

Recognizing dominant cultures around assessment and educational change in physics programs

Diana Sachmpazidi¹, Chandra Turpen¹, Jayna Petrella¹,
Robert P. Dalka¹, and Fatima N. Abdurrahman¹

Department of Physics, University of Maryland, College Park, Maryland 20742, USA



(Received 25 August 2023; accepted 18 March 2024; published 3 May 2024)

Leaders, policymakers, and researchers have called attention to the need to improve critical aspects of physics programs, from teaching and pedagogy to making physics more diverse and equitable. As such programmatic changes are challenging and require a second-order change to be effective, many physics faculty responsible for carrying them out are not equipped with the necessary experience and support to do so. This can result in a significant waste of resources and time. Moreover, while there is a robust body of literature in higher education focusing on institutional and cultural change, there is a limited understanding of the baseline of the culture of physics programs (where physics programs are starting from), a critical aspect that shapes the change effort. Dr. David Craig and Dr. Joel Corbo with the support of the American Physical Society and the American Association of Physics Teachers developed the Departmental Action Leadership Institutes (DALIs) to meet the needs of the physics community by supporting physics faculty to effectively design and implement departmental change focusing on areas needing improvement. In this research project, we developed case studies of five DALI-active physics programs from two DALI cohorts. We use a cultural dynamics lens to document facets of the dominant culture around how physics faculty approach and pursue change work. We see evidence of DALI participants' growing awareness of taken-for-granted assumptions about educational change processes and assessment practices within their departmental cultures and coming to recognize and value alternative ways of collaborating and enacting change in their local contexts. We found that physics faculty typically approach change work in a rushed and *ad hoc* way ignoring the use of formal evidence. In particular, we found that any data collection efforts are the primary responsibility of a single person, rarely becoming the focus of joint attention. Whenever data did receive joint attention, it was approached in a cursory way without meaningfully informing collective change efforts. This study lays the foundation to explore critical aspects of the dominant physics culture that may constrain enacting particular forms of programmatic change. In future work, we document the cultural shifts made by these DALI-active departments around change work.

DOI: [10.1103/PhysRevPhysEducRes.20.010132](https://doi.org/10.1103/PhysRevPhysEducRes.20.010132)

I. INTRODUCTION

Our society is growing increasingly dependent upon science and technology [1]. The volatile ecological and sociological landscape requires science, technology, engineering, and mathematics (STEM) departments to adapt to the society's emerging needs and demands [2,3]. For example, scholars and disciplinary organizations have been calling on the STEM education community to adopt new teaching practices to help students gain a deeper understanding of the subject matter and broaden the diversity of the student body [4–6]. Pursuing each of these endeavors requires change in higher education institutions [7].

In responding to these calls, higher education institutions often find that they do not have the infrastructure to implement the changes that are being asked of them. In parallel, they face financial pressures and substantial time constraints [3]. Some of the local challenges require adjustments (small modifications in a few areas) or isolated changes (deep changes but limited to one particular area) [8]. Such challenges are within the typical capabilities of institutions to implement and sustain. These are often referred to as *first-order change*. Other challenges, such as sweeping pedagogical changes or broadening participation, require transformational change. This is known as *second-order change* and is a dramatic change in the operational framework of an institution [9–11].

Institutional transformation requires altering the institution's culture (what to do and how to behave), the common set of beliefs and values that creates a shared interpretation, and understanding of events and actions [8,12]. Institutional transformation is both deep (altering values and assumptions) and pervasive (far reaching) [7,8,13,14].

Published by the American Physical Society under the terms of the Creative Commons Attribution 4.0 International license. Further distribution of this work must maintain attribution to the author(s) and the published article's title, journal citation, and DOI.

Enacting institutional transformation is significantly more difficult than making small adjustments in the existing operational framework of the institution. It is deliberate, requiring a strong alignment of goals and actions, and is long term [8]. For example, a growing body of academic leaders and faculty members seek to diversify the student body through recruitment and retention efforts. By doing so, they might reexamine and change the admission practices [15] or engage in opportunities to learn about and practice culturally responsive mentoring [16]. Such change efforts affect behavior or alter structures and affect broader parts of the institution beyond one particular program. For additional examples and elaborated descriptions of first-order and second-order changes, see Refs. [17–19].

However, when responding to local challenges that require institutional transformation, academic leaders may adopt simplistic approaches (e.g., adopting a single approach or strategy). In doing so, they may not consider the complex processes needed to support the change [7,19]. Recently, a growing number of physics faculty have been responsive to national calls to improve their programs and often engage in opportunities to receive support in enacting a change effort (i.e., [6,20,21]). While guided support is critical in helping physics faculty meaningfully engage in the change effort, it is equally important to consider the local organizational culture. This culture plays an important role in shaping the change process and the effectiveness of outcomes [19]. Changes in a complex environment are more likely to be effective and sustained when accompanied by intentional cultural change and changing underlying shared assumptions [12,22]. Higher education scholars have noted that understanding the institutional culture is not a panacea to all problems (i.e., [3,23]). However, an accurate interpretation of the local culture can offer critical insight into the most appropriate route to take at a given time for a given issue [23].

The physics community has a growing consensus on the need to improve key aspects of physics programs [24–27]. The existing literature on culture in physics (and in STEM) focuses on the cultural aspect of structures and underlying values that maintain privilege and oppressive systems [28–32] as well as the disciplinary culture of practicing and thinking as physicists [33–35]. For example, a physics program could increase the racial diversity of its incoming class of first years, but if the classroom and institutional culture are not welcoming and inclusive, these changes will not be sufficient to transform the program. Little work has been done to understand how the disciplinary culture shapes approaches to institutional transformation [36]. Such work is essential to make visible to physicists the underlying assumptions, values, and structures that shape and influence change efforts.

In this study, we aim to understand and document how the underlying physics culture emerges within department culture around the approach to institutional transformation. We do so by studying five case study physics programs that

participate in the Departmental Action Leadership Institute (DALI). This paper, as part of this larger study, centers on DALI faculty participants' reflections on typical past approaches to local change efforts.

II. BACKGROUND

To support physics departments in navigating change efforts in their undergraduate programs, American Physical Society (APS) and American Association of Physics Teachers (AAPT) developed the Effective Practices for Physics Programs (EP3) Initiative. The EP3 initiative broadly includes community engagement activities, research activities, and dissemination products such as the Guide. The EP3 Guide is a collection of knowledge, experience, and proven good practices focused on helping physics faculty improve aspects of their undergraduate programs (e.g., recruitment and retention, department culture) [37]. A key part of the EP3 initiative's community engagement efforts is the Departmental Action Leadership Institute (DALI) [21]. DALI was launched to offer practical guidance to interested faculty change leaders in pursuing transformational change efforts in their local departments.

A. The DALI principles

The Departmental Action Leadership Institute (DALI) was designed on a core value that embraces “cyclic self-reflection of change processes and outcomes to guide decisions and actions” [21]. The main concepts around effective change efforts being discussed in DALI sessions include the ideas that effective change efforts are

- Deliberately designed: driven by a clear understanding of the problem to be solved and current priorities.
- Context-dependent: driven by local goals, challenges, and contexts, rather than external mandates.
- Driven by a sense of ownership by department members of the process and outcomes, including a sense of collective responsibility for the health of the department.
- Driven by broad engagement so that a range of stakeholders are involved, actions (even if driven by a champion) involve a collaborative process, and work is grounded in a commitment to equity and inclusion.
- Grounded in evidence, including an accurate understanding of the available evidence about the problem and decision making based on appropriate interpretation of the evidence.
- Ongoing: change is not considered to be a one-and-done activity but instead change processes include opportunities to revisit outcomes and decisions on a regular basis.

B. The DALI structure

Departments apply to join DALI and nominate a pair of physics faculty to participate. DALI kick-off workshops

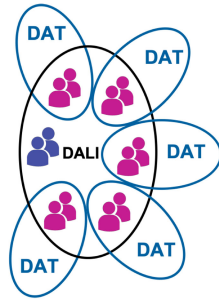


FIG. 1. The DALI structure: In each cohort, two experts in departmental change (in purple) facilitate the DALI yearlong DALI sessions. Each of the five participating departments is represented by two faculty members (in pink) who, in turn, form and facilitate the local DATs that are charged with carrying out that department's change effort.

and ongoing biweekly DALI sessions are facilitated by two experts in departmental change (see Fig. 1). Through these DALI sessions, participants receive support in responding to challenges and opportunities in their departments. In doing so, they build their capacity as change agents. DALI accepted its first cohort of five departments in Spring 2021. Since then, DALI has worked with four additional similarly sized cohorts of departments. The early kick-off workshops were virtual for cohorts 1 and 2 and in-person for cohorts 3, 4, and 5. Each DALI participant pair creates and leads a local team with multiple stakeholders following the Departmental Action Team (DAT) model [9,18,26]. The local DAT is charged with carrying out that department's change effort. DALI participation is concurrent with the DAT's local change effort.

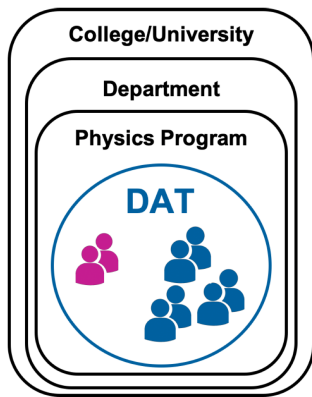


FIG. 2. The DAT structure: The DATs “do the work” of visioning, designing, implementing, and assessing the change. Each DAT is led by the respective DALI participant pair, who translate the ideas about change from the DALIs into practice in their DATs. The DATs include other department members (e.g., faculty, students, staff, and alums) who work with the leader pair to carry out the DAT's work. Each DAT is embedded in a particular physics program, department, and institutional context, which will all impact how the DAT carries out its work.

