Board 101: Compassion and Engineering Ethics: Validation of the Compassionate Engagement and Action Scales for the Engineering Education Context

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Abstract.

Compassion plays a crucial role in the development of ethical engineers and the engineering design process, as it fosters a commitment to creating solutions that prioritize the dignity, empowerment, and sense of security of individuals and society as a whole [1]. Sprecher and Ferh [2] describe compassion as a cognitive, affective, and behavioral process of recognizing self and others' suffering and feeling motivated to alleviate suffering. In other words, compassion is more than sympathy or empathy and has two components: engagement and action.

However, compassion may be overlooked in engineering ethics education because it is seen as personal rather than professional. This perception is related to the traditional idea that engineers should avoid emotional aspects of design to develop the most technically effective solutions to problems. This culture of emotional disengagement can inadvertently deter students from exploring and expanding their capacity for compassion. Avoiding compassion may reduce the capacity to thoroughly consider relevant ethical dimensions of a given design decision. In that order of ideas, there needs to be more methods and tools to understand the extent to which engineering students are inclined to engage in compassionate behaviors towards themselves and others.

This poster presents the early stages of a study that aims to validate the Compassionate Engagement and Action Scales developed by Gilbert et al. [3] for the context of engineering education so that compassion in engineering can be quantified and advocated for in a language that is often most relatable to STEM educators. The first step in this study consisted of a literature review of the psychometric validity and reliability evidence and the underlying construct definition to understand the strengths and scope of the instrument. Second, we followed an assessment through experts' judgment who scored the phrasing and adequacy for context and population, according to Jonsson and Svingb [4]. The final step was consolidating the findings in future strategies for the data collection and new research ideas. This adaptation is essential to ensure the instrument is meaningful to engineering students and accurately measure their compassionate engagement and actions.

The validation of this survey will facilitate new research paths in engineering education, enabling a better understanding of the factors that influence compassionate behaviors and how they can be encouraged. This study recognizes the importance of compassion in engineering education and aims to provide a

quantifiable framework for assessing compassionate engagement and actions among engineering students. This research seeks to bridge the gap between traditional engineering values and the need for a more caring, aware, and engaged engineering community by adapting the Compassionate Engagement and Action Scales to the engineering context. The results may facilitate new research pathways within engineering education (i.e., What factors influence compassionate behaviors, and how can they be encouraged?). Ultimately, the study advocates for a broader approach to engineering ethics that embraces compassionate values in the conception, design, and implementation of engineering projects.

Introduction.

In engineering, the prevailing discourse often concerns technical proficiency, innovation, and ethical considerations. Rarely, however, is compassion explicitly acknowledged as a foundational value within the engineering profession. According to Gilbert [3], compassion is a sensitivity to suffering in oneself and others and a steadfast commitment to alleviate and prevent that suffering. Drawing from the ethical framework proposed by Campbell [5], which defines care as "active compassion, empathy, and concern for the well-being of other living (and in some cases non-living) things" [p. 112], this paper explores compassion as an essential component of ethical engineering practice.

While engineering ethics has traditionally emphasized the importance of reflecting on the broader consequences of technological advancements, compassion extends beyond cognitive reflection. It embodies a motivational force beyond empathy and sympathy [3], driving engineers to translate ethical considerations into concrete, reflective actions that mitigate technology's adverse societal effects. Noteworthy scholars such as Williams [6] and Berne [7] have highlighted the teachability of compassion within the engineering context. Williams views compassion as a means to alleviate suffering and a fundamental element of care education can impart. Berne, conversely, sees compassion as a skill that can contribute to social justice, sustainability, and human well-being when integrated into engineering education and practice.

By investigating the integration of compassion as a core engineering value, this paper aims to contribute to the ongoing discourse on ethics in engineering education, emphasizing the potential of compassion to generate designs that prioritize the security, empowerment, and dignity of end-users [1]. Following Gilbert et al. [3], we conducted the early stage of assessment of the Compassionate Engagement and Action Scales (CEAS), which can be used to evaluate compassion's caring motivational processing and the competencies required for integration into engineering education. Through this exploration, we hope

to pave the way for a paradigm shift in engineering education, fostering a generation of engineers who excel in technical prowess and embody a profound commitment to compassionate and ethical practice.

The Compassionate Engagement and Action Scales for Self and Others.

Gilbert et al. [3] crafted the Compassionate Engagement and Action Scales for self and others to evaluate different dimensions of compassion. Developed within the evolution-informed motivational competencies approach, these scales focus on competencies related to *engaging* with and taking *actions* to alleviate distress. The CEAS is structured around three core orientations: compassion for others, compassion from others, and self-compassion. Table 1 presents the description of each competence associated with the orientations of compassion, according to the CEAS.

Table 1.

Competencies associated with each orientation of compassion.

