Board 35: Assessing Students' Perspectives and Attitudes Toward Social Justice and Compassion in Civil Engineering (Work in Progress)

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Abstract

Civil engineering works have the potential to exert long-term effects on society's fabric in ways that are not fully understood in the early phases of the systems development cycle. Despite this potential, civil engineering education has much room for improvement in training students on the social implications of engineering works, particularly how engineering can shape social vulnerability under climate change, natural hazards, and aging infrastructure, and on the power structures that contribute to the generation of systematic social injustices. This work-in-progress presents the results of the first stage of a broader study aimed at developing curricular interventions that build social justice awareness and compassion amongst students in the Lyles School of Civil Engineering at Purdue University. We followed a convergent mixed methods study (QUAN-qual), collecting quantitative and qualitative data through two questionnaires, one for social justice and another for compassion.

For the quantitative part, we used an ad-hoc survey that assessed the perspectives and attitudes of undergraduate and graduate students towards social justice behaviors and compassion; this last one is considered a precursor of social justice. The questionnaire was structured in three sections guided by three published surveys: 1) an adaptation of the Social Justice Perspective Survey (SJPS) related to perspectives on the role of social justice in engineering practice and previous experiences; 2) the Social Justice Attitudes sub-scale from the Social Justice Scale (SJS), and 3) the Compassion to Others subscale from the Compassionate Engagement and Action Scales for Self and Others. Additional open-ended questions were incorporated into the questionnaire to get feedback on participants' previous experience with social justice themes in the civil engineering program and their conception of social justice. Respondents completed the questionnaire voluntarily. We expect that the results of this work will inform the following stages of the study, in particular guiding the identification of learning objectives for a pilot curriculum to be delivered in Spring 2023 and serving as a baseline to measure future pedagogical interventions related to this topic.

Introduction

Civil engineering and human societies are inextricably linked. Civil engineering deals with the planning, design, construction, and maintenance of civil infrastructures that enable public services essential to society such as transportation and mobility, water and energy supplies, public health and safety, and buildings for human habitation and economic activities [1]. At the same time, these infrastructures are hard to change, costly to develop, and are long lasting (for decades and centuries) once established, meaning that they have the potential to exert broad and long-term influence on the health and economic and social fabric of human societies [2]. For these reasons, today’s decisions on civil engineering works can have substantial influence on the culture and distributional outcomes in societies, and such outcomes, in turn, can feed back to shape how infrastructures are re-produced for whom and where. Yet, despite the potential, civil engineering as a profession, and more importantly as a field of engineering education, still has much room for improvement in training students on the long-term social implications of civil engineering works, particularly how engineering can shape distributional outcomes and social justice under climate change, natural disasters and aging infrastructure [2].

Current civil engineering curricula at most universities in the U.S. are centered on science and engineering problem solving and include exposure to topics such as engineering economics and engineering ethics. This is critical for building the core competencies needed for the civil engineering profession. However, there are also concerns that this core competency is *incomplete* without engineers becoming more aware of long-term implications of their engineering work on society, especially those concerning how costs and benefits of civil engineering projects are distributed across different social groups and affect their wellbeing in the long-run [3]. For example, it has been argued that engineering education should put greater emphasis on engineers' social responsibility toward "an equal distribution of rights, opportunities, and resources in order to enhance human capabilities and reduce the risk and harms among the citizens of a society" [4, p. 10]. Thus, *complementary* education on social justice implications of civil engineering may benefit civil engineering education further.

We argue that integration of social implications of engineering as learning outcomes in civil engineering coursework requires, as a first step, the development of a baseline understanding of civil engineering undergraduate and graduate students' awareness of social justice, their perception of social justice, and their previous experiences with social justice-related educational content. Contributing to the development of this baseline knowledge is the objective of this paper. We conducted a survey to assess the awareness of these students towards social justice, their conception of social justice, and their previous educational experiences with social justice content in an academic setting. In addition, we recognize that social justice is related to questioning and changing the structures of power that underlie how distributional outcomes are decided in many situations [5]. Thus, civil engineering education can benefit from enhancing students' awareness of such power structures and how they manifest in civil infrastructure in ways that contribute to systematizing social injustice. An engineer's desire to address and change this power structure is what Williams has defined as "compassion." [6] We believe that compassion-focused engineering, i.e., training students on how the structures of power work, how to recognize when injustices occur through infrastructure design and outcomes, and how to empathize with the distress that others feel when injustice happens, has a place in civil engineering education.

In approaching this objective, we build on a corpus of existing knowledge that has been developed around assessing social justice attitudes and compassion in different fields: psychology [7]–[17], medical care [18]–[21], sociology [22], and education [23]–[25]. Much of these previous studies are based on undergraduate students in psychology or broader populations, such as adults or elders, instead of engineering students. Only the Engineering Social Justice Scale [26] and the Social Justice Perspective Survey [23] are focused on engineering faculty to assess their social justice attitudes and perceptions. However, these two surveys are designed for general engineering populations and thus do not incorporate some of the unique aspects of civil engineering works, i.e., their potential to exert broad and long-term influence on the health and economic and social fabric of human societies. To address these gaps, we modified and extended these latter two survey designs to better fit with civil engineering contexts. Then, we applied the resulting survey to the student population based in the Lyles School of Civil Engineering at Purdue University, one of the largest civil engineering programs in the US. We used the resulting

survey data to develop the baseline knowledge on social justice and compassion-related awareness and perception among the sample student population.

Methodology

We followed a convergent mixed methods study to assess the awareness of civil engineering undergraduate and graduate students towards social justice, how they conceive social justice, their previous experiences with social justice content, and their self-identification with compassionate behaviors [27]. We began by examining and comparing different survey instruments on the assessment of social justice and compassion attitudes (see Tables 1 and 2 in Appendix for the comparison of social justice-related instruments and compassion-related instruments, respectively). We evaluated the suitability of these candidate instruments by assessing them in five dimensions: purpose of the survey, target population, copyright fees for use, relation to engineering, and potential to be adapted to an engineering context. Our main criterion for selection was whether the questions in the instruments were amenable to being adapted to the civil engineering context. Based on this criterion, we excluded instruments that were heavily religion-based, community-based, activism-based, or advocacy-based. In the same way, compassion-related instruments developed from the patient's perspective, general perspectives around suffering, or self-compassion were omitted. This led to the selection of three questionnaires. The first, the Social Justice Perspective Survey (SJPS), was chosen as a means to understand the beliefs about social justice in engineering education. This survey is based on Cech's work on the factors that may contribute to engineers' disengagement with public welfare concerns, and has been applied to collect data about social justice content in engineering curricula [28]. Second, we selected the Engineering Social Justice Scale (ESJS) [26], which is based on the Social Justice Scale of Torres, Siers, and Olson [17]. This survey focuses on social justice attitudes. Third, we selected the Compassionate Engagement and Action Scales for Self and Others (CEASSO) [8], which is designed to measure compassion attitudes. All the chosen instruments are applicable and can be tailored to engineering faculty and students. Table 3 in the Appendix shows the characteristics of the questions in these questionnaires.