The DATs “do the work” of visioning, designing, implementing, and assessing the change. Each DAT is led by the respective DALI participant pair, who translate the ideas about change from DALIs into practice in their DATs. The DATs include other department members (e.g., faculty, students, staff, and alums) who work with the pair of change leaders to carry out the DAT's work. Each DAT is embedded in a particular physics program, department, and institutional context, which will all impact how the DAT carries out its work. The change leaders receive continued support within DALI in their pursuit of local change efforts (see Fig. 2).

The EP3 research effort focuses on understanding and documenting how change is enacted and sustained through collective, team-based efforts in local departments within the context of DALI support structures [38–40]. The research effort also focuses on documenting how the emerging microculture within such team-based efforts is situated within the dominant departmental culture. Of particular interest is how elements of this microculture spill over into other departmental areas toward larger-scale cultural change.

In this paper, we zoom in on DALI participants' critical reflections on the dominant departmental culture around past change efforts. By critical reflections, we mean reflections that surface and challenge taken-for-granted assumptions within existing institutional frameworks [41]. We argue that these critical reflections have been partially enabled by their DALI participation. In a future publication, we empirically document cultural shifts resulting from DALI participation by comparing to the dominant culture captured in this paper.

III. THEORETICAL FRAMEWORK

In this study, we draw upon the cultural dynamics theory as the lens to develop our research methods and discuss the results. Cultural dynamics theory is grounded in Schein's framework of organizational culture [12] combined with ideas from symbolic-interpretive perspectives [42]. Schein argues that three levels make up culture, ranging from visible and shallow to invisible and deep. On the surface are the *artifacts*, which are visible, tangible, and audible structures, tools, and behaviors. Above the artifacts lie the *espoused values*, which refer to principles, philosophies, and goals. At the core are the *basic assumptions*, which refer to taken-for-granted, known but not discussed patterns of the nature of the organization. According to Schein, the basic assumptions are the central elements needed to understand and change a culture [12,42]. Hatch [42] extended beyond Schein's model by introducing a new element, *symbols*, and expanding on the dynamic processes among the different model elements for understanding organizational culture. Hatch viewed symbols as distinguished elements from artifacts, arguing that symbols are artifacts with a meaning.

Scholarly work on organizational culture, such as Schein's *Organizational Culture and Leadership* [12], has its basis in studying corporations, which have fundamental differences from organizations of higher education. For example, they differ in the set of goals, sense of urgency, flexibility, or authority in decision making [43]. However, their similarities allow us to draw upon the same theoretical frameworks to understand their cultures and cultural shifts. For example, both organizations' environments are complex, constantly evolving, and influenced by external factors and conditions (e.g., demographic, political, and economic) [23]. Higher education scholars have successfully applied the concept of organizational culture to study higher education institutions [44]. Clark [45] defined four cultural dimensions that shape academic life: cultures of specific academic disciplines, the culture of the academic profession, institutional cultures, and the cultures of national higher education systems. In this paper, we focus on the first dimension, the study of the departmental culture in higher education within units that award physics and/or astronomy degrees.

In this study, DALI participants reflect on their departments' dominant culture around assessment and educational change through their early exposure to alternative principles introduced in the DALI. As the anthropologist Clifford Geertz defines, "Man is an animal in webs of significance he himself has spun. I take culture to be those webs, and the analysis of it to be interpretive one in search of meaning [46]." Therefore, institutional actors' interpretation of the culture is an essential element in the process of diagnosing culture. We present the emergent themes from faculty members' interviews and discuss the processes at play that constitute key dimensions of the dominant culture in physics programs.

In the standard mode of operations, we would not expect participants to be able to articulate underlying values and assumptions of their cultural communities, as these are often implicit [47]. However, in the context of our study, participants are embedded in an alternative community of practice (through DALI) [48] that introduces them to an alternative constellation of values and assumptions. This community supports their critical reflection on the dominant departmental culture. It is within this community of practice that participants come to be able to name and

articulate elements of the dominant departmental culture. This DALI setting introduces a set of principles (as shown in Sec. II) which make visible some taken-for-granted assumptions around the approach to educational change but not other ideologies that likely plausibly shape physics departmental cultures (e.g., meritocracy and whiteness).

In the following section, we discuss the methodology used for data collection and analysis. We then present the results which draw on combinations of Schein's cultural elements. Finally, we discuss the results by identifying the cultural processes that arise in participants' reflections on the departmental culture. We conclude the paper by summarizing the key points and implications for research and practice.

IV. METHODS

A. Study design

As a part of our larger study, we launched case study investigations of the subset participating in physics programs in DALI from the first and second cohorts (year 2021–2023) [49]. The focal five case study physics programs and their characteristics are summarized in Table I. In this paper, we use the first two sets of interviews with the two change agents from each case study program to document their reflections on the dominant culture of their local programs as it relates to the enactment of departmental change. Figure 3 shows the timeline of the research events with respect to DALI and DAT activities.

In the following paragraphs, we introduce each case study by presenting their institutional characteristics, identifying the two participating DALI change agents whose interviews are central to this paper. To protect anonymity, change agents are given pseudonyms. These pseudonyms begin with the same letter as their institution's pseudonym to help the reader associate them (e.g., institution: Maple College, change agents: Morgan and Misha). The institutional and program characteristics described in the following paragraphs were obtained from a combination of sources including, DALI applications, university websites, and interviews with change agents. To contextualize the findings, we present the profiles of these foci physics programs to understand the case of how change and assessment are situated within the culture of these physics programs.

TABLE I. Characteristics of the five case study physics programs. Note: Hispanic Serving Institution (HSI), Historically Black Colleges and Universities (HBCU), R2: Doctoral Universities—High research activity.

| Institution | Characteristics | Change agents |
|---------------------|--|---------------|
| Maple College | HSI, public, primarily undergraduate college | Misha, Morgan |
| Hemlock University | Public R2 primarily undergraduate | Harold, Henry |
| Palmetto University | HBCU, public, primarily undergraduate university | Paul, Pradeep |
| Ironwood University | Private, primarily undergraduate university | Ian, Isaac |
| Basswood University | Public, Ph.D. granting institution | Ben, Bill |

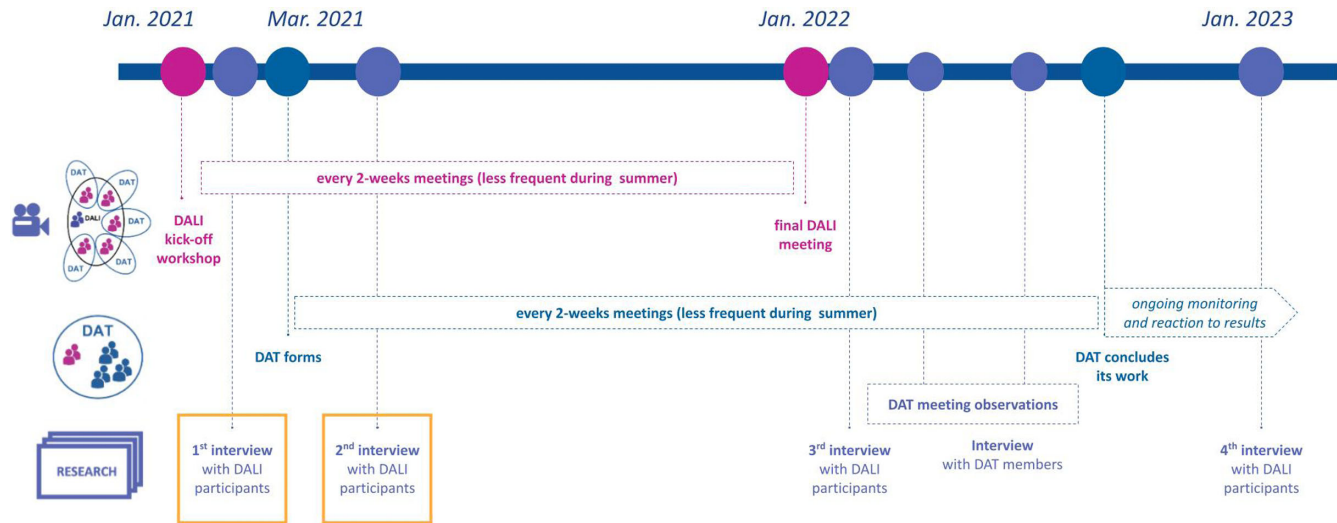


FIG. 3. Timeline of the DALI, DAT, and research events. Example from cohort 1 (2021–2023). In this paper, we draw results from the first and second interviews (highlighted in the timeline above) with the DALI participants.

1. Maple College

Maple College is a public, primarily undergraduate college. About 60% of Maple College students are Pell Grant eligible, about 20% are classified as “first-generation and low-income,” and about 35% are students of color. The two change leaders, Morgan and Misha, represent the physics program which, along with chemistry and earth sciences, make up the Physical Sciences Department. The physics program is currently navigating a challenging financial environment that includes a reduced college budget, which threatens the sustainability of the physics program. With program review upcoming, the change leaders applied to DALI hoping to receive support in their efforts to increase student enrollment and identify ways to assess the effectiveness of past curriculum changes.

