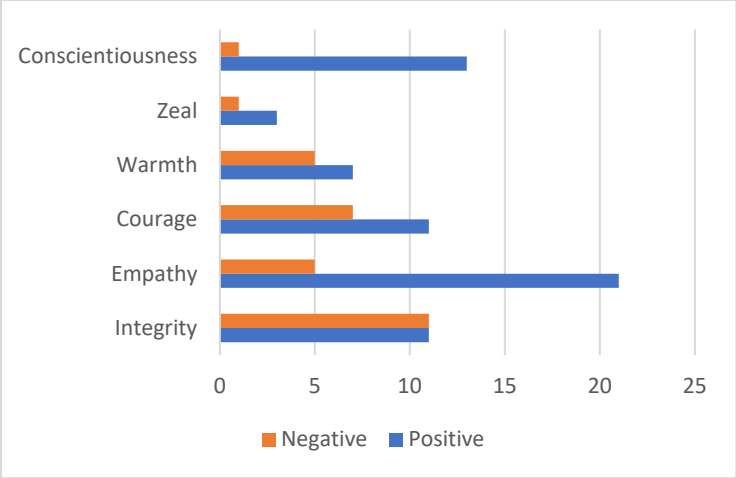

Figure 2: Chun's virtue ethics elements for transfer students

Figures 1 and 2 show that the first-year students' responses exhibited attributes of Integrity, Courage, and Conscientiousness with more than 20 responses for these themes, while the majority of transfer students' responses lay with Empathy and Conscientiousness. In addition, transfer students also demonstrated far more Empathy in positive- and negative-outcome responses than first-year students. For their part, first-year students more strongly demonstrated Integrity and Courage in their positive-outcome responses than transfer students, but the transfer students' negative-outcome responses were greater in number than those of their first-year counterparts.

Overall, there were considerably more responses with positive outcomes than with negative ones, from both first-year and transfer students. This finding supports the assertion that most teenage and young adult students care about how others would regard their actions and would want others to view their actions as beneficial rather than detrimental. However, while the percentages of responses with positive vs. negative outcomes is encouraging for both groups of students, the relatively large difference in the two sample sizes could influence the differences in percentages between them, as well as the differences in the number of responses for each of Chun's virtue ethics themes. These differences are illustrated in Tables 3 and 4 on the next two pages.

Certain differences in trends toward individual elements of Chun's virtue ethics themes emerged from closer scrutiny of the data, especially in the differences between the positive- and negative-outcome responses between first-year and transfer students.

First-year students exercised the Integrity theme most often with respect to Socially-Responsible actions for positive-outcome responses, where their actions seemed to be governed by societal norms for behavior in beneficial consideration of others. However, it was not clear from the students' responses whether or not the other people involved in the incident had any influence on how a particular student acted, because the student described only what they did.

The difference in sample size could explain why there was a greater number of themes and elements for first-year than for transfer students, as shown in Table 3, or conversely, as shown in

Table 4. However, the greater variety of negative outcomes for transfer students than for first-year students is either notable and could depend on shortcomings in the critical incident method and/or virtue ethics model employed, or it could be random.

Based on these results, it could be argued that the critical incident method may not be suitable for use with college students. As mentioned above, sample size of transfer students could also be a factor. However, this method has been used in a wide variety of professional fields, from communication to medicine, and Flanagan stipulated that specific methods of inquiry and analysis could be adapted to the conditions of each field [9], [11].

Another reason for this difference could lie with the limited number of themes and corresponding elements in Chun's virtue ethics model [12], [13]. The Chun model was informed by at least seven other frameworks or traditions, but may be too limited to fully describe the data in this study [12]. One of Chun's sources was Solomon's work in business ethics, from which he developed a more elaborate model with detailed descriptions of the ethical themes and elements that he had identified [18], [19]. Solomon's approach was also extended by Shanahan and Hyman [2].