Next, we assessed the expected time length of the chosen survey instruments. The original form of the survey included 79 question items, which would take about 35 minutes to complete. We considered this to be a prohibitively long time, and sought ways to create a more concise version of the survey while not compromising the objective of our study. First, we eliminated the questions related to social justice actions. This was possible because our focus is more on how civil engineers think and feel about this topic rather than how they would behave. For example, we incorporated into our survey only the attitudes component of the ESJS. Second, we revised the content and format of some of the existing questions in the selected surveys. For example, we converted the SJPS questions on the importance of certain social justice-related topics from multiple choice to open-ended response. This was done to identify how the participants perceive social justice without a predetermined set of responses. Finally, we only considered the *compassion engagement and actions to others* component of the CEASSO because the other two components are related to self-compassion and compassion shown by others. Both of these components were out of our scope. The resulting more concise version of the survey consisted of 46 items organized into four sections: an English adaptation of the SJPS, the *attitudes towards the action* component of the ESJS, the *compassion engagement and actions to others* component

of the CEASSO, and a demographic information section. Where possible, we modified the questions to use the Likert scale (1-4, 1-7, 1-10) to facilitate later analysis.

We also tailored the questions to fit the civil engineering context. For instance, in the SJPS section concerning the *Beliefs regarding the engineering culture and the social role of the engineering profession,* we revised the item *Un ingeniero responsable educa a otros acerca de la temática medioambiental* (A responsible engineer educates others about environmental issues) to *A responsible civil engineer educates others about environmental issues associated with the planning, design and implementation of civil engineering projects*. This modification allowed us to capture not only civil engineers' responsibility and action but also the practice of civil engineering in relation to this action. In the same way, we adapted the items of the ESJS to civil engineers instead of general engineering. For example, the item *I believe it is important that engineers act for social justice* was modified to *I believe it is important that civil engineers act for social justice*. Table 3 in the Appendix presents a summary of these modifications.

Furthermore, two civil engineering faculty members reviewed and enhanced the updated survey design for validation. Three changes were made as a result of this process. First, the survey was split into two different sets of questionnaires (one mandatory and one optional) for greater efficiency by respondents. The survey was divided into the Social Justice Awareness Survey (SJAS) and Compassion Survey (CS) (Appendix). Respondents could access and complete the latter survey after the demography-related questions as an optional survey. Second, some questions were improved for greater understandability. The questions related to the *Relative importance of non- technical contents in engineering education* and the *Beliefs on the relationship between social justice and engineering practice* were modified. In the former category, instead of asking for the importance of specific contents, we asked for the importance of covering social issues and public implications in the civil engineering curriculum. For the latter category, we modified the questions to an open-ended format to better identify the perceived issues or aspects associated with civil engineering. Third, we added questions that explicitly inquire about the respondents' previous experiences with social justice-related educational initiatives in civil engineering and their perceptions about the curricular design of a pilot. These questions elicit information on respondents' previous exposure to social justice content, the type of exposure (course, assignment, workshop, etc.), the preferred format of course delivery, and who would be ideal instructors.

The revised versions of the SJAS and CS questionnaires were implemented in Qualtrics following IRB approval in Fall 2022. The sample population is undergraduate and graduate students of the Lyles School of Civil Engineering at Purdue University. We used email invites to recruit survey respondents. Their participation was voluntary and no monetary incentives were given.

Preliminary findings

For this work-in-progress, we used the dimensions proposed in the original instruments for analyzing and presenting the quantitative data collected. The preliminary results from the Social Justice Awareness Survey and the Compassion Survey are discussed separately below.

For the first, we focus on four main dimensions: beliefs regarding the civil engineering culture and the role of civil engineering in society, attitudes towards actions for social justice, factors

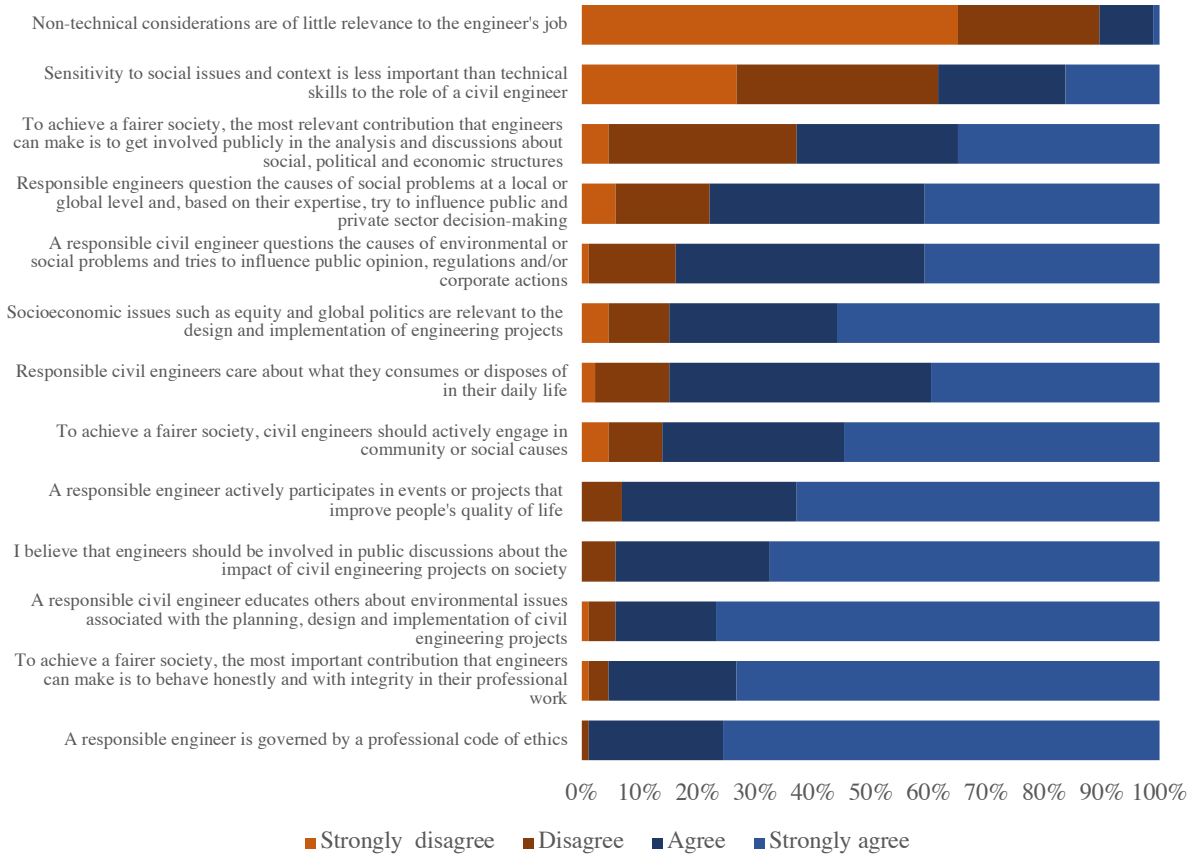
contributing to being a successful engineering professional, and importance of social justice content in civil engineering education. For the Compassion Survey, we present the results related to the *engagement with others' distress* dimension and the *inclination to act to alleviate others' distress* dimension.