Morgan is an associate professor and the assistant chair of the department. Morgan has been in the department for more than sixteen years and has led many of the department’s past curriculum changes. Misha is also an associate professor (at the time of the interview) and has been in the department for about 7 years.

2. Hemlock University

Hemlock University is a public, R2 institution. About 30% of its students are first-generation college students. The two change leaders, Harold and Henry, represent the Department of Physics and Engineering (11 tenure/tenure-track faculty, 2 adjunct faculty, an office administrator, and a lab technician). The department typically confers between 5 and 10 physics degrees per year. With recent changes in the department administration, there has been a push for more transparency and discussion around department issues. By participating in DALI, the department aimed to make its culture more welcoming to students from

marginalized backgrounds. The change agents applied to the DALI to gain support toward reflecting on the department’s shared goals, assessing progress, and making strategic plans for the future.

Harold and Henry are the two most senior members of the department. Harold is the new chair of the department and Henry is the interim chair.

3. Palmetto University

Palmetto University is a Historically Black College and University (HBCU). About 93% of its students are Black or African American and 55% are female. The two change leaders, Paul and Pradeep, represent a multidisciplinary department, which includes degree programs in biology, chemistry, and physics. The department has over 250 biology majors, 30 chemistry majors, and 6 physics majors (Fall 2020). The physics program includes four faculty members (three tenured or tenure track and one full-time physics adjunct). With a continuous decline in student enrollment in the institution and in the physics program in particular, the sustainability of the physics program is at risk. The change agents primarily applied to the DALI to receive support in developing a long-term sustainable process for enrollment growth in physics.

Paul is a senior physics professor and has also served as the academic program coordinator for physics. Pradeep is a tenure-track/tenured faculty member and joined the department in 2018.

4. Ironwood University

Ironwood University is a small undergraduate private college. The two change leaders, Ian and Issac, represent a multidisciplinary department offering degrees in physics and engineering. First-year students are required to take at

least two-quarters of introductory physics. The department includes 16 full-time faculty, usually 1-2 visiting faculty, and 3 technicians. The change agents applied to the DALI to receive support (i) to evaluate their program review and accreditation practices to address their upcoming program review through the Higher Learning Commission, and (ii) to improve the retention and recruitment of undergraduate physics majors, as well as related minors and special programs and certificates the department offers. Ian is an associate professor in the department. Isaac is a senior professor in the department.

5. Basswood University

Basswood University is a public science and engineering university with B.S., M.S., and Ph.D. programs. The number of B.S. physics degrees has increased gradually over time, to 5–7 per year. The two change leaders, Bill and Ben, represent the Physics Department and applied to the DALI to receive support to (i) further increase the number of physics majors, (ii) improve teaching and pedagogy, and (iii) improve assessment practices. Bill is an associate professor at the department and the associate department head. Ben is an assistant professor hired in 2020.

B. Data collection

In this analysis, we draw on both change leaders' first and second interviews within each case department. Critical reflections on the dominant culture were elicited through interview questions about lessons learned in early DALI kick-off workshops (first interviews) and the change approach taken by their DATs (second interviews). In particular, in the first interviews, participants were asked, among other prompts, to describe their experience of the early DALI kick-off workshops, what stood out to them, and how core aspects of DALI principles (e.g., grounded in evidence and broad stakeholder engagement) compare and contrast with their department or program culture [50]. Participants were asked to describe a past department change and how their department previously approached that effort.

In the second interview, participants were asked to describe their ongoing experience participating in DALI and what DALI principles they chose to draw upon when assembling and leading their DATs. Finally, the participants were asked to describe their DAT's approach to the change effort. During those descriptions, many participants reflected on their department's assumptions and typical approaches to past change efforts, emphasizing the differences with the novel approach of their DATs. The first and second interviews are roughly 6 months apart for each cohort with the DALI experience happening concurrently during this space of time.

C. Analytical approach

In this paper, we analyze the physics programs' dominant culture around enacting programmatic change. We identify elements of culture based on the four elements of cultural dynamics [12,42]—artifacts, symbols, espoused values, and basic assumptions. As *artifacts*, we considered observable structures and tools such as behavioral routines in departmental meetings, data collection protocols, or assessment reports. As *symbols*, we considered artifacts to which participants attribute particular cultural meanings. For example, data collection materials may indicate an instructors' level of investment in critical reflection and improvement (e.g., culture of assessment [51,52]). Alternatively, data collection materials could symbolically represent an act of compliance with external accreditation requirements (e.g., culture of compliance [51,52]). As *espoused values*, we considered participants' beliefs and philosophy around educational change, such as faculty members valuing data-informed decision making. Finally, by *underlying assumptions*, we consider any taken-for-granted, known but not discussed patterns of how things work at the department or program, such as the chair having the authority to make final decisions about the program's trajectory or limiting responsibility for departmental change work to only faculty.

We note that in this paper, we draw attention to one facet of the dominant departmental culture and deliberately do not attempt to discuss others. We solely focus on the culture around educational change and acknowledge that it is a partial view of the departmental culture.

We should note that while our analytical focus is on the culture of these foci physics programs, we also acknowledge that our participants (physics faculty) are embedded within larger and often overlapping systems (departments, institutions, and academia). While we do not attempt to distinguish them *per se*, we sometimes note when our participants refer to specific forms of cultural elements (e.g., disciplinary physics culture, program culture, and departmental culture).

We follow a multiple case study approach [53] to address the following research question: *How do faculty in these foci physics programs describe the dominant culture around assessment and approach to educational change?*

As such, our units of analysis are DALI participants' accounts of past departmental change efforts and assessment practices. We use DALI participants' interviews at two points in time (about 3 months apart). While we draw conclusions from these interviews, we should also acknowledge that for the purpose of the larger study, we collected and analyzed multiple other data sources, as shown in Fig. 3. Therefore, we bring a deep understanding of the local contexts of each of the participating physics programs. This helps guide our interpretations of the change leader interviews and the conclusions we draw.

We used thematic analysis to analyze DALI participants' interview data, a qualitative method for identifying, analyzing, and reporting patterns in the data [54]. The analysis followed the six phases of familiarizing with data, generalizing initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report [55]. We first identified transcript segments relevant to the change leaders' recollections on the dominant culture around the approach to the change effort in the physics program. Within this broader focus, we identified themes related to (a) who initiated and was involved in previous change efforts, (b) how the need for the particular change effort was identified; and (c) the role of data use in identifying and enacting the change. We then revised the multiple themes under a single theme. For example, participants described that prior change efforts were initiated based on some people's preconceived notions on what the best approach to address a particular issue is. Within these descriptions, they also mentioned that data were not a resource that was taken into consideration. As a result, we combined the initial subthemes of "rushed and ad-hoc approach to departmental change" with "ignoring the use of formal evidence."

Each theme draws on combinations of evidence from artifacts, symbols, values, and underlying assumptions. While we report the results across themes without directly specifying the type of cultural element, we reflect on each element of culture in the Discussion (Sec. VI). This way, we aim to lay the groundwork for identifying the specific aspects of the physics program's culture and discuss the implication resulting from each cultural element for the capacity of physics programs to enact intentional cultural change. We expand on each theme within the Results subsections, highlighting the similarities and small variations across case studies.

While individual research members had a higher contribution at given parts of the study, this study was highly collaborative overall. The interview protocols, initially drafted by CT and RD, and coding schemes resulted from an iterative feedback and editing process in the weekly research meetings. The first and third authors were more heavily engaged in the analysis and initial interpretation. The rest of the authors provided asynchronous and synchronous feedback at the research meetings multiple times while generating themes and determining how to structure the story arc of this paper.

D. Limitations

Even though we followed the DALI participants over the course of 2 years through interviews, the research team members were never embedded in the departments and have not directly observed the department's dominant culture prior to or after the DALI participation. We are only seeing a window into department culture based on the recollection and perceptions of some of the department

members. Moreover, we must note the self-selecting nature of participants. The DALI participants are people who want to make the change—it is why they applied to DALI. They are more likely to be critical of the dominant culture than typical faculty members. Finally, these programs are not representative of every physics department in the United States; the majority are B.S. granting institutions with relatively small physics programs. However, about 40% of undergraduates obtain physics degrees from B.S. granting institutions, representing a significant but often under-resourced portion of the physics community [56]. As such, the results are not generalizable to every program but are informative of how physicists think about programmatic change.

V. RESULTS

The main themes identified include the dominant culture around assessment and educational change. We find three themes that speak to the dominant culture in these physics programs:

- Rushed and *ad hoc* approach to departmental change ignoring formal evidence,
- Individualistic and siloed approach to the assessment of student learning, and
- Faculty-only discussions of departmental change.

The first theme of *a rushed and ad hoc approach to department change ignoring formal evidence* was evident across all five case study physics programs. This is a culture in which people rely heavily on their assumptions when approaching a departmental challenge. Attention to formal evidence is rare, and in most cases, when formal evidence is used, it is approached at a surface level without meaningfully informing the change effort.

The second theme of *an individualistic and siloed approach to assessment of student learning* captures cultural phenomena such as individual faculty members being solely responsible for designing their own courses and assessment tools. There is no collective responsibility over the decisions that go into course design. Across all case studies, although assessment of student learning is valued, it rarely receives collective attention.

Finally, the third theme of *faculty-only discussions of departmental change* refers to a culture that considers only the voices and perspectives of faculty members around departmental change. Students directly impacted by these decisions do not have any formal role in these conversations regarding departmental or educational change. In almost all programs in our study, we see patterns of student roles being limited and informal, mostly in one-off conversations with faculty or through student evaluations. While these are still ways to incorporate student voices, they do not leave space for empowerment to develop or invite students as equal partners in shaping the department's vision and goals centered on student needs.

