Measuring what matters: A human-centered design approach to survey development around departmental culture in physics

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Efforts to promote inclusive and sustainable cultural change in physics departments require reliable tools to measure progress. This paper describes the co-design and development of two survey instruments to assess departmental culture regarding inclusion and systemic change. Using human-centered design principles, we brought together stakeholders from physics and astronomy education in a series of facilitated co-design sessions. These collaborative discussions informed the survey constructs, representation of results, and alignment with users' values and goals. We detail our facilitation strategies and co-design activities, showing how this approach built consensus around key constructs for measuring cultural change. We also reflect on lessons learned and provide recommendations for others interested in using collaborative design to create tools that support and measure change. This work contributes to the growing practice of involving participants directly in the development of survey instruments. By centering users' experiences, we aim to support more effective and inclusive approaches to evaluating and advancing departmental change.

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I. INTRODUCTION

Institutions of higher education are constantly evolving in response to changes in demographics, funding structures, and broader societal pressures [1, 2]. Over time, these shifts can create opportunities to revisit and revise long held assumptions and norms. As institutions strive to become more equitable, accountable, and inclusive, meaningful and lasting cultural change must accompany programmatic changes [3]. However, one of the central challenges in these efforts is the lack of tools to consistently and effectively measure progress. Without such tools, it is difficult to reflect on problems in the change process, understand what is working, and adjust strategies accordingly.

This gap is especially significant for national change efforts in physics, such as those led by American Physical Society (APS) and American Institute of Physics (AIP), which aim to promote systemic change and greater inclusion across departments. These initiatives operate on a broad scale, yet the absence of validated and useful instruments makes it difficult to assess impact or monitor progress over time. For example, a survey to assess climate is conducted through the APS Climate Site Visits [4], however the survey is outdated and relevant only to a subset of department members (graduate students). To address this need, we sought to develop surveys that aimed to assess two dimensions of culture: systemic change and inclusion.

Traditional survey development often relies heavily on expert-driven processes, where researchers define what to measure based on literature reviews, theoretical models, or prior instruments [5]. While this approach can produce rigorous tools, it risks missing critical nuances of the specific contexts and lived experiences of those taking the survey and those seeking guidance from the survey results. Without stakeholder involvement, surveys may fail to capture locally relevant constructs or constructs that feel consequential to the designers of nationally led change initiatives, leading to limited practical utility.

Moreover, when intended users, such as department leaders, faculty, or students, are not engaged, they may perceive the survey as disconnected from their realities or priorities, undermining their motivation to participate meaningfully or to act on the findings. This is especially problematic in complex, systemic change efforts, where cultural dynamics and organizational readiness vary widely and require tailored approaches. Involving stakeholders throughout survey development helps ensure that the instrument is relevant to the participants' experiences, increasing buy-in and the likelihood that results will inform actionable change.

In this study, we brought together leaders from several major change efforts, including APS Inclusion Diversity and Equity Alliance (IDEA) [6], Effective Practices for Physics Programs (EP3) Departmental Action Leadership Institute (DALI) [7], and AIP Task Force to Elevate African American Representation in Undergraduate Physics and Astronomy (TEAM-UP) [8], as well as graduate student leaders to work to identify the most important aspects of departmental culture around systemic change and inclusion.

Our goal was to ensure that the tools being developed would reflect shared values across these initiatives and meet the practical needs of those who will interpret and apply the results. Through a series of structured collaborative design sessions, we facilitated dialogue among participants to reach agreement on the most important areas related to systemic change and inclusion. This process gave those who will ultimately use the surveys, such as department representatives and change leaders, a meaningful role in deciding what is measured. This process also encouraged us (as researchers) to think deeply about who we hoped would be guided by the survey instruments' results.

In this theoretical paper, we describe how we designed and facilitated the collaborative sessions, and we share the design and outcomes of this effort. By focusing on the lived experience and strategic priorities of those leading and/or supporting change, our approach lays the foundation for developing more meaningful tools to assess cultural change in physics departments. Understanding and supporting deep change, including shifts in values, behaviors, and collective efforts, requires tools that are both reliable and shaped by those involved in the work. This paper offers a model for building such tools through the human centered design approach.

II. THEORETICAL FRAMEWORK

Human Centered Design (HCD) has its roots in engineering and product design, where it emerged as a response to the limitations of technology-driven development that often overlooked user needs [9]. HCD emphasizes designing systems, tools, and environments based on a deep understanding of the people who will use them. "HCD thinking - especially when it includes research based on direct observation - will capture unexpected insights and produce innovation that more precisely reflects what consumers want" (2008, p. 8) [10]. The goal is to improve usability and effectiveness by integrating design decisions with user experiences and behaviors.

