Developing perspective-taking in first-year engineering students through art observation (PFE:RIEF)

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Abstract

Engineering graduates are expected to navigate stakeholder complexities and approach design problems from multiple viewpoints; however, the emphasis on preparing students for the Fundamentals of Engineering exam can drive pedagogy toward discrete, multiple-choice questions rather than open-ended reasoning. This NSF PFE: RIEF project uses an art observation technique known as Visual Thinking Strategies (VTS) to practice observation, communication, and active listening. These skills support students' perspective-taking, which is essential to professional engineering practice. Engineering students enrolled in a first-year Introduction to Civil and Environmental Engineering course (n=104) visited the campus art museum and were provided with two docent-facilitated tours of different types of artwork. Pre- and post-data were collected using the established Interpersonal Reactivity Index (IRI) perspective-taking subscale. Outcomes were compared with students from course sections that did not attend the museum or engage in VTS (n = 107) but completed the instrument and course curriculum the same semester. Preliminary results indicate a significant difference between the pre- and post-survey in the VTS sections ($p=0.02$), and no difference in the pre- and post-scores in the control group ($p=0.54$). Initial quantitative evidence suggests that VTS increases perspective-taking among engineering students. VTS is a low-cost, low-stakes avenue to develop perspective-taking competencies for undergraduate engineering students.

Introduction

Modern engineering problems require new graduates to have the skills to integrate multiple stakeholder perspectives with competing constraints, bridging the gap between technical solutions and the real-world communities they will serve. A consensus within the literature highlights the importance of a comprehensive education aimed at cultivating interpersonal skills in engineering professionals, such as empathetic perspective-taking [1] [2] [3]. Perspective-taking is foundational to effective teamwork, stakeholder engagement, and responsible professional judgment, yet often difficult to teach and assess within technically focused curricula. This gap is partly driven by curricular pressures to prepare students for the Fundamentals of Engineering (FE) exam, which can incentivize instructional approaches that emphasize discrete problem-solving and singular correct answers over open-ended reasoning and interpretation. As a result, many students have limited structured opportunities to practice considering alternative viewpoints or articulating how different stakeholders might perceive the same problem differently.

This project is motivated by the need for a tool in the engineering curriculum to enhance students' ability to view challenges from another's perspective and help educators facilitate the learning of perspective-taking among engineering students. Specifically, there is a need for low-cost, low-stakes, and easily implementable pedagogical approaches that can be integrated into existing courses without displacing core technical content. Arts-based learning approaches offer one such opportunity, as they create structured environments for observation, interpretation, dialogue, and reflection.

The study presented in this paper examines whether a brief, art-based experience can measurably strengthen perspective-taking in first-year engineering students. The following section situates this study within prior work on perspective-taking, empathy, and arts-based pedagogy, with particular attention to the theoretical and empirical gaps surrounding implementation. The methods section then describes a controlled, pre–post study design implemented in a first-year engineering course, followed by results that quantify changes in students' perspective-taking and offers future steps and implications of this work.

Background

Engineering design, such as infrastructure projects like dams and highways, increasingly must focus on climate resiliency and adaptation, while still meeting the needs of diverse groups and the environmental and social impacts. Engineers need to be able to understand the perspective of others to conduct their work effectively [4]. Perspective-taking is often considered a subset of empathy, focusing on the cognitive process of understanding different points of view rather than emotional, or affective, experiences. Currently, in engineering, most studies focus on measuring empathy as a whole [5] [6]. Concentrating more directly on perspective-taking, rather than empathy, can provide a more targeted understanding of the cognitive processes that shape engineering design thinking and problem-solving.

A way to practice perspective-taking is through art. By interpreting artworks, students can practice inference, using evidence to support their claims, and are exposed to other potential meanings from different observers. Art inherently feels low stakes to engineering students since it is not typically

seen within their discipline, allowing them to participate more freely and take more intellectual risks [7]. Additionally, the ambiguity of art mimics design problems that rarely have a 'right' answer. This naturally leads to different viewpoints and fosters discussion.

One structured approach for leveraging art to support perspective-taking is Visual Thinking Strategies (VTS), an art-based observation method centered on guided discussion and collective interpretation. VTS is a facilitated discussion of art used by museum guides that has been shown to enhance observation skills and encourage critical thinking [8]. Since its first application, it has expanded beyond the art field and has been implemented in over 30 medical schools to increase one's tolerance for ambiguity and prevent misdiagnosis [9].

Though VTS is a well-established pedagogical approach in the medical field, its application within engineering education remains limited. Existing engineering studies suggest that VTS can support collaborative dispositions and higher-order interpretive skills, such as increased affinity toward group work among undergraduates [10]. It also has shown gains in insight, contextual competence, reflective skepticism, and interdisciplinary thinking in graduate settings [11] [12]. However, this body of work has largely emphasized attitudinal or reflective outcomes, relied on small or specialized populations, and rarely examined changes in specific cognitive competencies central to engineering practice. As a result, there is limited empirical evidence on how VTS influences perspective-taking among undergraduate engineering students—particularly at the first-year level—and no prior studies have evaluated its impact using a controlled, pre–post comparison design.

Research Question

Guided by the need to identify effective, low-burden approaches for teaching perspective-taking in engineering students, the study presented in this paper measured the impact of an art-based pedagogical intervention on first-year engineering students. The research question was: how does participation in Visual Thinking Strategies (VTS) lead to measurable changes in perspective-taking among first-year engineering students?