A. Rushed and *ad hoc* approach to departmental change ignoring formal evidence

Across all five case study physics programs, change leaders reflect on the typical rushed and *ad hoc* approach to departmental change. People rely heavily on their own assumptions when approaching a departmental challenge. Attention to formal evidence is rare and in most cases when formal evidence is used, it is approached at a surface level without meaningfully informing the change effort.

Maple College's dominant culture of data use is largely superficial. Both change agents, Morgan and Misha, describe data as not having a central role in guiding the department's decision making. As Morgan described, department-level decisions were solely made based on people's perspectives on the ideas on the table and were rarely tied to any formal evidence. The approach to facing departmental issues was messy and *ad hoc*, as illustrated in Morgan's quotation below:

I think, in the past, we've just kind of been 'this is a good idea, let's try it' without even really trying to figure out what the problem is. We'd say, 'the problem is recruitment, okay, so let's talk to the high schools. Let's try to get in touch with guidance counselors'. Without really thinking about the other ways that we could recruit or really thinking about what are the most appropriate high schools to go to. So I think we've just kind of been like, 'let's try it and see if it sticks', kind of thing.—Morgan

Morgan continued describing the lack of assessment of student learning and relying on individual perspectives for decision making, stressing out the difficulty in assessing small, upper-level courses. She expressed her hope that through this upcoming team-based initiative that is data driven, people in the department will change perspectives and develop a communal responsibility over the change process based on assessment outcomes.

Assessment is actually very tricky and unfortunately, no one is that interested in assessment, except me. But I've been trying to get them more interested in assessment, because we don't assess our upper level physics courses really at all and it's hard because they're so small. [...] I guess typically someone would bring an idea and then people would either say 'oh yeah that's a good idea' or 'oh no we don't like that idea,' and if people say it's a good idea, then that person will work on it. [...] So I'm hoping that the data will encourage people to sort of have a more like communal responsibility for things and that we can start dividing up some of this work, because I feel like it tends to fall on me as the head of the

program and then if I say this needs to get done by next week, then they'll do it, but otherwise not.

In the above quotation, Morgan described a mandated, top-down approach to taking action regarding educational change. She expressed the shared expectation that people hold, which is that they are responsible for tasks being asked of them by an upper authority—in this case, Morgan, the program head. This mandated approach resembles a culture of compliance where people take the initiative only when required.

Physics faculty typically operated under a *shared assumption* that change should be approached in a fast and direct way. The dominant culture around change is clearly reflected in Morgan's narrative about the conversations in the room when the ideas about a deliberate approach to change were first introduced to DAT members.

I felt like, particularly the physics faculty, the education school faculty were fine, the students were fine, but the physics faculty were kinda like, 'team building? Hmm, nooo, we don't team build, we're physicists,' [laughter]. So all these sort of whether we would call like the 'touchy feely' parts of making sure everyone was setting ground rules for operation and making sure everyone was comfortable. I still feel we are kind of glossed over that, because people were, eye rolling a bit, but that whole thing and even the idea that we weren't going to actually decide anything to do for a while. There's still a couple people in the group who every, every meeting are like 'well, we should just do this.' And I'm like, 'no, no, we're not there already.—Morgan

As shown in the quotation above, the *shared assumptions* about the way to approach and enact change introduced challenges in the DAT at the early stages. However, before joining the DALI, Misha, also shared these assumptions with the rest of the physics faculty. When describing her own perspective on institutional change, she cited her role as a physicist and the way that physicists tend to think. She described that the "physicists'" thinking is tied to reading quantitative data, *assuming* that data speak on its own and that change will automatically emerge without any particularly deliberate effort. Later, when she was exposed to the conversation on change in the leadership institute, it was an "eye-opening" experience since taking a deliberate approach to change was not something she had considered before.

I should say as a physicist, the social sciences of research is a hard thing for me, because I tend to look at numbers and graphs. I mean that's what makes sense to me naturally. But when people say things like, how do you assemble an efficient

team or things like that, my natural tendency is to idle, because I'm like, 'well, it's going to happen or it's not'. But to listen to 'Oh no, there is a deliberate way of doing this, and there's a way you can design certain things to facilitate it. There are concrete steps you can take to make these things happen'. That's kind of a revelation for me.—Misha

Similarly, *Palmetto University's* dominant culture around assessment is described as *ad hoc*. Paul explained that his experience in DALI helped him reflect critically on the department's past approach to change efforts. He provided an example, mentioning that people rushed to make decisions and relied on surface-level data that were not particularly useful to the problem at hand. In Paul's words,

The change efforts have not been focused and not that organized. They've just been sort of, 'oh let's go out and start visiting schools so we can increase enrollment', or 'oh let's write this proposal to bring money to provide funds to hold events and get kids encouraged to come into our programs' and so on.—Paul

He expounded further on his value of the alternative approach offered in the DALI workshops, below:

The DALI has helped me realize the importance of spending the time defining the problem—finding out what the source of the problem is—the real source, not just the obvious low enrollment, but what's behind, all of the factors behind that and developing a plan. And so, a longer term, more patient structured approach to identifying the problem in proposing a plan to solve it is what the DALI has helped me with, which I didn't have in past change efforts. [...] This is, I think a more organized approach that will take time, but in the end I think we'll have a more-believable program or plan, that's more likely to be implemented and more likely to succeed.—Paul

As we see in the above quotation, the comparison with the DALI (or DAT) approach to first take the time to define the problem and understand the root of the problem helped Paul reflect on the *ad hoc* and rushed nature of past departmental change efforts.

Hemlock University's dominant culture with regard to educational change is constrained by a predetermined agenda that past committees could not innovate on. In the quotation below, Harold reflects on the narrow scope of work the typical committees must navigate around and compares this to the novel approach of taking time to investigate the root of the problem:

Traditional committees [at the department] have an agenda, and you need to address this, and we're going to do it this way. But here [in the DAT] it's like, we're still trying to figure out even what the question is that we're trying to answer, before we can start answering it.—Harold

While people at Hemlock typically use data to inform their decision making, Harold explained that these committees use less formal data gathering approaches. The committees often look into public data from other universities to consider the best approach for their own context. Henry expressed his disappointment around the route that faculty conversation take in these spaces, emphasizing that it is more of a "winning an argument" approach instead of an authentic data-based one:

I will say some of the work of the DAT has felt like much more authentic in the exchange of ideas, rather than I'd say some of the previous department conversations really felt more like winning an argument. You basically had decided what did you want the outcome to be, and then you were trying to argue for that outcome, rather than well let's collect data, analyze the data, think about the data, let's hear from all these different sources, it feels just like a much more authentic process [the one on the DAT].—Henry

Ironwood University's dominant culture around its approach to educational change is also rushed and *ad hoc*, ignoring the use of formal evidence. Ian emphasized the deliberate approach to understanding the context of an issue discussed within the DALI kick-off workshop and how this compared to the typical approach taken in the department. He described that the physics department tends not to take a structured approach to change. Most of the change in the department is done last minute in order to solve an immediate issue, as shown below:

One thing that probably stands out as most memorable [from the DALI workshops] is the effort to establish a theme and reflect on the baseline of the state of the department, which many of us are often skipping, or maybe not willing to take the time to do that. Most of the time you just kind of a kind of put together a team, you know, we have a goal, a lot of the times it's kind of a putting out fires type of goal, and you put a team and you do something and you're done.—Ian

Isaac corroborated Ian's argument about the lack of strategic thinking when it comes to setting goals. He cited faculty's heavy schedule and lack of time as barriers that prevent them from dedicating time to think long term and come up with a strategic plan that is informed by data:

As far as the department goes, I mean, in some sense, I think we're victims really of our schedule. We're so heavily loaded that I think no one gets time to do a lot of strategic thinking long term. [...] [In terms of] strategic thinking, I don't know, I think we still sort of go by gut more than a lot of benchmarking.—Isaac

More specifically, when it comes to data and informed decision making, both change agents, Isaac and Ian, described a culture that resembles a culture of compliance—people collecting data when it is externally required (e.g., serving program accreditation purposes). With the lack of data and time to invest in strategic thinking, people typically have been making decisions where they go “by gut,” as shown below:

So I think in assessing courses we have a very data-centric approach because we were required to. But in strategic thinking, I don't know, I think we still sort of go ‘by gut,’ more than, more than a lot of benchmarking. I mean we have to do some benchmarking because someone asks us to do it, but I don't think we do it very actively.—Isaac

For *Basswood University*, their approach to change efforts is similar to the rest of the programs described above. While there are formal structures at the university level to collect and analyze student data, in many cases, people rely on their own starting assumptions to approach a departmental issue. Bill, when describing an attempt to address an issue at the graduate level, mentioned that there was no formation of a dedicated team to work on it. In their change approach, there was a set of scattered people who relied on their notions around the problem to come up with possible solutions. In this case, there was no data collection or use of external evidence (e.g., literature) to inform people's understanding of the issue at hand or help in their decision making.

We have started and so far we are more or less what I would name ‘kick and rush’. So start something and see if that brings an effect or not, without really thinking about that really starting in a structured approach. [...] There was no real formation of a dedicated team. Just a couple of people who had different opinions on this. And we exchanged that [...] and at the end the conclusion was that, there's nothing which we can do.—Bill

Bill shared an example of a previous attempt of departmental change that originated from a program review. In this example, Bill describes that the effort was more of a “top-down” approach. An outcome of the program review was a few recommendations for improvement. The department

developed a list of action items based on these recommendations and assigned them to a group of faculty members.