86 current students from the Lyles School of Civil Engineering responded on a voluntary basis to the Social Justice Awareness Survey. 71 participants finished the questionnaire and provided demographic information. Of these, 52% self-identified as males, 45% as females, 1% as non-binary, and 1% preferred not to say. The participants were undergraduate students (n=44) and graduate students (n=27), mainly from the U.S. (n=51). Fifteen additional participants completed the survey but did not provide demographic information.

Social Justice Awareness Survey

Beliefs regarding the civil engineering culture and the role of civil engineering in society
Adapted from Jimenez, Pascual, and Mejia [23] – Likert scale 1-4. As illustrated in Figure 1, most participants tend to agree that civil engineers should be aware of the social and environmental problems that generate inequity, and engage in their solution.

Figure 1. Results pertaining to the *Beliefs regarding the civil engineering culture and the role of civil engineering in society*

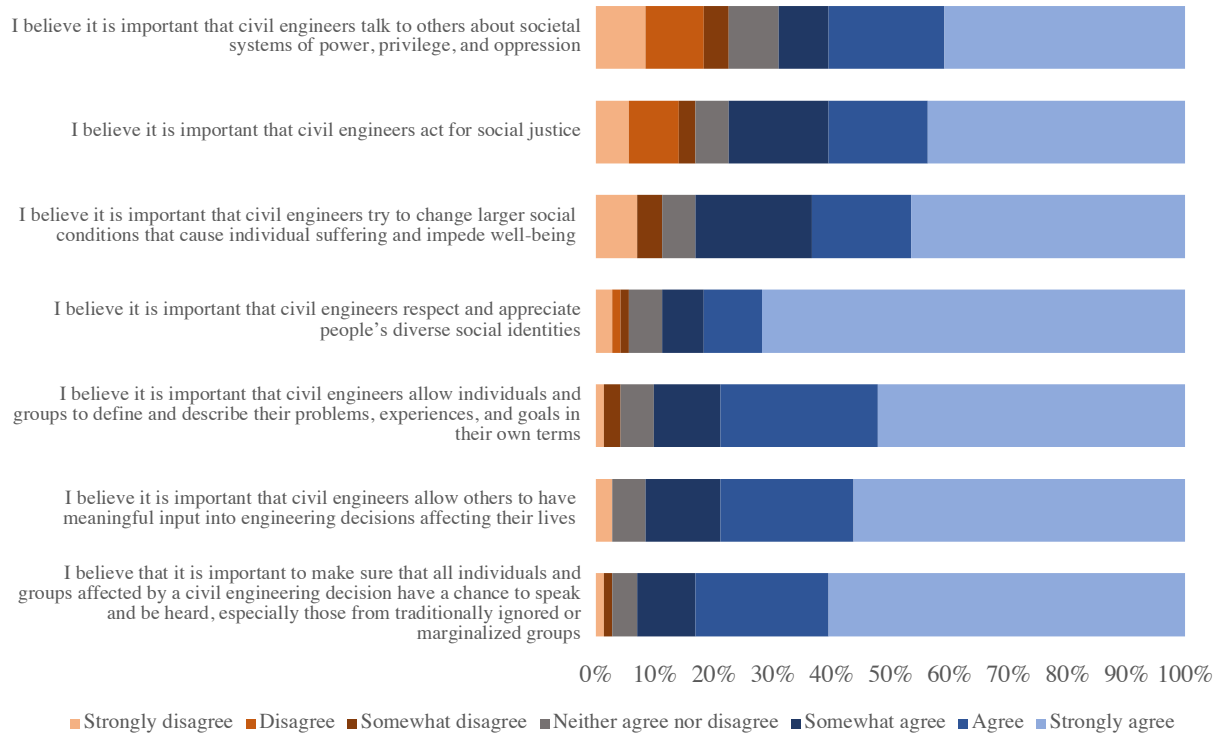


Note: Results pertain to the total of participants who provided the information (n=86)

This positive trend is mainly seen as being associated with traditional engineering ethics and professionalism, including the role played by engineers in educating the public. Slightly less agreement is expressed with statements that emphasize the role of the engineer as actively engaged in shaping and influencing public opinion and decision making, and questioning causes of social and environmental problems. The two statements for which the participants indicate less agreement relate to the importance that *sensitivity to social issues and context* and *public involvement in discussions of social, political and economic structures* have in the perceived role of a civil engineer.

Attitudes towards actions for social justice
Adapted from Lutz [26] –Likert scale 1-7. As shown in Figure 2, the responses suggest an agreement that, in their profession, civil engineers should respect and be sensitive to diversity and both allow and value input from individuals and communities affected by engineering decisions. However, the responses show less agreement with prompts that speak to civil engineers going beyond this to advocate for social justice and effect change.

Figure 2. Results pertaining to the A*ttitudes toward the actions of civil engineering concerning social justice*

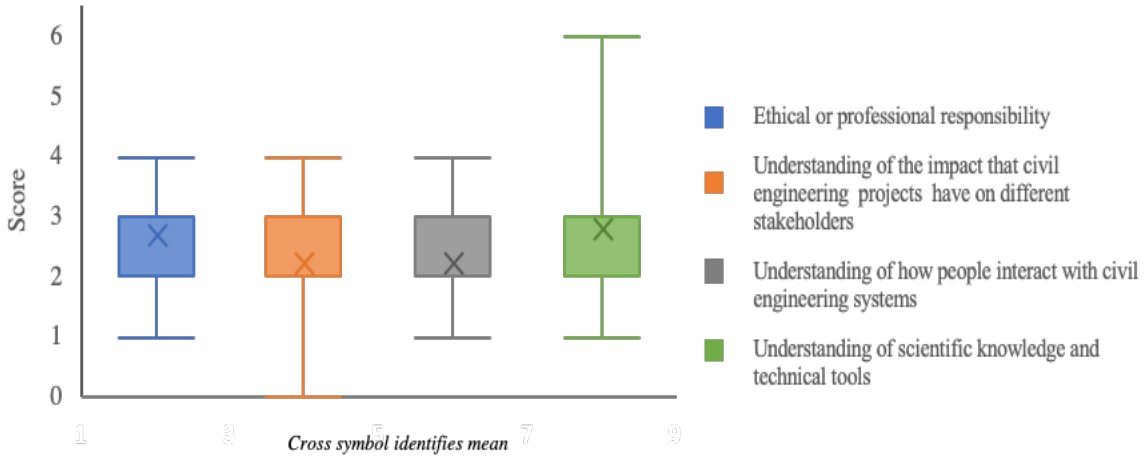


Note: Results pertain to the total of participants who provided the information (n=86)