Table 3: Predominant Themes and Elements for Responses with Positive Outcomes

Student Type	***Theme***	***Element***	***Example Response***
First-Year	Integrity	Socially Responsible	My friend was struggling to carry groceries, so I left my other friends while I was playing basketball with them to help him carry all of it to his apartment on the third floor.
First-Year	Courage	Competent	I choose certain clothes to wear to show people that I'm more put together with nicer clothing.
First-Year	Conscientiousness	Reliable	My senior year of high school, I did not want to play baseball because I had burned out, reached a plateau, and was injured. However, I decided to join the team anyway to show people that my "virtue" was not a quitter, and I could show commitment to my extracurriculars.
First-Year	Conscientiousness	Hardworking	At work I took on a task voluntarily so my managers would know that I was actively trying in the job, showing that I'll go the extra mile.
Transfer	Empathy	Concerned	When I wanted to approach an old friend when I was with my friend, I wasn't going to do it at first as he might have thought it would be rude, but I did it anyways. It turns out, it wasn't rude at all, and they also talked with each other.
Transfer	Conscientiousness	Hardworking	When I decided to transfer because I wanted to prove myself capable of achieving my goals and to show others that I'm hardworking and can achieve my goals.

Table 4: Predominant Themes and Elements for Responses with Negative Outcomes

Student Type	***Theme***	***Element***	***Example Response***
First-Year	Integrity	Honest	I once told someone I liked Pitbull. I don't like his music, but I didn't want them to not know I didn't like his music because who doesn't like Pitbull.
First-Year	Warmth	Friendly	Back in high school, I got behind in one of my classes and wanted to work to catch up. However, my friends wanted to hang out with me. I wanted to avoid the stigma of being a "nerd" (although in hindsight, they would've understood why I stayed) so I went with them so I would be perceived as a fun guy.
Transfer	Integrity	Honest	I've made decisions based on whether or not people will think I'm not smart. I've pretended to know something when I really didn't because I didn't want to be judged.
Transfer	Integrity	Sincere	One time I crossed the line and let a project fail on a team to spite one person. I crossed the line because I didn't put my recommendations first and acted in a self-interest way. This drove a rift within the team and did not demonstrate any positive virtue by me. I suppose that I wanted to show that I meant business, but I think all it showed was vindictiveness.
Transfer	Courage	Ambitious	During a robotics competition we had to select another team which would team up with. I thought a low ranked team would be better for us than other high ranked teams. But the team was low ranked. So, I selected a team that had a higher team ranking, because I thought my teammates would think lowly of me. Looking back at it now, we should have selected the low ranked team.
Transfer	Courage	Achievement-Oriented	This virtue was downgraded to something "noble," since it was out of fake morals of a fake accomplishment. During summer camp I cheated in archery and was given praise for becoming one of the best (but it was all a lie).

Conclusions and Recommendations

We have presented the results from our study of engineering students' responses to a survey question about the exercise of virtue ethics through the recall of critical incidents involving ethical decisions and their rationale with respect to this framework. These methods of inquiry were informed by prior studies with adults, as reported in the literature. Our next step is to administer the same survey question to a more homogeneous study sample consisting of first-year students in their second semester of college, instead of the relatively small sample size and mixture of both first-year and transfer students. A larger study scope and sample might also give us the opportunity to explore the dichotomy between how students care about and feel responsible for the welfare of others vs. a lack of concern for how their actions are perceived by others. To what extent could engineering students act altruistically, without regard for how others view them?

The methods and results from this study will also inform the content and delivery of our engineering ethics unit, especially with respect to the meaning of the virtue ethics framework and its guided practice by the students. Both content and delivery would become clearer and more concise, with the supporting literature employed to help students to better understand what this framework is and how to apply it.

In addition, the virtue ethics scale developed by Solomon and further promoted by Shanahan and Hyman could be applied to a larger and more homogeneous study sample of similar students and its results compared to the results from this study [2], [18], [19]. This comparison may help to determine whether our current research methods had introduced too many variables to yield conclusive results.

Our intent is to provide engineering students with a fundamental understanding of the variations in ethical frameworks and their practice, to augment their familiarity with the NSPE Code of Ethics for Engineers [6]. The Code stipulates that engineers act in all ways for the benefit and welfare of the public, in specific ways that correspond to Chun's virtue ethics themes of integrity, courage, and conscientiousness [12], [13].

References

[1] J. McCracken, W. Martin, and J. Shaw, "Virtue ethics and the parable of the Sandhu," *Journal of Business Ethics*, vol. 17, pp. 25–38, 1998.

[2] K. J. Shanahan and M. R. Hyman, "The development of a virtue ethics scale," *Journal of Business Ethics*, vol. 42, pp. 197–208, 2003.

[3] R. Chun, "Ethical character and virtue of organizations: an empirical assessment and strategic implications," *Journal of Business Ethics*, vol. 57, pp. 269–284, 2005, doi: 10.1007/s10551-004-6591-2.