Orientation	Competence	Description
Compassion for Others	Engagement	Competencies related to turning towards and emotionally connecting with the suffering of others.
	Action	Competencies related to taking actions to alleviate and prevent the suffering of others.
Compassion from Others	Engagement	Competencies related to turning to others and experiencing them as helpful, creating a sense of social context.
	Action	Competencies related to the capacity to elicit compassion from others and being responsive rather than defensive when offered help and compassion.
Self-Compassion	Engagement	Competencies related to being sensitive to and emotionally moved by one's suffering or distress.
	Action	Competencies related to taking actions to alleviate one's suffering and being responsive to oneself with compassion.

The initial psychometric validation of the CEAS involved extensive testing, including *exploratory factor analysis* (EFA) in a British sample and *confirmatory factor analysis* (CFA) in samples from the USA and Portugal. The scales demonstrated robust validity, reliability, and temporal stability. Subsequent psychometric studies confirmed these qualities, including diverse samples from the USA, UK, and Australia. The CFA indicated an adequate fit based on various criteria, including chi-square, RSMEA,

CFI, IFI, SMRS, and Cronbach's alphas ranged between .70 and .96 for scales and subscales, meaning that internal consistency of the instrument varies between acceptable and excellent. In addition, the CEAS exhibits positive correlations with positive affect, life satisfaction, and other compassion measures. Simultaneously, it shows negative correlations with depression, anxiety, stress, and self-criticism. The flexibility of the scales allows researchers and practitioners to use them either as single-factor scales or as separate engagement and action factors for in-depth exploration of each compassion orientation.

Research question.

The development and validation of the CEAS present an invaluable tool for comprehensively assessing compassion's multifaceted nature. This instrument sheds light on how individuals, particularly in engineering education, might engage with and address distress across diverse contexts. By employing the CEAS, we may gain insights into engineers' approaches to problem-solving, thereby informing the design and implementation of educational initiatives that prioritize human-centered solutions. The overarching research question driving this project is: "What is the evidence of validity and reliability of the Compassionate Engagement and Action Scales in the context of engineering education, and how are its attributes distributed among American engineering undergraduate students?" However, this poster paper focuses explicitly on the initial stages of the study, addressing the question: "What are the content validity agreement scores of the Compassionate Engagement and Action Scales for Self and Others in engineering education, as evaluated by experts?"

Methods.

To gauge the comprehensibility of the CEAS within the context of engineering education, we validated the clarity and adequacy of the context and population with experts in the field. This validation involved seeking the expertise of professionals to evaluate the instrument and determine the *agreement percentage* among their responses, which is one of the methods mentioned by Johnson and Svingby [4]. Three engineering undergraduate professors, each holding a doctoral degree and being native English speakers, were selected from Purdue University, St. Vincent College, and The California Institute of Technology (Caltech) to serve as expert evaluators. These individuals were contacted via email and given explicit instructions to evaluate the clarity of CEAS items within the context of engineering education. We organized all CEAS items in a Google Sheet to facilitate the evaluation process, with subsequent columns indicating the dimension and subdimension of each item. An additional column was assigned to assess clarity, while a final column allowed for comments on writing, phrasing, and any other concerns. Each item underwent evaluation based on a scale that included scores such as: "1-The item is unclear," "2-The item requires significant modifications or a major revision in the use of words according to their meaning

or arrangement," "3-Very specific modification of some terms in the item is needed," and "4-The item is clear, with appropriate semantics and syntax."

We received two comprehensive assessments and, as a result, exclusively incorporated the data from these evaluations into the quantitative analysis to derive the results. For the quantitative assessment, data analysis involved calculating the agreement percentage as an indicator of inter-rater reliability by summing the values assigned by each evaluator to the item over the sum of the maximum possible scores for that particular item [8]. This process was carried out for all 30 items under consideration. During the analysis of these results, we used a minimum score of 70%, according to Stemler [9], which indicates that the evaluators considered adequate and appropriate clarity and phrasing of the item to the context and population of engineering education. Conversely, incomplete information from the third evaluator was also considered in the qualitative data analysis. We employed a thematic analysis approach to identify recurring themes and patterns in the qualitative feedback provided. This dual-method approach allowed for a comprehensive examination of quantitative and qualitative aspects, providing a nuanced understanding of the CEAS instrument in engineering education.

Results.

All the items present a high clarity and phrasing to be implemented with engineering students. The most agreement is in *self-compassion* (97%), followed by *compassion to others* (93%), and finally, *compassion from others* (88%). Additionally, the subdimensions of *engagement* have higher scores (94%) than *action* (91%). Table 2 summarizes the agreement percentages for each item.

Table 2.