Factors contributing to being a successful engineering professional
Adapted from Jimenez, Pascual, and Mejia [23] – Likert scale 1-4. The participants were asked to score four factors that are believed to be important to the civil engineering profession. According to the responses, the participants place more weight on scientific knowledge and technical tools (*M*=2.83; SD=1.12) and on ethical and professional responsibility (*M*=2.69;

SD=0.79) as contributing factors to being a successful engineer. While they place slightly lower value on factors concerned with understanding the interaction of people with civil engineering systems (M=2.25; SD=0.74) and the impact of civil engineering systems on different stakeholders (*M*=2.23; SD=0.80), overall these results suggest the participants of this survey are generally sensitive to the social aspects of civil engineering (Figure 3).

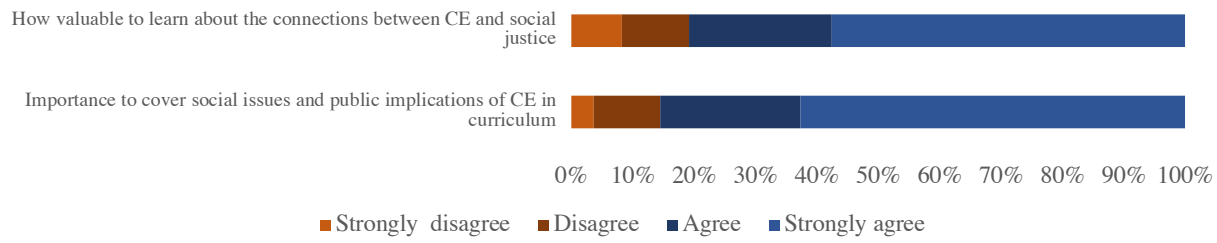
Figure 3. Results pertaining to the *Factors contributing to being a successful engineering professional*



Importance of social justice content in civil engineering education

Over 80% of the participants responded positively regarding the inclusion of content related to social justice and to the societal impacts of civil engineering in the civil engineering curriculum (Figure 4). This speaks to the potential of positive acceptance of the future pilot.

Figure 4. Results pertaining to the *Importance of social justice contents in civil engineering education*



Note: Results pertain to the total of participants who provided the information (n=86)

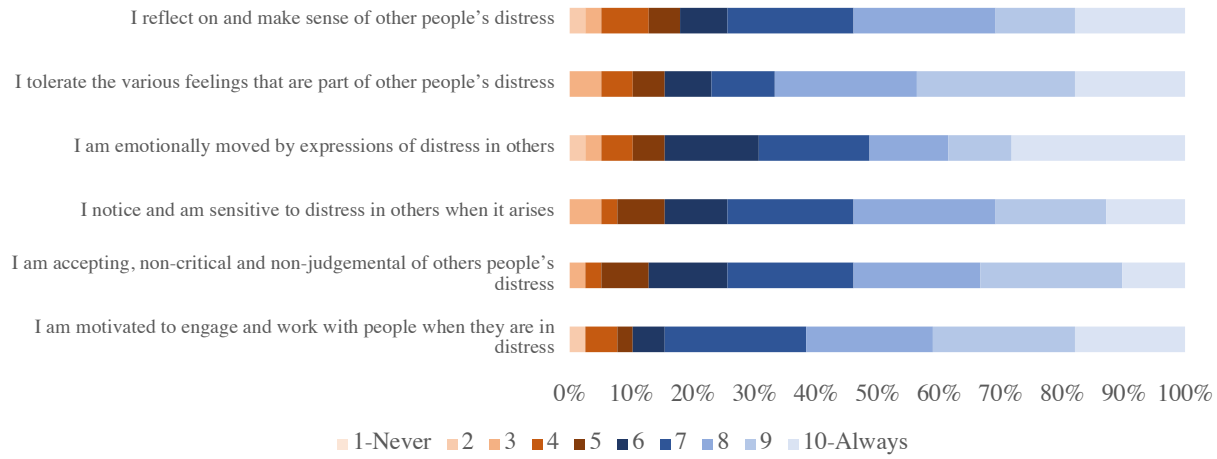
Compassion Survey

For this part of the study we used the Compassionate Engagement and Action sub-scales for others [8]– Likert scale 1-10. 39 participants (54.9%) opted to respond to the Compassion to Others sub-scale. 38 shared their demographic information. Of these, 58% self-identified as males, 37% as females, 2% as non-binary, and 3% preferred not to say. The participants were undergraduate students (n=21) and graduate students (n=17), mainly from the U.S. (n=25).

Engagement with others' distress

The responses suggest that the participants self-identify as individuals who are sensitive to distress and motivated to help those experiencing distress. This includes accepting and responding empathetically to others' distress and being motivated to continue the relationship with them (Figure 5).

Figure 5. Results pertaining to the *Compassion to Others subscale - Engagement*

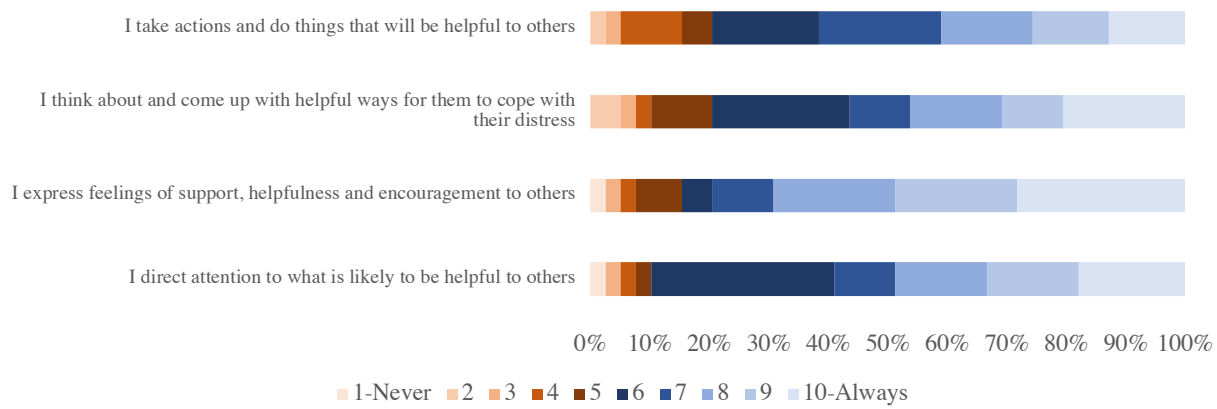


Note: Results pertain to the total of participants who provided the information (n=39)

Inclination to act to alleviate others' distress

Finally, the participants are prone to express their feelings of support and pay attention to help alleviate others' distress. However, the responses indicate that participants less frequently take action to help (Figure 6).