In applying HCD principles to our work through a partipatory approach, we centered the design of our survey instruments around the perspectives of their intended users (leaders of change initiatives and stakeholders within physics departments). Through collaborative design sessions, we engaged these users directly in shaping what aspects of departmental culture the surveys should prioritize and measure. This approach ensured that the resulting tools are not only methodologically sound but also meaningful and actionable for those leading cultural change efforts.

To provide a conceptual foundation for these co-design conversations, we introduced participants to Schein's organizational culture model [11] through analogies described in Section III. This model offers a structured way to understand how culture manifests within organizations across three levels: visible and tangible *artifacts* such as physical environments and behaviors; *espoused values* which represent the stated principles and goals of the organization; and *basic assumptions*, the deep, often unconscious beliefs and norms that shape how members perceive and interact with their environment. By grounding our discussions in this framework, participants could more effectively identify and prioritize the key cultural dimensions that the surveys should assess.

III. CO-DESIGN DEVELOPMENT AND PARTICIPANT RECRUITMENT

In this novel approach, we engaged in HCD by creating collaborative design sessions that brought together 15 stakeholders holding multiple roles, including leaders of APS and AIP change initiatives, APS site visit leaders, department chairs, members of the APS Committee on Minorities (CoM) and Committee on the Status of Women in Physics (CSWP), representatives from AIP Research (formerly the Statistical Research Center), faculty members, and student representatives. These sessions provided a space for participants to collectively identify critical indicators of departmental culture related to equity and inclusion as well as systemic change. Due to the limited number of individuals involved in these initiatives, including detailed demographic information could risk identifiably. Instead, we emphasize that the participants represented a diverse range of identities and perspectives, all united by shared values regarding equity and inclusion.

We focused on APS and AIP change initiatives led by professional societies and local departmental stakeholders because they all led long-time scale, team-based work that sought to accomplish second-order change. Second-order change refers to a deeper transformation that goes beyond surface-level adjustments to policies or practices [12–14]. Second-order change involves shifts in the underlying beliefs, values, and assumptions that shape how organizations function. It challenges existing systems and asks members of the organization to think and act in fundamentally different ways [11, 15]. This type of change is often complex and requires collective reflection and sustained commitment.

To design and facilitate these sessions effectively, we partnered with the University of Maryland Academy for Innovation and Entrepreneurship (AIE), leveraging their expertise to develop strategies and activities that fostered a welcoming and inclusive environment where all voices were heard. In conversation with AIE we refined our goals for each sessions, iterated on the design of activities, and solicited feedback on our modes of engagement, discussion prompts, and ways of recording ideas that arose. The results of these co-design sessions informed the creation of survey tools. These survey tools enable the assessment of where departments are starting from. Such results will allow the leaders of APS and AIP change initiatives to tailor their efforts to existing departmental cultures.

IV. RESULTS

A. Co-design Activities and Facilitation

The co-design activities were conducted over four two-hour sessions within a one-month period. Due to scheduling constraints involving fifteen participants, the larger group was divided into two smaller groups. The first two sessions were held separately for each group, while the final two sessions were conducted jointly. All sessions took place virtually via Zoom. Meeting notes were recorded by the facilitators/researchers in a shared Google agenda document. Throughout the sessions, we, the facilitators shared our screen to display PowerPoint slides, which were used to guide discussions and activities. Table I summarizes the goals for each co-design session.

Session	Goals
Session I	Foster psychological safety, establish collaboration norms, set shared goals and expectations, and identify key components of inclusion.
Session II	Strengthen psychological safety and identify core elements of an effective change process.
Session III	React to and consider use of data representations for each change initiative and APS Site Visits, converge on data representation for each change initiative.
Session IV	Converge toward decision-making, reflect and discuss on sample of candidate items, discuss and converge toward co-design outcomes.

Table I: Goals for each of the co-design sessions

The first co-design session started with participant introductions and ice-breaker prompts. This was followed by a project overview that outlined the goals of the initiative, the intended focus of the survey, and the purposes and audiences it was being designed to serve. After walking participants through the goals for each session (as presented in Table I), we introduced activities aimed at establishing collaboration norms.