In spring 2019 we had a program review, which was in general very positive. But of course, from that the review came up with a list of what things that could be improved in the undergraduate and the graduate programs. And so our department put together this list of actions that need to be addressed. And in a department meeting, we decided who could take over a couple of these tasks, form a group on a couple of these questions and come up with solutions.—Bill

More recently, people in the physics department started to look at data more deliberately than it was typically done. The data concerned student evaluations and other course-related satisfaction surveys collected and analyzed by the university. The physics department receives the outcomes of the analyzed data in aggregate. Bill mentioned that the purpose of the DAT will be to focus on these data. Moreover, Ben, a junior faculty member in the department, shared his intention to analyze student data from his course under the recently introduced flipped instruction model over the traditional lectures and share it in a faculty meeting. He expects that the data will inform people whether they should keep the new changes or return to traditional lectures.

Although the physics department does value change and improvement, there are concerns about the amount of time that implementing successful change would require. The department is hesitant to allocate time toward change efforts because it may take away from the faculty's individual research.

So, usually the department is very supportive to any efforts cause there's always the question whether there's enough time to join an effort and to invest the amount of time needed to do surveys, for example, to analyze surveys. So, I think doing a survey is not just putting a bunch of questions up there, one really needs to think about what the outcome should be. And so most of us are involved in research that takes a lot of time, then if it comes down to the question [of if] we invest the time, then that sometimes might become a problem.—Bill

While everybody recognizes that educational change is essential, the question comes as to whether faculty should take time away from their research responsibilities to engage in programmatic change. This quotation shows the competing values around research productivity and the improvement of educational outcomes. Ultimately, higher administration “pushes” faculty to engage in programmatic change efforts while continuing to heavily (if not only)

reward research productivity. This often results in a clash of priorities and, in the end, comes at the expense of effective systemic change and educational outcomes for students. This clash of priorities often means rushed change efforts for these departments that do not consider formal evidence or a deep understanding of the underlying issues.

B. Individualistic and siloed approach to assessment of student learning

Across all case studies, we find evidence of a dominant culture around assessment of student learning that is individualistic and siloed. Faculty members are responsible for the design of their own courses and assessment tools, which often include self-developed questionnaires or research-validated surveys and assessments of student learning (e.g., the Force Concept Inventory [57]). There is no collective responsibility over the decisions that go into course design. Across all case studies, although assessment of student learning is valued, it rarely receives collective attention across multiple courses. The concept of “grounded in evidence” was extensively discussed in the early DALI kick-off workshops. One of the DALI principles is building an accurate understanding of the available evidence about the problem and decision making based on appropriate interpretation of the evidence [21]. Assessment of student learning resulted from the idea of the change effort being “grounded in evidence.” The interview protocol was designed to actively prompt participants’ reflections on the assessment of student learning. In particular, we asked them what the typical approaches in the program are to assess student learning and to what extent (if any) data inform decision making.

When it comes to program change, *Maple College* has a culture that has been described as rushed, unstructured, and *ad hoc*. However, we find reports of two approaches to assessment of student learning. Individuals who value assessment and growth (culture of student assessment) and individuals who engage with assessment only because it is externally mandated (culture of compliance). In either case, the assessment of student learning at Maple is primarily the responsibility of individuals without collective attention to data. Misha’s quotation, below, describes the situation:

Also, there have been some department wide reorganizations efforts but there’s never been anything like a comprehensive look and data collection with an overall overarching theme in mind at all. There’s always assessment done, it’s always like your feedback, usually teacher feedback which just goes to the teacher and you read about your own feedback and you take what you can from it and if you are the kind of person who believes in growth, you do some changes to your teaching techniques, but if you are the person

who never looked at it, you never look at it.—
Misha

Individual instructors collect and analyze their own data, but there is a lack of clear communication in terms of what other instructors’ assessment practices are. There is no larger discussion about assessment outcomes or how data may be used to inform departmental changes. Morgan describes the one occasion where data across multiple instructors and courses were shared with her. The instructors shared the data with the physics program head, Morgan, who stated that she used the data collected over 6 years to identify areas that need improvement. In that assessment, she realized that the tools they have been using are not relevant in many cases to what instructors are teaching, as shown below:

We were trying to redesign the lab manual to try to address some of these issues and then also just to look at the test and be like, there are things on this test that we don’t even teach and that’s why they’re not [doing well] because we don’t really teach [those concepts], there a lot of questions about those dot diagrams of motion, we don’t even present them with that. So it’s not incredibly surprising that they don’t do well on that.—
Morgan

The above quotation suggests that while assessment of student learning is used in the department, many of the assessment tools are irrelevant and do not directly capture what needs to be assessed. The siloed nature of the assessment of student learning is also reflected in the fact that a single person, Morgan, as the program head, realized this mismatch when she conducted a summative assessment of the tools instructors use to assess their courses.

At *Hemlock University*, attention to course design and assessment of student learning is primary responsibilities of individual instructors. For example, Henry shared a story of a prior change effort to an introductory lab sequence emphasizing the lack of shared responsibility over course decisions which will eventually have consequences for the quality of instruction, as explained below:

I mean it’s still challenging because I feel as though often what happens is there’s a couple of motivated people who do all the changes and do all the work, but it’s not a shared responsibility and therefore, the outcome isn’t shared. And if those people then move away from those labs, the institutional knowledge kind of disappears for why we’re doing it a certain way and things begin to shift. And to be honest, I think that the instructors who take over that lab, they don’t understand why, I mean it seems like a lot of work and it’s hard and the students are struggling with

it, why are we doing this, which are all reasonable questions.—Henry

In *Ironwood University's* case, the change agents shared that assessment of student learning is primarily done when it is externally required (e.g., accreditation purposes). Instructors are required to collect data of student learning; however, these data are not analyzed. The fact that data are collected but not analyzed is another flavor of the siloed approach to the assessment of student learning. Isaac realizes that there are some sorts of decisions made in the department where they go “by gut,” due to the lack of data, as shown below:

We're part of HLC which is another accreditation organization, where we are required to do a quantitative sort of assessment of courses. So, at the level of courses, I think the data approach or the database approach is definitely there. I think what we're lacking is the stuff that hopefully DALI is starting to address, where we look at national trends. So in those areas we go a lot by gut—Isaac

Moreover, Ian stated that although there are other forms of data being collected, e.g., student surveys, it's not analyzed or interpreted thoroughly, citing faculty members' lack of training in social data analysis.

We have done a conceptual survey and electricity and magnetism, in our last of the intro physics sequence. We have done that survey for several years now, probably three or four. And then we have done some other surveys, earlier this year spring and winter. [...] we haven't really had also time to think of ways to analyze it partially because none of us really have that training—Ian

Basswood University is a unique case among the rest of the departments, in the fact that some courses at Basswood are combined with courses at another state university. This aspect of how the courses in the department are run makes the assessment of student learning and collective attention to courses necessary. Ben described that there are practices where data across courses are analyzed and compared to inform instructional practices, as shown below:

I mean, we are mostly data driven as a department. So for example, we introduced a four credit version of introductory physics this last semester. And I was teaching, actually, one of the courses. Another instructor was teaching more. I'm actually compiling data now of how the gain of the students in this particular course compared with the similar course given in this school, in our institution for the last 10 years as well as how it

compares to the national average. So we take the students' studies very, very seriously, and then present this data in the faculty meeting—Ben

Bill, on the other hand, shared another example where assessment of student learning was not included in the conversation. Faculty members across the two institutions that run combined courses met to discuss the increasing failure rate in the graduate-level comprehensive examination. Rather than investigating the reason for the declining passage rates, the bar was lowered to allow more students to pass.

“And so we do our program together with them and have a lot of lectures as broadcasted by a video conference system. And we do this qualifying exam as a common exam. So, a few students are here and a few students are over there. And then we come to a common conclusion of who passes the qualifier. So usually what happens is that we lower the bar for passing the qualifier. But still, there are a couple of students who are not able to pass this even lowered bar, and then have to leave the program, although they have done that in the core classes.”—Bill

The above quotation further corroborates our previous finding regarding the rushed and superficial approach to the change process, where in the case of graduate education, assessment of student learning is largely ignored.

Overall, we see evidence of emerging collaborative practices, such as Basswood. Additionally, programs like Maple have seeds of productive individual faculty data practices. However, the primary way in which all five programs have engaged in past assessments is individualistic and siloed, without pervasive communication strategies.

C. Faculty-only discussions around departmental change

One of the core principles guiding the DAT model is the partnership with students [18,38,58]. Under this model, faculty and staff actively invite students to share their experiences and input to help meet the needs of the student population. In this process, students are empowered and the DATs strive to make equal members in the departmental decision making around undergraduate education. As DALI change leaders are expected to form and lead DATs in their local departments, the concept of “students as partners” was extensively discussed in the early DALI kick-off workshops. The interview protocol was designed to actively prompt participants' reflections on the concept. In particular, we asked them whether there have been any past efforts to include students in faculty discussions and

decision making, and if so, what did that look like and how does it compare to the concept of “students as partners” as discussed in DALI.