Figure 6. Results pertaining to the *Compassion to Others subscale - Actions*



Note: Results pertain to the total of participants who provided the information (n=39)

Discussion and future work

Most of the undergraduate and graduate students who responded to the surveys exhibit positive attitudes toward understanding social problems as individual civil engineers. Similarly, the responders of the Compassion for Others subscale indicate a willingness to empathize with the distress that others manifest. However, when asked to go beyond the cognitive and emotional levels to take action (advocate, talk, plan to act, or act), responders showed themselves slightly less prone to engage. Among the potential reasons is that engineering students may have an interest in helping but not know how to do it, as emerged from a previous study [29]. This may also derive from a strong belief in economic individualism and work ethics as Jimenez, Pascual, and Mejia found in engineering faculty [23]. Overall, this result resonates with Jimenez, Pascual, and Mejia who found that the engineering professors who participated in their study "associate the responsibility of engineers with an individual behavior that respects professional laws and regulations, more than with the behaviors in which engineers act together with other agents to solve community problems." [23, p. 87]. A round of interviews could help unveil the reasons behind these responses.

This work-in-progress did not compare the responses among different populations. Identifying the similarities and differences between undergraduate and graduate students and genders would be valuable. This deeper analysis will require the use of the lenses of the engineering mindsets [3] and the engineering ideologies [28] to unveil possible causes that serve as barriers of social justice attitudes in civil engineering students.

The qualitative questions of this questionnaire focused on students' conception of social justice, their previous exposure to social justice content during their civil engineering education, and their views of whether this type of content might be best delivered in focused form or embedded in other coursework. Analysis of these data is planned as part of future work. We expect that students' perspectives will be an invaluable resource in identifying ideas, pedagogical models, learning objectives, and means to deliver content during the design and implementation of the pilot curriculum. Our educational perspective is founded on the idea that students' input in a collaborative curriculum design is critical not only to the pilot's success, but also, and more importantly, to achieving a more just civil engineering.

References

[1] U.S. Bureau of Labor Statistics, "Civil Engineers - Occupational Outlook Handbook." https://www.bls.gov/ooh/architecture-and-engineering/civil-engineers.htm#tab-1 (accessed Feb. 28, 2023).

[2] H. Said, V. Y. Jessica Ngo, and K. Bezrukova, "Introducing Civil Engineering Students to Ethical Infrastructure Development: Toll Road Design Exercise," in *Construction Research Congress 2016*, San Juan, Puerto Rico, May 2016, pp. 99–109. doi: 10.1061/9780784479827.011.

[3] D. Riley, *Engineering and social justice*. Cham, Switzerland: Springer, 2008.

[4] J. C. Lucena, *Engineering education for social justice: critical explorations and opportunities*. Dordrecht: Springer, 2013.

[5] M. Adams and L. A. Bell, Eds., *Teaching for Diversity and Social Justice*, 0 ed. Routledge, 2016. doi: 10.4324/9781315775852.

[6] C. R. Williams, "Compassion, Suffering and the Self: A Moral Psychology of Social Justice," *Curr. Sociol.*, vol. 56, no. 1, pp. 5–24, Jan. 2008, doi: 10.1177/0011392107084376.

[7] A. F. Corning and D. J. Myers, "Individual Orientation Toward Engagement in Social Action," *Polit. Psychol.*, vol. 23, no. 4, pp. 703–729, Dec. 2002, doi: 10.1111/0162-895X.00304.
[8] 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.
[9] J. Y. Hwang, T. Plante, and K. Lackey, "The Development of the Santa Clara Brief Compassion Scale: An Abbreviation of Sprecher and Fehr's Compassionate Love Scale," *Pastor. Psychol.*, vol. 56, no. 4, pp. 421–428, Mar. 2008, doi: 10.1007/s11089-008-0117-2.
[10] J. M. Marszalek, C. Barber, and J. E. Nilsson, "Development of the Social Issues Advocacy Scale-2 (SIAS-2)," *Soc. Justice Res.*, vol. 30, no. 2, pp. 117–144, Jun. 2017, doi: 10.1007/s11211-017-0284-3.
[11] M. J. Miller *et al.*, "College students' social justice interest and commitment: A social-cognitive perspective.," *J. Couns. Psychol.*, vol. 56, no. 4, pp. 495–507, Oct. 2009, doi: 10.1037/a0017220.
[12] K. D. Neff, "The Development and Validation of a Scale to Measure Self-Compassion," *Self Identity*, vol. 2, pp. 223–250, 2003, doi: 10.1080/15298860390209035.
[13] J. E. Nilsson, J. M. Marszalek, R. M. Linnemeyer, A. D. Bahner, and L. H. Misialek, "Development and Assessment of the Social Issues Advocacy Scale," *Educ. Psychol. Meas.*, vol. 71, no. 1, pp. 258–275, Feb. 2011, doi: 10.1177/0013164410391581.
[14] E. Pommier, K. D. Neff, and I. Tóth-Király, "The Development and Validation of the Compassion Scale," *Assessment*, vol. 27, no. 1, pp. 21–39, Jan. 2020, doi: 10.1177/1073191119874108.
[15] F. Raes, E. Pommier, K. D. Neff, and D. Van Gucht, "Construction and factorial validation of a short form of the Self-Compassion Scale," *Clin. Psychol. Psychother.*, vol. 18, no. 3, pp. 250–255, May 2011, doi: 10.1002/cpp.702.
[16] T. Özge, "Development of Social Justice Awareness Scale: Exploratory (EFA) and Confirmatory (CFA) Factor Analysis," *Int. Online J. Educ. Teach. IOJET*, vol. 8, no. 3, pp. 1603–1622, 2021.
[17] S. R. Torres-Harding, B. Siers, and B. D. Olson, "Development and Psychometric Evaluation of the Social Justice Scale (SJS)," *Am. J. Community Psychol.*, vol. 50, no. 1–2, pp. 77–88, Sep. 2012, doi: 10.1007/s10464-011-9478-2.
[18] L. Burnell and D. L. Agan, "Compassionate Care: Can it be Defined and Measured? The Development of the Compassionate Care Assessment Tool," *Int. J. Caring Sci.*, vol. 6, no. 1, pp. 180–187, 2013.
[19] T. Hacker, "The relational compassion scale: development and validation of a new self rated scale for the assessment of self-other compassion," University of Glasgow, 2008.
[20] B. A. Lown, S. J. Muncer, and R. Chadwick, "Can compassionate healthcare be measured? The Schwartz Center Compassionate Care Scale™," *Patient Educ. Couns.*, vol. 98, no. 8, pp. 1005–1010, Aug. 2015, doi: 10.1016/j.pec.2015.03.019.
[21] D. Martins, N. A. Nicholas, M. Shaheen, L. Jones, and K. Norris, "The Development and Evaluation of a Compassion Scale," *J. Health Care Poor Underserved*, vol. 24, no. 3, pp. 1235–1246, 2013, doi: 10.1353/hpu.2013.0148.
[22] 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.