Participants were divided into breakout groups and asked to reflect on the following prompts:

- Think of the most difficult team you've been part of. What made the experience negative?
- Share this experience with your partner.
- Reflect on the best team you've worked with.
- Communicate that experience in your breakout group.
- Discuss both positive and negative experiences.
- Suggest team behaviors and norms that contributed to success.

Following these breakout discussions, participants were invited to propose two to three team norms by writing them on a shared slide (on virtual sticky notes). Returning from the breakout groups, we held a larger discussion to around the norms that were put into the sticky notes.

Following the collaboration norms activity, we resumed the presentation to introduce key touchstone concepts. Specifically, we presented the distinction between divergent thinking (generating multiple ideas) and convergent thinking (narrowing down and making decisions) to help participants develop a shared vocabulary for the different modes of group brainstorming. Another foundational concept was introduced through an assumption-storming activity. Participants were invited to reflect on what motivated their involvement in the survey design process and what hopes they had for the survey's impact. This activity served to surface underlying assumptions, ensuring the design process remained aligned with participants' expectations and needs. Identifying assumptions early makes it possible to test those assumptions and course-correct as needed before significant amount of time and energy are invested. The first hour of this first session was concluded with the above activities and after a short break, the group reconvened to continue with the main part.

For the remainder of the session, the goal was to identify the values and behaviors that characterize an inclusive physics department. The first prompt asked participants to identify values they associate with inclusion. The second prompt invited deeper reflection: *"What do these components 'look like' to you? If you were conducting an extended site visit, what would you look for to be convinced that this space embodies that value?"* Participants were again divided into breakout groups and provided with virtual sticky notes to record and share their ideas collaboratively. The session concluded with ideas on both values and associated example behavior. For instance, one value identified was a "mindset that everyone in the department belongs," paired with the behavior "respectful and friendly interactions."

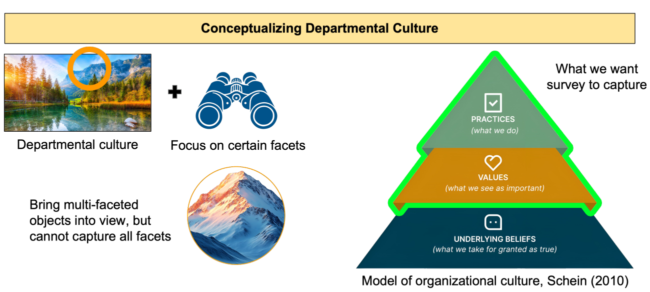

Figure 1: The metaphor used to conceptualize departmental culture.

The second co-design session began with additional icebreaker prompts and community building activities. These repeated introductions were intended to help participants feel more comfortable with one another and to continue fostering a sense of psychological safety and trust within the group.

The session then transitioned to touchstone concepts relevant to the design of the survey, which aimed to assess departmental culture. To support participants in conceptualizing this complex and abstract idea, we introduced a metaphor: departmental culture as a dynamic landscape. This landscape might include a variety of features, such as rivers, trees, and mountains symbolizing different aspects of departmental culture. (See Figure 1.) To extend the metaphor, we likened the survey to a pair of binoculars: just as binoculars allow an observer to zoom in on specific features of a landscape, a well-designed survey enables researchers to focus on particular elements of departmental culture. This framing helped participants understand both the scope of culture and the importance of intentionally selecting which aspects to examine, recognizing that it's impossible to capture all at once. After a short break, the session resumed with the main activity by identifying values and associated behaviors that support effective systemic change, using a process similar to the earlier activity focused on inclusion.

The third co-design session brought together all fifteen participants for the first time in a joint session. To begin, the researchers revisited the touchstone concepts of divergent and convergent thinking, emphasizing that while previous sessions focused on divergent thinking, the upcoming sessions would begin shifting toward a convergent mode, aimed at refining and narrowing down those ideas.

As preparation, we had synthesized the values and behaviors identified in earlier sessions related to inclusion and effective systemic change. This synthesis combined input from both main groups and their respective breakout subgroups (two per group). The session started with brief introductions, since it was the first time all participants were meeting in the same virtual space.

We then presented the initial draft of the synthesis and invited participants to review, provide feedback, and co-edit the content to address any gaps or misrepresentations. The primary goal of the session was to use this collaborative review process as a foundation for transitioning into the convergent phase of brainstorming. To do this, we facilitated two structured activities. In the first activity, participants were divided into two groups. One group focused on identifying the highest-priority values related to inclusion, while the other focused on values related to effective systemic change processes. Each participant was given four "voting dots" to indicate their personal priorities: three standard dots and one designated as "essential" or "non-negotiable," allowing individuals to highlight the values they viewed as most critical.