In the past, the few collective departmental change efforts at *Maple College* only included faculty members. While there were cases where faculty members would informally solicit student input to inform areas needing improvement, those conversations were random and unstructured. Misha described how surprised she was when she first heard of the idea to formally include students as partners in the department change efforts, as shown below:

We did not even think of including students in this [change effort], which is stupid in retrospect because if you are doing all these things for students, why wouldn't you talk to students and for some reason, we didn't think that was necessary. So now I'm like 'whaaat?' So, it makes sense.—Misha

Prior to that, faculty members at Maple assumed by default that there is no room for students when it comes to participating in departmental-level conversations. Similarly, Morgan expressed that she shared the assumption that program change could only involve faculty to meet, discuss, and take action.

The idea of assembling a diverse team, I thought, was really useful having students [and alumni]. [...] That idea of having a team, and then having a team that meets with sort of the long view, this isn't a team that just meets a few times. That was very useful and I'm not sure I would have thought of including all those people. I think I would have sort of been like 'oh well the faculty will meet and talk about it' so I thought that was very helpful.—Morgan

Misha's quotation below summarizes the dominant culture around change work which typically included only faculty members coming together at a departmental meeting. In those meetings, a few more vocal members dominate and convince others solely based on their preconceived notions, without basing it off on any formal evidence, and eventually pursue the change.

We never had students participate in department affairs [...] we also did not have a lot of data collection [going on]. [We] pretty much went by what faculty members had an opinion on. Usually, we have a department meeting, a couple of people might dominate this conversation or not, and it would usually be some kind of consensus that the faculty members come to, and then implement that change. So that's pretty much been how things are working.—Misha

As shown in the quotations above, discussions and decisions around department change at Maple College were formed only by faculty members. It is interesting to note the two change agents' positive reactions to include student members in these conversations. This particular aspect and the typical interactions that faculty had in these spaces indicate the lack of deliberation in planning and pursuing departmental change efforts.

In the case of *Palmetto University*, the idea of partnering with students for departmental educational change was present but has been largely informal. Pradeep, below, mentioned that his main interactions with students focused on general discussions:

We don't [partner with students], this is something we have to work on. I don't know about [others], but, in my case, I generally ask some questions, like what is your plan, or what is your career goal and how the classes are going, which courses [do] you like or not. They also ask me some questions... One student, she's working with me and she asked me why I chose physics, what made me to choose that particular physics research. So mostly we talk about physics, classes, careers, research, yeah. These are the main topics.—Pradeep

Paul stated that given the traditions of HBCU institutions (as is Palmetto) in being very student centered and dedicated to the education of Black students, Palmetto has more regular student-faculty interactions than some of the larger institutions in the country. He stated that Palmetto's physics program has a pattern of close personal contact with the students, where faculty regularly solicit students' perspectives and input on several issues. However, this was done mainly informally. The DAT has formalized this process in a more focused way than it was done in the past, as shown in his quotation below:

The department's pretty good about that [student-faculty interactions]. Our chair and the faculty are—again HBCUs pride themselves on the nurturing environment that they provide—it's unlike, I went to the [redacted—institution name] for my undergrad, I went to [redacted—institution name, institution name] for graduate school and so those are big schools. And those departments, those faculty never knew who I was. Except in graduate school of course. But [at Palmetto] we all know the students and we also lean on those students. We've got students from the high school coming in on Friday. So we lean on them and they lean on us. We get them internships, we get them academic year research employment and things of that nature. So their involvement, I think the DAT has helped formalize their input but they're

involved in and providing us with ideas all the time. It may not be pointed, like what can we improve, we don't walk up and say what can we improve. But in the course of conversation outside of the DAT, over the past couple years this student may say 'Oh I think we should do this', or we make a point of asking what should we do and she'll be able to provide her input. So the DAT more formalizes and focuses on specific topics. But we've always had good student input, I think anyway."—Paul

As shown above, while the student-faculty interactions are informal, they are patterned. Palmetto's culture is influenced by this HBCU tradition of being very student centered. We have accounts that describe cultivated student-faculty relationships based on support and care. It is a resource that can be built on when partnering with students in departmental change.

In the case of *Hemlock University*, conversations and decisions about changes in undergraduate education were made only by faculty members. As Harold explained, typically three to four faculty members form a committee, come up with suggestions, and then present them to the rest of the department during the departmental meetings. Similarly to the rest of the cases presented in this paper, individual faculty members informally solicit student input which they bring into the departmental meetings.

The idea of including students as equal partners in the change process was something that excited both Hemlock's change agents, Harold and Henry. More specifically, Harold emphasized that they were surprised by the unique input that students bring to the table, which not even the youngest faculty members could have contributed.

I'm the oldest one in the department and we have a couple faculty members who are in their late 20s, and so everybody feels that they're kind of young and tuned in but we're not. Once we start hearing the students talking and speaking their language and there's no idea what they're talking about. I even though I think a lot of the faculty feel that we're kind of really tuned in and aware of how students are thinking and what they're feeling but we're not. And actually having students sit there in the small group meeting with us and say, well, actually, this is how we feel you know.—Harold

As shown above, although there were informal conversations among students and faculty, faculty members did not realize the wide and unique range of perspectives students bring in before they formally included them as change partners in the educational change process. It is within the context of the DAT that students have

opportunities to openly and clearly express their concerns, needs, and perspectives.

Most recent department change efforts at *Ironwood University* concerned instructional change. Ian mentioned that most of these changes were straightforward, such as using new lab equipment. The only student input considered was in the form of student evaluations. Moreover, Isaac explained that students' typical input to the department has been informal. Students have assisted faculty with certain tasks but do not have a leadership role or a substantial say in the process, as shown below:

Yeah, I would say [that students were involved] very informally [in the past]. So I think that might be a big change as a result of this. Now in our DAT we have, I want to say we have three students. Before that, it was more like, well I know a couple of students so I keep kind of needling them [...]. So I had a couple of my research students organize a talk last year. So students ended up helping us, but not in any formal way. And I think in a lot of cases it was more like something that they weren't leading. Whereas, what I hope is that we can inspire them to be sort of leaders in that sphere. [...] So that's the thing that I want established on a more ongoing basis. I think our good students could be our best ambassadors [...]. But so far, I don't think they have a very formidable say.—Isaac

Finally, the *Basswood University* case corroborates with the existing findings across the rest of the departments when it comes to including students in the educational change process. Before DALI, it was only faculty members who would be involved in the change process. Students' input was limited to taking course evaluation surveys, as shown in Ben's quotation below:

In all other department business [besides the DAT], particularly in the courses, we harvest student evaluation surveys. And I guess the students participate in the make-up of the course through these evaluations. That's probably the right way of saying it. They are not involved in designing the syllabus, and stuff like that, but the syllabus will be designed in such a way that a student will like it—Ben

Ben shared the perception that course evaluation surveys are a means through which students can give their input and thus indirectly shape the course design in a way that will satisfy their needs.

The idea of partnering with students came to disrupt faculty members' assumptions about who should shape the change process.

During the workshop we discussed also to include students, which seems to be a very natural way but we did not think about that before.—Bill

As Bill stated above, it is natural to include students, although it is something that was first introduced as an idea in DALI.

When reflecting on student involvement in these interviews, many change leaders expressed this idea that it is “natural” that they be included in change efforts. However, in the dominant culture of the department, the student perspectives were often not formally considered. It is through their DALI experience and working in their DATs that change agents are able to reflect on the lack of student involvement in the majority of departmental discussions.

VI. DISCUSSION

This study was conducted within the particular setting of the Departmental Action Leadership Institute (DALI). The findings of this study resulted from the early experience participants had within DALI. Within this context, participants could reflect and describe their typical and past approaches to pursuing programmatic change and assessment of student learning and who is involved in these spaces and efforts.

While there are several aspects of culture, we focused on how faculty work together and the role of data and information as a driver for and of change in this article. At this stage of the work, we summarize the “steady state” of culture within these programs, but the theoretical framework that we draw from sets the foundation for modeling cultural dynamics in our follow-up paper.

In this paper, we identified three cultural dimensions of educational change. Our findings indicate that the dominant culture of these five physics programs includes *a rushed and ad hoc approach to departmental change ignoring formal evidence*. The tasks around educational change were prescribed and lacked internal motivation [59,60]. This finding is consistent with Fisher and Henderson’s review study [60] which documented that in prescribed tasks, participants are provided with motivation and encouragement to follow one’s vision, as opposed to emergent tasks where participants create new ideas that lead to the vision. Moreover, we found that *the assessment of student learning is a primary responsibility of individual instructors and is siloed, lacking collective attention and reflection on student outcomes assessment*. We found two primary approaches to assessing student learning, a culture that espouses the value of student learning and a culture of compliance to external mandates around use of data.

Scholarship in higher education documented at least three types of assessment cultures, including *improvement of student learning*, *fear*, and *compliance* [52,61]. Skidmore *et al.* [51] studied how faculty members coalesce

into groups in terms of their perceived cultures of assessment. The authors documented a fourth culture: *the evolving student learning culture*. The evolving student learning culture refers to faculty who conduct assessment practices by being equally motivated by improving student learning and complying with accountability structures. The authors also found that the most prominent cultures of assessment among faculty from the College of Science are those of cultures of students learning (40%) and evolving (30%). In comparison, cultures of compliance (18%) and fear (11%) exist at lower rates. The authors discussed that faculty members belonging to the culture of compliance group were more likely to be embedded in primarily bachelor’s degree granting institutions. Of the five case study institutions in our study, four are primarily undergraduate institutions. Assessment and evaluation fall on faculty’s shoulders, who often lack experience, training, resources, and support to pursue effective and lasting educational change. Moreover, such efforts are often not compensated, rewarded, or evaluated [62,63], and it has been reported that faculty often view service as a waste of time and a barrier to their academic success [63,64]. Finally, we documented evidence about the *isolated nature of departmental change that includes only faculty, ignoring the formal inclusion of any outside faculty voices*. Given the external financial pressures, attention to primarily serving program reviews, and pressure to quickly generate results, these efforts feel more like a duty or chore rather than an authentic effort to improve the program and serve students’ needs. As a result, it is not a surprise that these efforts are often unsuccessful.

