Developing a Survey Tool to Measure Cultural Transformation in a College of Engineering

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Introduction

This work-in-progress empirical research paper describes the development of a survey tool, grounded in cultural transformation theory, to measure cultural change within one engineering institution. Cultural transformation theory (CTT) defines culture as a continuum from a dominator model, with strict hierarchies and fear-based leadership, to a partnership model, with egalitarian, trust-based leadership structures. This theory is particularly useful for studying engineering culture, which is shaped by traditionally masculine values, norms, and assumptions [1], [2], [3]. These values, norms, and assumptions contribute to conditions, including negative interpersonal relationships, favoritism toward majority students, and subtle and overt denigration of skills, that result in a phenomenon known as a "chilly climate" [4], [5], [6] This chilly climate has been shown to negatively impact women and students from underrepresented groups, resulting in experiences of isolation and self-doubt [6] Ultimately, the chilly climate has been linked to lower rates of retention and persistence among women and students from underrepresented groups [6]. Experiencing an unwelcoming or "chilly" environment during undergraduate studies has been recognized as a contributing factor to the hesitation among underrepresented groups in engineering to pursue higher degrees in engineering [11], [12]. Moreover, the United States needs more engineers; recent reports suggest that the engineering profession needs to grow by 15% to meet increasing demand and retirements [13]. To meet the demand for more engineers, we must grow participation and educate engineers from all demographic groups. However, the percentage of engineering graduates from certain under-represented groups has experienced a slight decrease in recent years [14]. Recent policy changes further threaten the United States' ability to meet rising demand for engineers [15].

The Need for Engineering-Specific Cultural Assessment Tools

Godfrey and Parker [16] offer a valuable foundation for analyzing values and cultural norms in engineering [17]. However, their framework, which was developed from an ethnographic study of one institution in New Zealand, is limited in its ability to assess cultural change. Unlike other fields such as the social sciences (i.e., psychology [18] or anthropology [19]), which have long employed robust frameworks to assess cultural dynamics, engineering has yet to develop or adopt similarly comprehensive and systematic approaches. This gap can be attributed to the unique cultural context of engineering, which is often characterized by an emphasis on objectivity, technical rigor and discrimination [9], [10], [20]. Such norms contribute to a professional identity that may undervalue interpersonal, social, and emotional dimensions of learning factors that are central to understanding cultural climate [21]. Furthermore, engineering environments have been criticized for fostering competitive and exclusionary dynamics [20], [22], which can disproportionately impact students from historically underrepresented backgrounds. As a result, general climate instruments may overlook or underrepresent these systemic and relational patterns specific to engineering. Thus, we aim to address this significant gap in the field: the absence of structured, consistent frameworks for measuring cultural change across engineering educational contexts. Such a structured tool would enable greater

collaboration across engineering to identify barriers, track progress, and implement evidence-based strategies to support cultural transformation and encourage inclusiveness.
Some tools for measuring cultural change, such as the four categories of change strategies [23], climate surveys [24], and inclusion audits [25] do exist within STEM education [26]. However, there is an opportunity to develop assessment tools, grounded in theory, to track cultural change. Moreover, there is a critical need for a robust, standardized framework to measure and track cultural change in engineering education. Without such a framework, it is difficult to assess the effectiveness of interventions and track the progress of efforts to foster a more inclusive, collaborative, and equitable learning environment. The survey tool we are building seeks to fill this gap, offering a structured approach for cultural assessment within engineering education while also being designed with enough flexibility to potentially be adapted for use in other disciplinary context facing similar cultural challenges. By prioritizing the measurement of cultural change within engineering, specifically, engineering education can continue to move beyond surface-level diversity efforts and address the systemic barriers that contribute to chilly, exclusive environments.

Theoretical Framework – Cultural Transformation Theory

Cultural transformation theory (CTT) offers a new perspective on culture change in engineering. The theory was proposed by Eisler in 1987 and aims to better understand how people build relationships within a culture [27]. CTT defines culture as a continuum from dominator to partnership models. In domination models, relationships are fear-based, strictly hierarchical, and distinguished by a disregard for soft or compassionate values [27], [28]. At the other end of the continuum are partnership models, in which interactions are trust-based, egalitarian, and constructed around hierarchies of actualization [27], [28]. According to the CTT theory, a shift towards a partnership model is necessary to foster a more equal, just, and compassionate society. According to Eisler, achieving change requires changing the beliefs, values, and practices that support the dominator system. CTT offers a unique way of characterizing relationships and cultural change. It has been applied successfully to analyze the structure of relationships in healthcare [17]; we seek to apply it to understanding cultural shifts in engineering. We developed items to measure students' perspectives under 5 CTT constructs: Power Dynamics and Authority; Gender and Diversity; Relationships and Community; Learning Environment; and Reflection and Growth. Below are concise definitions for the constructs.