[23] P. Jiménez, J. Pascual, and A. Mejía, "Educating Engineers Under a Social Justice Perspective," *Int. J. Eng. Pedagogy IJEP*, vol. 10, no. 3, p. 82, May 2020, doi: 10.3991/ijep.v10i3.13673.

[24] G. R. Kirk and J. Grohs, "Civic Attitudes and the Undergraduate Experience," in *Civic Engagement and Community Service at Research Universities*, K. M. Soria and T. D. Mitchell, Eds. London: Palgrave Macmillan UK, 2016, pp. 125–141. doi: 10.1057/978-1-137-55312-6_7.

[25] B. E. Moely, S. H. Mercer, V. Ilustre, D. Miron, and M. McFarland, "Psychometric Properties and Correlates of the Civic Attitudes and Skills Questionnaire (CASQ): A Measure of Students' Attitudes Related to Service-Learning," *Mich. J. Community Serv. Learn.*, vol. 8, pp. 15–26, 2002.

[26] B. D. Lutz and S. Peuker, "Preliminary Development and Validation of the Engineering Social Justice Scale," in *American Society for Engineering Education, 2022*, Minneapolis, MN, Jun. 2022.

[27] J. W. Creswell and V. L. Plano Clark, *Designing and conducting mixed methods research*, Third Edition. Los Angeles: SAGE, 2018.

[28] E. A. Cech, "The (mis) framing of social justice: Why ideologies of depoliticization and meritocracy hinder engineers' ability to think about social injustices," in *Engineering education for social justice: Critical explorations and opportunities*, 2013, pp. 67–84.

[29] C. Vargas-Ordóñez, "Exploration of Conceptions and Attitudes of Chemical Engineers from Bogotá and Manizales about Chemical Engineering," University of Los Andes, 2018.

Appendix

Table 1. Comparison of social justice-related instruments

Scale/Survey	Purpose	Population	Copyright fees	Engineering related	Adaptability
Activism Orientation Scale (AOS)	Activism and advocacy-based dimensions	N/A	N	N	N/A
Social Issues Advocacy Scale-2 (SIAS-2)	Activism and advocacy-based dimensions	N/A	N	N	N/A
Social Issues Questionnaire (SIQ)	Social justice commitment and self-efficacy	College students	N	N	N
Social Justice Perspective Survey (SJPS)	*Social justice perspective*	*Engineering faculty*	*N*	*Y*	*Y*
Social Justice Scale (SJS) - Tarhan	Social justice awareness	Middle school students	N	N	N/A
Social Justice Scale (SJS) – Lutz based on Torres	*Attitudes, perceived behavioral control, subjective norms, behavioral intentions*	*Engineering undergrad students*	*N*	*N*	*Y*

Note: Rows in italic correspond to the chosen instruments for the aim of the study.

Table 2. Comparison of compassion-related instruments

Scale/Survey	Purpose	Population	Copyright fees	Engineering related	Adaptability
Civic Attitudes and Skills Questionnaire (CASQ)	Attitudes, skills, and behavioral intentions affected by service-learning participation	Undergrad students	N	N	N
Compassion Scale (CS-M)	Religion-based dimensions	N/A	N	N	N/A
Compassion Scale (CS-P)	Other's general life suffering-dimensions	N/A	N	N	N/A
Compassionate Care Assessment Tool (CCAT)	Patient's perspective	N/A	Y	N	N/A
Compassionate engagement and action scales for self and others	*Compassion for and from others and myself scales*	*Undergrad students*	*N*	*N*	*Y*
Compassionate Love Scale (CLS)	Other's general life suffering-dimensions	N/A	N	N	N/A
Measures of Community	Community-based dimensions	N/A	N	N	N/A

Orientation (MoCO)					
Relational Compassion Scale (RCS)	Other and respondent's general life suffering-dimensions	N/A	N	N	N/A
Santa Clara Brief Compassion Scale (SCBCS)	Religion-based dimensions	N/A	N	N	N/A
Self-Compassion Scale (SCS)	Self-compassion	N/A	N	N	N/A
Self-Compassion Scale: short form (SCS-SF)	Self-compassion	N/A	N	N	N/A
The Schwartz Center Compassionate Care Scale (SCCCS)	Patient's perspective	N/A	Y	N	N/A

Note: Row in italic corresponds to the chosen instruments for the aim of the study.

Table 3. Summary of the changes done to selected items

Questionnaire	Original	Final version
Social Justice Perspective Survey [23]	A responsible engineer educates others about environmental issues	A responsible civil engineer educates others about environmental issues associated with the planning, design and implementation of civil engineering projects
	Non-technical considerations are of little relevance to the engineer's job	Non-technical considerations are of little relevance to the civil engineer's job
	To achieve a fairer society, the most important contribution that civil engineers can make is to actively engage in community or social causes	To achieve a fairer society, civil engineers should actively engage in community or social causes.
	Responsible engineers care about what they consume or dispose of in their daily life	Responsible civil engineers care about what they consume or dispose of in their daily life
	A responsible engineer questions the causes of environmental problems and tries to influence public opinion, or the corporate agenda or regulations	A responsible civil engineer questions the causes of environmental or social problems and tries to influence public opinion, regulations and/or corporate actions
	To achieve a fairer society, the most important contribution that engineers can make is to behave honestly and with integrity in their professional work	To achieve a fairer society, the most important contribution that civil engineers can make is to behave honestly and with integrity in their professional work
	A responsible engineer is governed by a professional code of ethics	A responsible civil engineer is governed by a professional code of ethics
	A responsible engineer questions the causes of social problems at a local or global level and, based on his expertise, tries to influence public and private decision-making	Responsible engineers question the causes of social problems at a local or global level and, based on their expertise, try to influence public and private sector decision-making