[4] J. M. Doris, "Persons, situations, and virtue ethics," *Nous*, vol. 32, no. 4, pp. 504–530, Dec. 1998.

[5] E. Agnew Cochran and D. F. Weaver, "Can virtue be learned? An exploration of student learning experiences in ethics courses and their implications for influencing moral character," *Teaching Theology & Religion*, vol. 20, no. 3, pp. 243–256, 2017, doi: 10.1111/teth./12392.

[6] National Society of Professional Engineers, "NSPE code of ethics for engineers," Alexandria, VA, 2024. Accessed: Jan. 19, 2024. [Online]. Available: https://www.nspe.org/resources/ethics/code-ethics

[7] W. Sinnott-Armstrong, "Consequentialism," *Stanford Encyclopedia of Philosophy*. Stanford Center for the Study of Language and Information, Stanford, CA, p. 12, Oct. 04, 2023. Accessed: Jan. 19, 2024. [Online]. Available: https://plato.stanford.edu/entries/consequentialism

[8] M. Mallinger, "Decisive decision making: an exercise using ethical frameworks," *Journal of Management Education*, vol. 21, no. 3, pp. 411–417, 1997.

[9] J. C. Flanagan, "The critical incident technique," *Psychological Bulletin*, vol. 51, no. 4, pp. 327–358, 1954.

[10] K. FitzGerald, N. S. Seale, C. A. Kerins, and R. McElvaney, "The critical incident technique: a useful tool for conducting qualitative research," *Journal of Dental Education*, vol. 72, no. 3, pp. 299–304, Mar. 2008.

[11] L. D. Butterfield, W. A. Borgen, N. E. Amundson, and A. T. Maglio, "Fifty years of the critical incident technique: 1954-2004 and beyond," *Qualitative Research*, vol. 5, no. 4, pp. 475–497, 2005.

[12] R. Chun, "Ethical character and virtue of organizations: an empirical assessment and strategic implications," *Journal of Business Ethics*, vol. 57, pp. 269–284, 2005, doi: 10.1007/s10551-004-6591-2.

[13] R. Chun, "How virtuous global firms say they are: a content analysis of ethical values," *Journal of Business Ethics*, vol. 155, pp. 57–73, 2019, doi: 10.1007/s10551-017-3525-3.

[14] M. Byrne, "Critical incident technique as a qualitative research method," *AORN Journal*, vol. 74, no. 4, pp. 536–540, Oct. 2001.

[15] M. J. Bitner, B. H. Booms, and M. S. Tetreault, "The service encounter: diagnosing favorable and unfavorable incidents," *Journal of Marketing*, vol. 54, pp. 71–84, Jan. 1990.

[16] J. Van Doorn *et al.*, "Customer engagement behavior: theoretical foundations and research directions," *Journal of Service Research*, vol. 13, no. 3, pp. 253–266, 2010.

[17] W. R. Dunn and D. D. Hamilton, "The critical incident technique: a brief guide," *Medical Teacher*, vol. 8, no. 3, pp. 207–215, 1986.

[18] R. C. Solomon, "Corporate roles, personal virtues: an Aristotelian approach to business ethics," *Business Ethics Quarterly*, vol. 2, no. 3, pp. 317–339, 1992.

[19] R. C. Solomon, *A better way to think about business: how personal integrity leads to corporate success*. New York, NY: Oxford University Press, 1999.
[20] D. R. Krathwohl, "Chapter 8: sampling, representation and external generality," in *Methods of educational and social science research- the logic of methods*, 3rd ed., Long Grove, IL: Waveland Press, 2009, pp. 159–186.
[21] J. Stewart and F. Martinello, "Are transfer students different? an examination of first-year grades and course withdrawals," *Canadian Journal of Higher Education*, vol. 42, no. 1, pp. 25–42, 2012.
[22] Li, "They need help: transfer students from four-year to four-year institutions," *The Review of Higher Education*, vol. 33, no. 2, pp. 1–31, 2010.
[23] F. S. Laanen, "Transfer Student Adjustment," in *New Directions for Community Colleges*, vol. 114, San Francisco, CA: Jossey-Bass, 2001, pp. 5–13.
[24] B. A. Summers, "What were Aristotle's four cardinal virtues?" The Collector. Accessed: Jan. 30, 2024. [Online]. Available: https://www.thecollector.com/aristotle-four-cardinal-virtues/