A. Rushed and *ad hoc* approach to departmental change ignoring formal evidence

Across all case studies, we found a pattern of a dominant culture around educational change that was *ad hoc* and rushed, often just “putting out fires” and lacking strategic thinking. Faculty formed committees to collectively approach a given problem; however, these collaborations were often based on people’s assumptions and biases. Other times, they were constrained in nature as these committees were asked to work around highly prescribed charges. Moreover, past change efforts lacked a meaningful assessment of the landscape around the problem area. For example, Henry stated that faculty at Hemlock typically used publicly available data to inform their conversations around local programmatic changes. However, these conversations looked like more of a “winning an argument” approach where people brought their agendas and biases instead of an authentic, open discussion based on available data.

The culture of taking a rushed and *ad hoc* approach to departmental change, largely ignoring formal evidence, partially reflects the departmental assumptions, values, symbols, and practices [42]. The early DALI experience

helped participants reflect on the dominant departmental *assumptions* by comparing and contrasting them with the new approach discussed in the kick-off workshops. For example, a common pattern across all case studies is that departmental change is *ad hoc*, direct, and fast (“kick and rush”), without considering whether the required change is first- or second-order change [8,65] and, thus, are unable to adjust their change process as needed. Moreover, the *artifact* of highly prescribed agendas indicates the narrow window within which people are called to work on, an aspect which *symbolizes* the lack of agency and openness to exploring new or alternative pathways [60].

Data are used to confirm one’s argument. Physics faculty are primarily evaluated and promoted based on their research productivity, not the time and energy they put into service activities, such as engaging and pursuing educational change. The external financial pressures and the volatile funding landscape of higher education amplify the institutional and departmental *values* and *practices* that put a higher emphasis on faculty seeking external funding sources. These *values* create an urgency for seeing immediate change, magically resolving complex departmental problems, and push faculty into taking surface-level approaches when engaging with educational change.

Physics faculty value data and make informed decisions by the nature of their profession. However, their approach to data and informed decision making vary regarding educational problems that fall outside the scope of their research agendas. Lack of time, heavy schedule, and the need to quickly solve problems (“putting out fires”) are often cited reasons for the rushed and *ad hoc* approaches to educational change. Moreover, the lack of meaningful attention to data collection and interpretation is another side effect of the departmental culture tied to the narrow definitions of faculty success. This definition puts a high weighting factor on research productivity, ignoring investment in directly and meaningfully serving student needs.

Specifically in the case of Maple and Ironwood, we saw that people typically collect data when it is (externally) mandated. Culture of compliance is a term that refers to this exact phenomenon, where people collect and engage with any form of data only when it is externally mandated and seen as a duty instead of a meaningful, iterative process to improve student learning [51]. The primary focus of external organizations is to assess the department without intentional attention to improving them as those cannot deeply understand the departmental culture at each institution they assess. Thus, physics departments tend not to be committed to collecting and interpreting data mandated by an external organization. Assessment done in this way reflects a “top-down” approach, and collecting the required information is seen within the department as a chore that can be completed and ignored. As such, top-down approaches to reform are often unsuccessful at generating widespread change [66]. Top-down approaches tend to

limit faculty’s agency around the change effort or task at hand [59,67].

B. Individualistic and siloed approach to assessment of student learning

We found accounts that emphasize people’s *values* and investment into the assessment of student learning as a means to improve instruction and student outcomes (culture of student assessment), as well as nuances that speak to using assessment only because it is externally mandated (culture of compliance) [51,52]. Consistent across case studies, we found that assessment of student learning is the primary responsibility of individuals (what data to collect, how to collect data, and how to interpret data). Assessment of student learning rarely receives collective attention [39]. In the few cases that it does, the process resembles the faculty discussions and collaborations around educational change, as described earlier. In particular, we see collective efforts over assessing student learning being rushed and *ad hoc* without centering data.

We also identified the *assumption* that participants held around team collaboration. For example, Misha, citing her physicist identity, assumed that effective team collaboration would emerge naturally or it would not. She emphasized how surprised she was to learn in DALI that effective team processes should be intentionally and deliberately cultivated. Instead, physics faculty typically form committees (or teams) with highly prescribed charges on what needs to be done without an open, authentic conversation to understand what the root of the problem is. In these spaces, people typically try to win an argument—an approach that highlights the lack of effective team collaboration processes built upon open communication and transparent decision making.

C. Faculty-only discussions of departmental change

Another example where participants reflected on their own *assumptions* is when within the DALI spaces, the facilitators suggested taking a more collective, team-based approach to educational change that involves students. In their interviews, the DALI participants stated that it is atypical in the department to include students in faculty conversations. However, when it was proposed in the DALI, the participants reacted that it is natural to have students in departmental change efforts since the decision being made in these spaces directly influences the student body. As many participants stated, students bring a unique perspective that adds significant value to the conversation. In particular, faculty members emphasized that DAT students brought in different meanings of the educational systems. Sharing these meanings can prompt revision of faculty’s implicit assumptions and have the potential to be generative for cultural change. Before students formally joined the local DAT, their input indirectly and informally

informed faculty members' ideas around the areas needing change, e.g., in hallway conversations [38].

The concept of partnering with students is not new in the international arena [68–73]. Most of these studies explore the concept of students as partners on curriculum and instructional change, rather than program change more broadly. For example, in the United Kingdom, it is common for students and staff to come together as partners in change around learning and teaching in higher education [74]. In the United States, the concept of *partnering with students* has recently received great attention. Scholars on organizational change expanded on what this concept might look like in practice for faculty and students [18,58,68,75]. As we expand on this theme in our follow-up paper, we discuss what other examples or models of partnering with students look like.

VII. CONCLUSIONS

Higher education institutions are required to transform in order to respond to the numerous emerging changes in the surrounding environment (e.g., financial pressure and changing demographics) [7]. Understanding and reflecting on the underlying culture around the approach to educational change is critical to the effectiveness of the change effort. This article provided empirical data on the dominant culture of five physics programs to advance our understanding of how physics faculty approach and pursue educational change. It helped build awareness of ineffective change practices that might be typical in physics departments. If you are a stakeholder embedded in a physics program and recognize these elements of dominant culture in your own department, you may be looking for alternatives. Some places to start might be the following resources [18,19,59] or you might consider applying for a future DALI cohort.

Within this dominant culture around educational change, we also found productive seeds that can help situate a cultural shift at potentially a large departmental scale. More specifically, we found that individual faculty members value and are invested in using data on their instructional practices. If, within these existing structures, the use of data, data interpretation, and reflection happened at a collective level, this could, over time, potentially support the productive use of other departmental data. Moreover, we also saw that individual faculty members value and seek student input at an informal level (unstructured, *ad hoc*). Similarly, if a collective of faculty members start communicating with students through a more structured approach, this could also facilitate a potential cultural shift where students have a “seat at the table” and a formal role in educational or departmental change discussions. In our follow-up paper, we will give a concrete view of what

partnering with students in collective change efforts can look like.

We must note again that these results are not generalizable across physics departments or programs, as these included in this study do not represent the full landscape of physics programs in the United States. However, it is highly important to focus on B.S. granting institutions as they do produce a high number of physics graduates (about 40% [56]) while still being disproportionately underresourced.

This study provides a starting point for discussing and analyzing the baseline of how departmental culture influences the departmental change process. These baseline departmental cultures will inherently matter for our professional communities' pursuits for transformational change since they could better tailor the offered supports and resources to meet departments on where they are starting from.

In future work, we will use additional data from DALI participants and DAT members to document the emerging microculture that resulted from the departments' participation in DALI. In particular, we will focus on the novel approach of these departments to educational change, assessment of student learning, and partnering with multiple and diverse stakeholders to advance their collective efforts to improve critical aspects of their programs. Finally, we will discuss the influence of DALI as a professional development resource. In particular, we will discuss the role of DALI in advancing faculty's skills and knowledge around teamwork collaboration on educational change that has the potential to generate cultural change.