	Social skills are less important than technical skills in the performance of a engineer	Engineers' sensitivity to social issues and context is less important than technical skills to the role of a civil engineer
	A responsible engineer actively participates in events or projects that improve people's quality of life	A responsible civil engineer actively participates in events or projects that improve people's quality of life
	Socioeconomic issues such as equity and global politics are relevant to the design and implementation of engineering projects	Socioeconomic issues such as equity and global politics are relevant to the design and implementation of civil engineering projects
	To achieve a fairer society, the most relevant contribution that engineers can make is to get involved publicly in the analysis and discussions about social, political and economic structures	To achieve a fairer society, the most relevant contribution that civil engineers can make is to get involved publicly in the analysis and discussions about social, political and economic structures
	I believe that civil engineers should be involved in public discussions about the impact of engineering on society	I believe that civil engineers should be involved in public discussions about the impact of civil engineering projects on society
	In your opinion, to what extent do the following factors contribute to a engineer being a good professional? Distribute 10 points among the factors shown. - Ethical or professional responsibility - Understanding of the impact that engineering projects or systems have on the different stakeholders (interest groups) - Understanding how people interact with engineering - Understanding of scientific knowledge and technological tools	In your opinion, to what extent do the following factors contribute to a engineer being a good professional? Distribute 10 points among the factors shown. - Ethical or professional responsibility - Understanding of the impact that civil engineering projects or systems have on different stakeholders (interest groups) - Understanding of how people interact with civil engineering systems - Understanding of scientific knowledge and technical tools
	In your opinion, in what degree civil engineer's work is relate to the topics listed below? Peace or nonviolence Gender equality Care of the environmental Poverty Public security	What importance do you assign to the ethical, social issues and public implications of civil engineering as part of the civil engineering program?
Engineering social justice scale [26]	I believe that it is important to make sure that all individuals and groups affected by a CIVIL engineering decision have a chance to speak and be heard, especially those from traditionally ignored or marginalized groups	I believe that it is important to make sure that all individuals and groups affected by a civil engineering decision have a chance to speak and be heard, especially those from traditionally ignored or marginalized groups
	I believe it is important that engineers allow individuals and groups to define and describe their problems, experiences, and goals in their own terms	I believe it is important that civil engineers allow individuals and groups to define and describe their problems, experiences, and goals in their own terms
	I believe it is important that engineers talk to others about societal systems of power, privilege, and oppression	I believe it is important that civil engineers talk to others about societal systems of power, privilege, and oppression
	I believe it is important that engineers try to change larger social conditions that cause individual suffering and impede well-being	I believe it is important that civil engineers try to change larger social conditions that cause individual suffering and impede well-being

I believe it is important that engineers respect and appreciate people's diverse social identities	I believe it is important that civil engineers respect and appreciate people's diverse social identities
I believe it is important that engineers allow others to have meaningful input into CIVIL engineering decisions affecting their lives	I believe it is important that civil engineers allow others to have meaningful input into civil engineering decisions affecting their lives
I believe it is important that engineers act for social justice	I believe it is important that civil engineers act for social justice

Table 3. Characteristics of the chosen questionnaires.

Type	Name	Purpose	Framework	Likert scale	Dimension	# items
Survey	Social Justice Perspective Survey [23] 25 items	Identify faculty beliefs regarding social justice and the engineering profession	Cech's 3 pillars associated to the engineering culture that contribute to a behavior of disengagement to public welfare concerns: 1. Depoliticization, where cultural and social concerns are irrelevant to engineering practice, 2. Technical/Social Dualism, where engineers separate technical from social tasks and skills, and 3. Meritocratic Ideology, where success is believed to be a result of individual talent, and where the way things are done is not usually questioned (favoring the status quo)	1-4 (Strongly Disagree-Strongly Agree)	Beliefs regarding the engineering culture and the social role of the engineering profession Beliefs on the relationship between social justice and engineering practice Relative importance of non- technical contents in engineering education Contributing factors of a successful engineering practice (Public welfare beliefs and cultural emphases) Best practices and successful initiatives to include social justice themes into engineering programs (open-ended)	9 5 5 4 2
Instrument	Engineering social justice scale [26] 24 items	Measure Attitudes, perceived behavioral control, subjective norms, behavioral	Theory of planned behavior: Attitudes + Norms + Behavioral control → Intention → Behavior	1-7 (Strongly Disagree-Strongly Agree)	Social Justice Attitudes: Involving general dispositions towards a given behavior Social Justice Perceived Behavioral Control: One's perceived ability to perform an act Social Justice Subjective Norms: support, or lack thereof, provided in an environment for performing a given behavior Social Justice Behavioral Intentions: intentions to act for social justice.	11 5 4 4
Battery of instruments	Compassionate engagement and action scales for self and others [8] 3 instruments, 10 items each	Compassion competencies derived from an evolutionary motivational and competencies approach to compassion	Compassion as motivation	1-10 (Never-Always)	Compassion to Others - Engagement (6 items) - Actions (4 items) Compassion from Others - Engagement (6 items) - Actions (4 items) Self-compassion - Engagement (6 items) - Actions (4 items)	10 10 10

Note: * = Dimensions chosen to evaluate.

Social Justice Awareness-Survey

I. Beliefs regarding the engineering culture and the social role of the engineering profession

Please indicate your level of agreement with each of the following statements:

1. A responsible civil engineer educates others about environmental issues associated with the planning, design and implementation of civil engineering projects.

	1	2	3	4	
Strongly disagree	○	○	○	○	Strongly agree

2. Non-technical considerations are of little relevance to the engineer's job

	1	2	3	4	
Strongly disagree	○	○	○	○	Strongly agree

3. To achieve a fairer society, civil engineers should actively engage in community or social causes.

	1	2	3	4	
Strongly disagree	○	○	○	○	Strongly agree

4. Responsible civil engineers care about what they consumes or disposes of in their daily life

	1	2	3	4	
Strongly disagree	○	○	○	○	Strongly agree

5. A responsible civil engineer questions the causes of environmental or social problems and tries to influence public opinion, regulations and/or corporate actions

	1	2	3	4	
Strongly disagree	○	○	○	○	Strongly agree

6. To achieve a fairer society, the most important contribution that engineers can make is to behave honestly and with integrity in their professional work

	1	2	3	4	
Strongly disagree	○	○	○	○	Strongly agree

7. A responsible engineer is governed by a professional code of ethics

	1	2	3	4	
Strongly disagree	○	○	○	○	Strongly agree

8. Responsible engineers question the causes of social problems at a local or global level and, based on their expertise, try to influence public and private sector decision-making

	1	2	3	4	
Strongly disagree	○	○	○	○	Strongly agree

9. Sensitivity to social issues and context is less important than technical skills to the role of a civil engineer

	1	2	3	4	
Strongly disagree	○	○	○	○	Strongly agree

10. A responsible engineer actively participates in events or projects that improve people's quality of life

	1	2	3	4	
Strongly disagree	○	○	○	○	Strongly agree

11. Socioeconomic issues such as equity and global politics are relevant to the design and implementation of engineering projects

	1 (1)	2 (2)	3 (3)	4 (4)	
Strongly disagree	○	○	○	○	Strongly agree

12. To achieve a fairer society, the most relevant contribution that engineers can make is to get involved publicly in the analysis and discussions about social, political and economic structures

	1	2	3	4	
Strongly disagree	○	○	○	○	Strongly agree

13. I believe that engineers should be involved in public discussions about the impact of civil engineering projects on society

	1	2	3	4	
Strongly disagree	○	○	○	○	Strongly agree

II. Contributing factors of a successful engineering practice (Public welfare beliefs and cultural emphases)

14. In your opinion, to what extent do the following factors contribute to a civil engineer being a good professional? Distribute 10 points among the factors shown.