Item-specific agreement percentages for implementing the Compassionate Engagement and Action Scales (CEAS) in engineering education settings

Dimension Subdimension	Item	Compassion to Others	Compassion from Others	Self-compassion
Engagement	1	100	87.5	100
	2	87.5	87.5	100
	3	87.5	87.5	100
	4	87.5	87.5	87.5
	5	100	87.5	100
	6	100	87.5	100
Action	7	87.5	87.5	87.5
	8	100	87.5	87.5

	9	75.0	87.5	100
	10	100	87.5	100
Engagement total		93.8	87.5	97.9
Action total		90.6	87.5	93.8
Total		92.5	87.5	96.3

In terms of qualitative findings, several recurring themes have surfaced. Evaluators consistently observed that three specific items simultaneously requested information about different situations. They recommended dividing the content into distinct items to enhance clarity and precision. Additionally, concerns have arisen regarding the precise conceptual identity of *engagement* and *action*, prompting reflections on potential distinctions between these terms. Despite the instrument's intention to differentiate private events from public events, grouping emotions, feelings, and thoughts within the same subdimension has sparked ontological uncertainties. On the other hand, the term *others* has emerged as a point of discussion, with evaluators seeking clarification on its meaning in this context and the intentions behind its inclusion in the evaluation. A common query revolves around whether *others* refer to *all others* and if it is necessary to specify the exploration to a particular instance of others. Furthermore, evaluators have recommended avoiding an informal language register in the phrasing of items, emphasizing the significance of maintaining a formal and professional tone throughout the evaluation instrument. These qualitative insights shed light on areas where refinements may enhance the overall clarity and effectiveness of the CEAS within an engineering education context.

Discussion and Future Work.

In light of the feedback from expert evaluators, implementing the CEAS with engineering students is a viable next step. However, a critical prelude to this involves a meticulous review of the instructions for each dimension, with particular emphasis on refining the definition of "others" to ensure adequacy, appropriateness, and clarity for the intended audience. Additionally, considering the collected information from students, conducting psychometric analyses becomes a plausible approach to assess the CEAS's validity and reliability. These analyses will serve the dual purpose of addressing the concerns raised by expert evaluators regarding how engineering students might interpret the items when responding to the instrument. Despite this, it is worth noting that the CEAS boasts a robust foundation, demonstrating excellent validity in prior psychometric studies spanning various domains, including psychosocial and healthcare settings. This strong basis instills confidence in applying the CEAS within the engineering student population, anticipating a seamless integration with minimal challenges.

The results may facilitate new research pathways within engineering education (i.e., What factors influence compassionate behaviors, and how can they be encouraged?). Ultimately, the study advocates for a broader approach to engineering ethics that embraces compassionate values in the conception, design, and implementation of engineering projects. Nevertheless, in the future, once the CAES is implemented, the results can be cross-referenced with specific educational and psychosocial variables, offering additional insights into how the evaluation outcomes are related to the design reasoning and various factors, and enriching our understanding of the interplay between academic skills and broader contextual elements.

References.

[1] P. Seshadri, C. H. Joslyn, M. M. Hynes, and T. Reid, "Compassionate design: considerations that impact the users' dignity, empowerment and sense of security," *Des. Sci.*, vol. 5, p. e21, 2019, doi: 10.1017/dsj.2019.18.

[2] S. Sprecher and B. Fehr, "Compassionate love for close others and humanity," *J. Soc. Pers. Relatsh.*, vol. 22, no. 5, pp. 629–651, Oct. 2005, doi: 10.1177/0265407505056439.

[3] P. Gilbert *et al.*, "The development of compassionate engagement and action scales for self and others," *J. Compassionate Health Care*, vol. 4, no. 1, p. 4, Dec. 2017, doi: 10.1186/s40639-017-0033-3.

[4] A. Jonsson and G. Svingby, "The use of scoring rubrics: Reliability, validity and educational consequences," *Educ. Res. Rev.*, vol. 2, no. 2, pp. 130–144, Jan. 2007, doi: 10.1016/j.edurev.2007.05.002.

[5] R. C. Campbell, "How can engineering students learn to care? How can Engineering faculty teach to care?," *Eng. Educ. Soc. Justice Crit. Explor. Oppor.*, pp. 111–131, 2013.

[6] C. R. Williams, "Compassion, suffering and the self: A moral psychology of social justice," *Curr. Sociol.*, vol. 56, no. 1, pp. 5–24, 2008.

[7] R. W. Berne, "Global vision, technological skills, and systems thinking are essential qualities for peace engineering. Compassion too?," presented at the 2018 World Engineering Education Forum-Global Engineering Deans Council (WEEF-GEDC), IEEE, 2018, pp. 1–6.

[8] A. A. Bryington, D. J. Palmer, and M. W. Watkins, "The estimation of interobserver agreement in behavioral assessment.," *Behav. Anal. Today*, vol. 3, no. 3, p. 323, 2002.

[9] S. E. Stemler, "A comparison of consensus, consistency, and measurement approaches to estimating interrater reliability," *Pract. Assess. Res. Eval.*, vol. 9, no. 4, 2004, doi:

10.7275/96JP-XZ07.