Methods

Participants were engineering students enrolled in a first-year *Introduction to Civil and Environmental Engineering* course. Half of the course sections engaged in VTS at an art museum (n=104), and the remainder of the course sections followed the standard curriculum without the VTS activities (n=107). All sections completed the perspective-taking subset of the established Interpersonal Reactivity Index (IRI) instrument at the beginning and the end of the semester. The IRI perspective-taking subset consisted of seven questions with 1-5 Likert scale responses [13]. Negatively worded items were reverse coded before averaging. Higher values reflect greater self-reported perspective-taking skills. For comparison between pre- and post-surveys and between VTS and control sections, the mean differences and p-values for 95% confidence intervals were measured. IRI averages in the VTS sections were also stratified into low initial scores (2.0 – 3.0), moderate initial scores (3.01 – 4.0), and high initial scores (4.01 – 5.0) to better understand the change observed among students.

Students enrolled in the VTS sections completed two docent-facilitated campus art museum visits featuring artwork diverse in media, themes, and time periods. Facilitators used open-ended VTS prompts to engage the students in observation, evidence-based claims, and active listening. Students were divided into groups of 15. Art museum tour guides were formally trained in VTS and asked each group the following three open-ended questions at each artwork: (1) what is happening in this artwork, (2) what do you see that makes you say that, and (3) what else can you find?

The facilitator repeated the participants' ideas to the cohort and compared the cohort's ideas. This helped to ensure that all participants had the chance to participate and that all opinions were acknowledged. This guided viewing of one piece of art lasted about 10-15 minutes, observing six unique works of art during each 1-hour museum visit. The study was approved by Kennesaw State University's Institutional Review Board.

Results and Discussion

Students completed the IRI survey at the start and end of the semester. Figure 1 summarizes the mean of the seven perspective-taking questions for both the VTS and control sections, before and after VTS. Within the VTS sections, scores increased significantly ($p = 0.02$), contrasting with the control sections that showed no detectable change ($p = 0.54$).

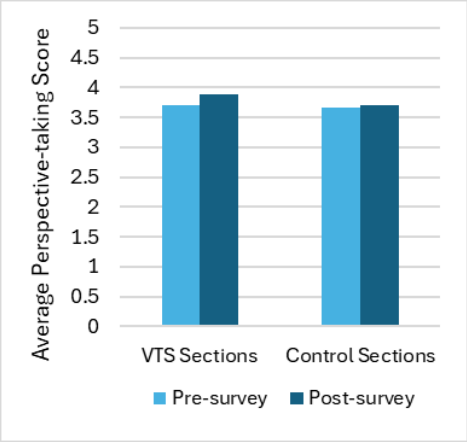

Figure 1: Average Perspective-taking score from all sections

The largest gains occurred among students with low initial perspective-taking scores, with an average increase of 1.45 points on the 5-point scale, as seen in Figure 2. Students with moderate initial scores showed no significant change. Students with high initial scores experienced a decrease of 0.61 points, suggesting a ceiling effect or increased self-reflection that tempered apparent gains.

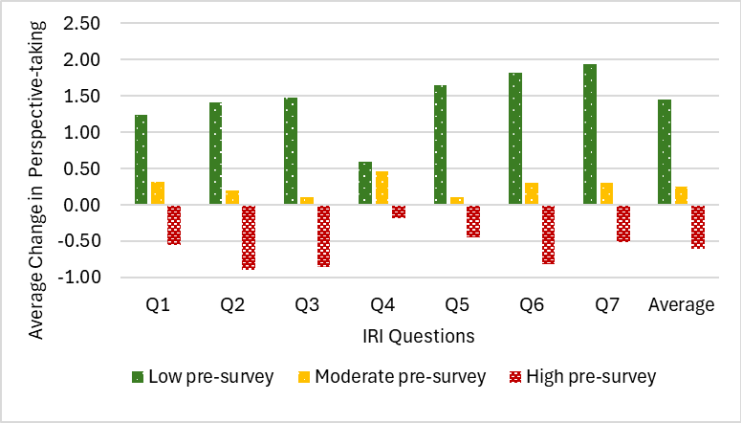

Figure 2: Average change in perspective-taking per question, stratified by pre-survey average

Question 4 (*If I'm sure I'm right about something, I don't waste much time listening to other people's arguments*) exhibited the smallest pre–post change among the perspective-taking items. This item was negatively worded and reverse coded prior to analysis, a format that may produce attenuated change in pre–post survey designs compared to positively worded items. As a result, the smaller observed change for this question may reflect measurement effects rather than a lack of impact from the VTS activities.

Question 7 (*Before criticizing somebody, I try to imagine how I would feel if I were in their place*) demonstrated the largest pre–post gain among the perspective-taking items. This pattern aligns with the structure of VTS, which emphasizes active listening, considering alternative interpretations, and reflecting on others' viewpoints during facilitated discussion. The observed increase suggests growth in cognitive perspective-taking that is directly relevant to engineering practice, particularly for effective teamwork and constructive stakeholder engagement.

Conclusion

Engineering students that visited the art museum and participated in VTS sessions showed an increase in their average self-reported perspective-taking ability. Students with an initial score of 3 (or less) out of 5 showed the largest increase in their post-survey score. These gains were only seen in the VTS group, and no meaningful change was observed in the control group. These findings provide new empirical evidence that an arts-based intervention can strengthen perspective-taking among first-year engineering students. This helps to address a gap in engineering education research that has largely focused on empathy more broadly or on advanced learners. Future work building on this study will analyze qualitative design artifacts to examine whether increases in perspective-taking are reflected in how students frame engineering problems. More specifically, this type of analysis should assess whether students identify a greater number and diversity of stakeholders in their design prompts and help determine whether gains in self-reported perspective-taking translate into observable changes in design reasoning.

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