In the second activity, the groups swapped focus. Participants who had initially prioritized inclusion values were asked to review and respond to the top-priority selections made by the group focused on systemic change and vice versa. This cross-group reflection encouraged broader dialogue and helped surface alignment, tensions, or differences in how participants viewed the relative importance of each value area.

The fourth and final co-design session focused on collaboratively identifying effective data representation formats tailored to different audiences. Participants, among others, included leaders from key organizations such as APS IDEA, AIP TEAM-UP, and EP3 DALI. One major discussion point centered on determining what should be emphasized in the final reports for each change initiative, considering the specific goals and audiences of each effort. Additional conversations addressed potential challenges and concerns around sharing aggregate survey results potentially with individual departments.

B. Outcomes of the Co-design Sessions

Following the co-design sessions, we continued to synthesize the outcomes, focusing on both values and behaviors, and worked to identify connections between them. Relevant literature was incorporated into this next phase to inform the development of the main constructs. The DELTA instrument served as a key reference. It guided the design of survey items that assess both the current state of the department (behaviors and procedures) and the ideal or desired state (values and beliefs) [16].

At this stage, the survey designed to assess effective systemic change processes, named the *Culture Around Systemic Change survey,* is fully developed and is currently being administered nationally in collaboration with AIP Research. We followed established steps in survey design, including think-aloud interviews and review by an expert panel. We piloted the survey 63 physics departments. Results from the exploratory factor analysis suggested a five factor survey. Table II presents the final set of constructs identified after the pilot administration of the survey. Results from the pilot study are discussed in a separate 2025 PERC Proceedings Paper [17]. A second survey, focused on inclusion, is currently being developed.

Factor	Definition
Open Minds	Willingness of department members to consider new perspectives and revise their thinking in an effort to improve the overall well-being of the community.
Student Involvement	Extent to which students are actively engaged in departmental change efforts through collaboration with faculty and staff and input in decision-making to ensure changes are informed by students' values and goals.
Collective Evidence	Collaborative analysis of evidence about students' experiences to reach shared understanding, guide decision-making, and implement informed changes to improve programs.
Sustainability	Departmental commitment to ensuring the longevity and effectiveness of change efforts through proactive planning, systematic monitoring, assessment, and documentation.
Disrupting Injustices	The department's commitment to centering the voices, needs, and participation of underrepresented groups in physics to address power imbalances and create a more just system.

Table II: The constructs and definitions of the resulted Culture around Systemic Change Survey.

V. LESSONS LEARNED AND RECOMMENDATIONS

In running such collaborative co-design sessions, we echo advice we received from our AIE consultants: Don't underestimate the need for activities that build psychological safety among participants. In retrospect, we see these community-building activities as essential to the collaborative divergent and convergent design thinking we were to generate in our sessions. As we reflect on these experiences, we see the time that we spent carefully developing these co-design activities as highly worthwhile. It allowed us to move through the complex survey development with more nuanced input from many perspectives and more confidence in our designs as a result.

The co-designs sessions surfaced a construct we would have missed in a research-only design. For example, participants made a clear case that effective departmental change requires *disrupting systemic inequities,* prompting us to add a dedicated, core construct with targeted items to the *Culture around Systemic Change survey,* rather than reserving this idea only for the equity and inclusion survey. This is an example of providing concrete evidence for the methodological value of the co-design sessions.

These co-design sessions helped us build camaraderie across change initiatives. They helped change initiative leaders to become invested in the results that might come from our survey tools and to see our ambitious project as more feasible. With time, we hope to learn more about how this contributes to the longer-time scale uptake and use of these survey tools.

One limitation of this work is the lack of evaluation done on the participants' experiences within the co-design sessions. In earlier phases of this work, we didn't expect for this co-design process to be a scholarly contribution in of itself. We see this as a fruitful direction for future work.

This co-design work inspired one of our study participants to adapt this approach to their own survey development context. We see this as a marker of success from this work. This suggests that at least one participant recognized this methodology as valuable. This independent project successfully adapted these methods to their study context as reported on in a recent publication [18].

The work presented in this paper motivates us to further explore using other participatory opportunities throughout the research study process. We hope that by sharing these experiences it can inspire others to consider such methods also. We can now envision future studies where the recruitment of departmental liaisons could support us in connecting with and communicating with local stakeholders. This could enable greater response rates, better communication between researchers and local change agents, and greater practical utility emerging from our research activities.

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