Ethical or professional responsibility :	_____	(1)
Understanding of the impact that civil engineering projects or systems have on different stakeholders (interest groups) :	_____	(2)
Understanding of how people interact with civil engineering systems :	_____	(3)
Understanding of scientific knowledge and technical tools :	_____	(4)
Total	_____	

15. How important is it to cover social issues and public implications of civil engineering works in the civil engineering curriculum?

	1	2	3	4	
Irrelevant	○	○	○	○	Very important

III. Beliefs on the relationship between social justice and engineering practice

16. When you think of social justice and civil engineering, what issues or aspects come to your mind? List your top three things.
_____

IV. Previous experiences with social-justice related educational initiatives

17. In the context of your engineering education have you been exposed to broader issues of social justice?

○ Yes

○ No

○ I don't know

18. Was this exposure to social justice in the form of a course, an assignment, a class, a workshop, and were connections made to engineering activities? Please provide as much detail as possible.
_____

V. Social justice-related curriculum perspectives in civil engineering

19. Please suggest any additional learning experiences or activities that might help improve civil engineering education about social justice. If you have no suggestions, simply state "none".
_____

20. How valuable do you believe it is for students to learn about the connections between civil engineering and social justice as part of the civil engineering curriculum?

	1	2	3	4	
Not valuable	○	○	○	○	Very valuable

21. Would this type of content be best delivered in a focused form (e.g. as a separate course, seminar) or embedded in technical coursework?

- ○ Focused form
- ○ Embedded in technical coursework

22. From whom do you think would these topics be best delivered (e.g. faculty member, activist, sociologist, practitioner, other)? _____

VI. Engineering social justice attitudes

Please indicate your level of agreement with each of the following statements:

23. I believe that it is important to make sure that all individuals and groups affected by a civil engineering decision have a chance to speak and be heard, especially those from traditionally ignored or marginalized groups

	1	2	3	4	5	6	7	
Strongly disagree	○	○	○	○	○	○	○	Strongly agree

24. I believe it is important that civil engineers allow individuals and groups to define and describe their problems, experiences, and goals in their own terms

	1	2	3	4	5	6	7	
Strongly disagree	○	○	○	○	○	○	○	Strongly agree

25. I believe it is important that civil engineers talk to others about societal systems of power, privilege, and oppression

	1	2	3	4	5	6	7	
Strongly disagree	○	○	○	○	○	○	○	Strongly agree

26. I believe it is important that civil engineers try to change larger social conditions that cause individual suffering and impede well-being

	1	2	3	4	5	6	7	
Strongly disagree	○	○	○	○	○	○	○	Strongly agree

27. I believe it is important that civil engineers respect and appreciate people's diverse social identities

	1	2	3	4	5	6	7	
Strongly disagree	○	○	○	○	○	○	○	Strongly agree

28. I believe it is important that civil engineers allow others to have meaningful input into engineering decisions affecting their lives

	1	2	3	4	5	6	7	
Strongly disagree	○	○	○	○	○	○	○	Strongly agree

29. I believe it is important that civil engineers act for social justice

	1	2	3	4	5	6	7	
Strongly disagree	○	○	○	○	○	○	○	Strongly agree

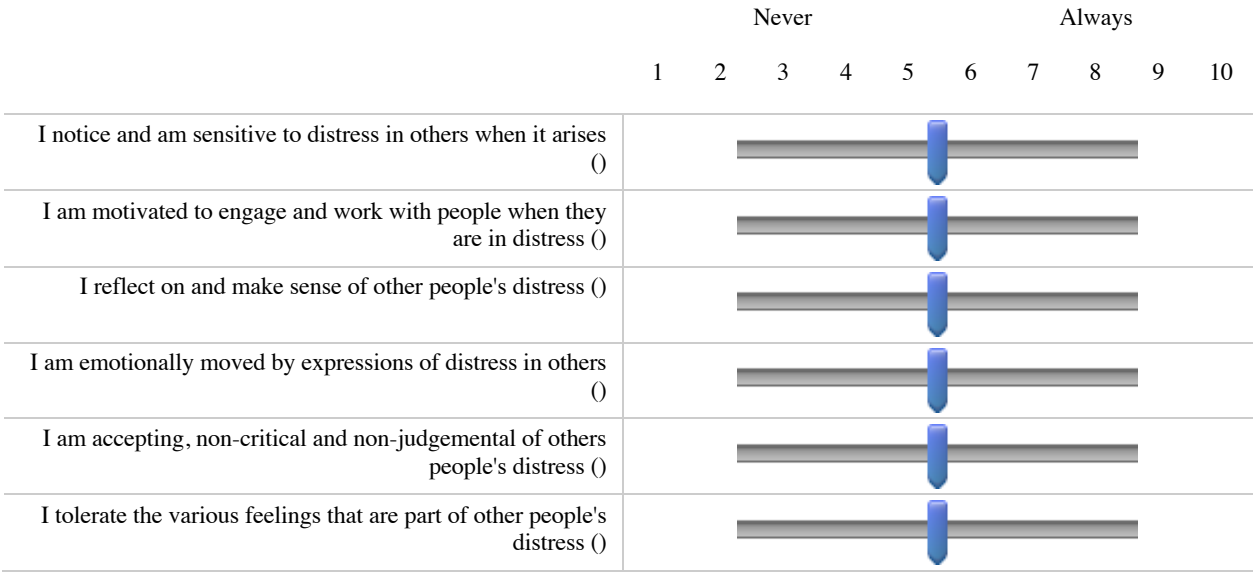
Compassion for Others Survey

We appreciate your willingness to continue with this additional survey.

As mentioned in the previous survey, compassion is considered as a precursor of actions to contribute to alleviating distress generated by social injustice.

We want to know your level of engagement and attitudes as a civil engineer towards that distress that others experience.

1. Please, indicate how frequently you experience the following:



2. Please indicate how frequently you engage with the following statements about alleviating others' distress generated by social injustices