The construct of *Power Dynamics and Authority* aims to measure how power is distributed within the engineering education environment. The items developed aim to explore the presence of hierarchical structures, favoritism, and how authority influences students within the college. This construct also addresses whether certain groups are systematically privileged over others, reflecting a dominator culture, or if power is equitably shared, indicative of a partnership culture. The construct of *Relationships and Community* aims to examine the social and collaborative aspects of being a student in engineering education. Here, we are interested in evaluating how relationships amongst students, faculty, and the institution foster a sense of belonging, cooperation and mutual support. CTT provides an efficient construct for this purpose; the 'dominator end' of the spectrum often emphasizes competition and individualism, whereas the 'partnership end' of the spectrum promotes collaboration and cooperation, which according to CTT, leads to collective success. The construct of *Gender and Diversity* aims to measure

students' perceptions of institutional efforts to address bias, discrimination, and promote inclusion. Guided by Cultural Transformation Theory, this construct contrasts dominator cultures where exclusion and inequality persist with partnership cultures that actively support diverse identities and equitable practices. The construct of *Learning Environment* aims to examine the overall climate of the classroom in terms of support, creativity, and collaboration. Rooted in Cultural Transformation Theory, it distinguishes environments shaped by control and rigidity (dominator) from those that foster innovation, psychological safety, and mutual learning (partnership). The construct of *Reflection and Growth* aims to assess the extent to which students are encouraged to reflect on their development, consider the societal impact of their work, and engage in lifelong learning. Aligned with Cultural Transformation Theory, this construct contrasts environments that prioritize correctness and performance (dominator) with those that nurture ethical awareness, adaptability, and personal growth (partnership).

Methods

This work-in-progress paper reports on the initial modification of an existing institutional climate survey using CTT. The modified survey was deployed within the College of Engineering (COE) at a large, midwestern, R1 land-grant university in Fall 2024. Rather than developing an entirely new instrument, the research team modified existing items in the climate survey and constructed new ones to reflect the dominator-partnership continuum at the heart of CTT. The purpose of the modification is to ascertain where the COE falls in the dominator-to-partnership spectrum. Data collected from the survey is currently being analyzed.

Site Description. This work was conducted at a large, midwestern, land-grant, research-intensive university. While the university is in an urban area, it serves students from rural areas throughout the state. The college of engineering currently has an undergraduate student population of over 4,000, over 200 faculty, and more than 20 undergraduate degree programs. The present work was undertaken as part of the establishment of an Inclusive Excellence Center in the COE, as supported by a Broadening Participation in Engineering grant from the National Science Foundation. The purpose of the center was to improve recruitment and retention of students from rural areas.

Data Collection. Every 3 years, the COE administers a climate survey to all students and faculty within the college to measure perspectives on the college's overall climate. We developed and deployed survey items within this existing college-wide climate survey. The research team developed items (see Table 1 for sample items) to measure where the college falls on the dominator-to-partnership spectrum, as described in CTT. These self-reported items were measured using a five-point Likert scale, which has successfully measured CTT-related phenomena in past literature in the context of the assessment of inclusive excellence faculty and staff workshops within life and physical sciences departments [35] and experiences of faculty from marginalized groups working in STEM fields [36]. Given that we intend to measure cultural shift broadly across multiple populations (e.g., undergraduate students, staff, faculty), we developed our own scale to pilot the measurement of cultural shifts in engineering, particularly in understanding the spectrum from domination to partnership. Some sample items we developed are shown in Table 1.

Table 1: Sample items developed to measure dominator to partnership spectrum

Construct	***Item in Survey*** *Instructions:* Please indicate the extent to which you agree or disagree with the following statements. Use the scale: 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree and 5 = Strongly Agree.
Power Dynamics and Authority	1. Certain groups are favored over others in my classes.
Relationships and Community	1. Students in my college often work together to solve problems, rather than compete against each other. 2. My classes emphasize the importance of building strong interpersonal relationships among students. 3. Instructors in my classes prioritize academic performance over wellbeing. 4. Being the best in my classes is important.

Preliminary Findings

At this stage, the research team has completed the development and deployment of the survey tool to measure cultural transformation within the College of Engineering, guided by Cultural Transformation Theory. Data were collected during the Fall 2024 semester, and the responses are currently being analyzed. While specific findings are not yet available, the survey aims to provide insights into measuring where the COE falls on the dominator-to-partnership spectrum. We expect to uncover patterns that reveal how the college fosters (or inhibits) an inclusive and collaborative culture. Once analyzed, the data will offer insights into the cultural shifts prompted by the newly established Engineering Inclusive Excellence Center. These findings will contribute to refining the survey tool and guiding future interventions to promote a culture of inclusivity, collaboration, and equity in engineering education.

Future Work

The National Science Foundation grant funding supporting this work was terminated on April 25, 2025. We are including the following plans for future work that were established prior to this termination. The research team hopes to carry out these plans in some capacity and encourages the broader research community to develop tools for assessing cultural transformation within engineering education. The next steps in this research involve analyzing the collected survey data to identify trends and insights regarding the dominator-to-partnership spectrum within the College of Engineering. To ensure the robustness of the framework, we will conduct validity and reliability checks using established statistical methods such as exploratory factor analysis and Cronbach's alpha. These steps will refine the instrument, ensuring it accurately captures the intended constructs and provides reliable measurements of cultural transformation. Our key aim is to develop a cultural transformation theory (CTT) based instrument that can be adapted to different contexts. By designing a flexible yet robust tool, we seek to create a framework that can be applied across various engineering education environments to systematically measure and foster cultural change. This adaptability will allow the instrument to address diverse cultural dynamics and challenges while maintaining consistency in its core measurement principles. While the current study presents only a single snapshot of the college's culture using the adapted

CTT-based survey, we acknowledge that cultural transformation is a long-term, systemic process. A one-time survey alone cannot fully capture transformation in action but serves as a critical baseline. Hence, future work will involve longitudinal studies that will assess changes over time and evaluate the sustained impact of the Inclusive Excellence Center on the COE. We also plan to incorporate qualitative methods, such as focus groups or interviews, to provide richer context to the quantitative findings. These insights will not only inform continuous improvement efforts within the college but will also serve as a foundation for broader discussions on cultural transformation in engineering education.

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