ACKNOWLEDGMENTS

The authors are grateful to the DALI faculty members for participating in this study. The authors also thank the EP3 Project Management Team Members (Michael Wittmann, David Craig, Michael Jackson, Joel Corbo, Stephanie Chasteen, Sam McKagan, Kathryn Woodle, Christine O'Donnell, Sean Costello, Theodore Hodapp, and Robert Hilborn) for their formative feedback on this study. Finally, the authors acknowledge financial support by the American Physical Society (APS), APS-IF-7 to Dr. Corbo and Dr. Craig, American Association of Physics Teachers (AAPT), and the National Science Foundation (NSF) under Grant No. 1821372. R. P. D. was supported by the National Science Foundation Graduate Research Fellowship Program under Grant No. DGE 2236417. We acknowledge that support from the APS Innovation Fund contributed to sustaining this innovative professional development setting. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

- [1] P. C. of Advisors on Science & Technology, *Prepare and Inspire: K-12 Education in Science Technology, Engineering, and Math (STEM) for America's Future* (National Science Foundation, Washington, DC, 2010), https://www.nsf.gov/attachments/117803/public/2a--Prepare_and-Inspire--PCAST.pdf.
- [2] Demographic turning points for the United States: Population projections for 2020 to 2060.
- [3] A. Kezar and P. D. Eckel, The effect of institutional culture on change strategies in higher education: Universal principles or culturally responsive concepts?, *J. Higher Educ.* **73**, 435 (2002).
- [4] K. Foote, X. Neumeyer, C. Henderson, M. Dancy, and R. Beichner, Diffusion of research-based instructional strategies: The case of scale-up, *Int. J. STEM Educ.* **1**, 10 (2014).
- [5] T. Hodapp and K. Woodle, A bridge between undergraduate and doctoral degrees, *Phys. Today* **70**, No. 2, 50 (2017).
- [6] The AIP National Task Force to elevate African American representation in undergraduate physics and astronomy (team-up).
- [7] P. D. Eckel and A. J. Kezar, *Taking the Reins: Institutional Transformation in Higher Education* (Rowman & Littlefield Publishers, Inc., Blue Ridge Summit, PA, 2003).
- [8] H. B. Eckel, P., and M. Green, *En route to transformation. On change: Occasional paper*, Technical Report 1 (American Council on Education, Washington, DC, 1998).
- [9] G. M. Quan, J. C. Corbo, N. D. Finkelstein, A. Pawlak, K. Falkenberg, C. Geanious, C. Ngai, C. Smith, S. Wise, M. E. Pilgrim, and D. L. Reinholz, Designing for institutional transformation: Six principles for department-level interventions, *Phys. Rev. Phys. Educ. Res.* **15**, 010141 (2019).
- [10] T. Woodin, V. C. Carter, and L. Fletcher, Vision and change in biology undergraduate education, a call for action—initial responses, *CBE Life Sci. Educ.* **9**, 71 (2011).
- [11] C. L. Fry, *Achieving Systemic Change: A Source-book for Advancing and Funding Undergraduate STEM Education*, Technical Report (Association of American Colleges and Universities, Washington, DC, 2014).
- [12] E. Schein, *Organizational Culture and Leadership* (Jossey-Bass, San Francisco, 2004).
- [13] A. Kezar, Understanding sensemaking/sensegiving in transformational change processes from the bottom up, *Higher Educ.* **65**, 761 (2013).
- [14] S. R. Harper and S. Hurtado, Nine themes in campus racial climates and implications for institutional transformation, *New Dir. Stud. Serv.* **2007**, 7 (2007).
- [15] S. F. Roberts, E. Pyfrom, J. A. Hoffman, C. Pai, E. K. Reagan, and A. E. Light, Review of racially equitable admissions practices in stem doctoral programs, *Educ. Sci.* **11**, 270 (2021).
- [16] J. Davis and K. McIntosh Allen, Culturally responsive mentoring and instruction for middle school black boys in STEM programs, *J. Afr. Am. Males Educ.* **11**, 43 (2020).
- [17] Departmental action team project.
- [18] C. Ngai, J. C. Corbo, K. L. Falkenberg, C. Geanious, A. Pawlak, M. E. Pilgrim, G. M. Quan, D. L. Reinholz, C. Smith, and S. B. Wise, *Facilitating Change in Higher Education: The Departmental Action Team Model* (Glitter Cannon Press, 2020).
- [19] A. Kezar, *How Colleges Change: Understanding, Learning, and Enacting Change* (Routledge, New York, NY, 2014).
- [20] American Physical Society [APS]. (n.d.). APS Inclusion, Diversity, Equity, Alliance. APS IDEA, <https://www.aps.org/programs/innovation/fund/idea.cfm>.
- [21] Effective Practices for Physics Programs [EP3] (n.d.) EP3 Departmental Action Leadership Institutes. EP3 DALI, <https://ep3guide.org/dali>.
- [22] R. P. C. Argyris and D. Smith, *Action Science* (Jossey-Bass, San Francisco, 1985).
- [23] W. G. Tierney, Organizational culture in higher education: Defining the essentials, *J. Higher Educ.* **59**, 2 (1998).
- [24] R. S. Barthelemy, M. McCormick, and C. Henderson, Gender discrimination in physics and astronomy: Graduate student experiences of sexism and gender microaggressions, *Phys. Rev. Phys. Educ. Res.* **12**, 020119 (2016).
- [25] R. S. Barthelemy, M. Swirtz, S. Garmon, E. H. Simmons, K. Reeves, M. L. Falk, W. Deconinck, E. A. Long, and T. J. Atherton, LGBT+ physicists: Harassment, persistence, and uneven support, *Phys. Rev. Phys. Educ. Res.* **18**, 010124 (2022).
- [26] J. C. Corbo, D. L. Reinholz, M. H. Dancy, S. Deetz, and N. Finkelstein, Framework for transforming departmental culture to support educational innovation, *Phys. Rev. Phys. Educ. Res.* **12**, 010113 (2016).
- [27] G. L. Cochran, S. Hyater-Adams, C. Alvarado, C. Prescod-Weinstein, and A. R. Daane, Social justice and physics education, *Teaching and Learning for Social Justice and Equity in Higher Education: Content Areas* (Springer, New York, 2021), pp. 125–147.
- [28] Z. Hazari and G. Potvin, Views on female underrepresentation in physics: Retraining women or reinventing physics?, *Electron. J. Res. Sci. Math. Educ.* **10** (2005).
- [29] M. Bremer and R. Hughes, How novices perceive the culture of physics, *J. Women Minorities Sci. Eng.* **23**, 169 (2017).
- [30] S. Moshfeghyeganeh and Z. Hazari, Effect of culture on women physicists' career choice: A comparison of muslim majority countries and the West, *Phys. Rev. Phys. Educ. Res.* **17**, 010114 (2021).
- [31] H. B. Carlone, The cultural production of science in reform-based physics: Girls' access, participation, and resistance, *J. Res. Sci. Teach.* **41**, 392 (2004).
- [32] K. Rolin, Gender and physics: Feminist philosophy and science education, *Sci. Educ.* **17**, 1111 (2008).
- [33] E. F. Redish, Introducing students to the culture of physics: Explicating elements of the hidden curriculum, *AIP Conf. Proc.* **1289**, 49 (2010).
- [34] E. Redish and E. Kuo, Language of physics, language of math: Disciplinary culture and dynamic epistemology, *Sci. Educ.* **24**, 561 (2015).
- [35] G. D. Thijs and E. Van Den Berg, Cultural factors in the origin and remediation of alternative conceptions in physics, *Sci. Educ.* **4**, 317 (1995).
- [36] R. Barthelemy, M. Lenz, A. Knaub, J. Gerton, and P. Sandick, Graduate program reform in one department of physics and astronomy: From tragedy to more progressive policies and an evolving culture, *Phys. Rev. Phys. Educ. Res.* **19**, 010102 (2023).
- [37] Effective Practices for Physics Programs [EP3] (n.d.) EP3 Guide, <https://ep3guide.org/>.

- [38] F. N. Abdurrahman, C. Turpen, and D. Sachmpazidi, A case study of cultural change: Learning to partner with students, in *2022 Physics Education Research Conference Proceedings*, edited by B. W. Frank, D. Jones, and Q. X. Ryan (2022), pp. 24–29.
- [39] D. Sachmpazidi, C. Turpen, and R. P. Dalka, *Changing the culture: Documenting shifts in a department's norms around data use, presented at PER Conf. 2022, Grand Rapids, MI*, edited by B. W. Frank, D. Jones, and Q. X. Ryan, <http://dx.doi.org/10.1119/perc.2022.pr.Sachmpazidi>.
- [40] R. P. Dalka, C. Turpen, J. C. Corbo, and D. A. Craig, *Exploring faculty's explanations of enrollment issues: Where does responsibility and control reside?, presented at PER Conf. 2022, Grand Rapids, MI*, edited by B. W. Frank, D. Jones, and Q. X. Ryan, [10.1119/perc.2022.pr.Dalka](https://doi.org/10.1119/perc.2022.pr.Dalka).
- [41] S. Brookfield, The concept of critical reflection: Promises and contradictions, *Eur. J. Soc. Work* **12**, 293 (2009).
- [42] M. J. Hatch, The dynamics of organizational culture, *Acad. Manag. Rev.* **18**, 657 (1993).
- [43] J. W. DEAN and D. Y. CLARKE, How are businesses and universities different?: How are they similar?, in *The Insider's Guide to Working with Universities: Practical Insights for Board Members, Businesspeople, Entrepreneurs, Philanthropists, Alumni, Parents, and Administrators* (University of North Carolina Press, Chapel Hill, NC, 2019), pp. 12–30.
- [44] A. T. Masland, Organizational culture in the study of higher education, *Rev. High. Educ.* **8**, 157 (1985).
- [45] B. R. Clark, *Academic Culture* (1980), <https://eric.ed.gov/?id=ED187186>.
- [46] C. Geertz, *The Interpretation of Cultures* (Basic Books, New York, NY, 1973).
- [47] B. Rogoff, *The Cultural Nature of Human Development* (Oxford University Press, New York, 2003).
- [48] R. P. Dalka, C. Turpen, J. C. Corbo, and D. A. Craig, Considering the departmental action leadership Institute as a community of transformation: What's highlighted and what's missed?, presented at PER Conf. 2023, Sacramento, CA, [10.1119/perc.2023.pr.Dalka](https://doi.org/10.1119/perc.2023.pr.Dalka).
- [49] J. W. Creswell, W. E. Hanson, V. L. Clark Plano, and A. Morales, Qualitative research designs: Selection and implementation, *Couns. Psychol.* **35**, 236 (2007).
- [50] Effective Practices for Physics Programs [EP3] (n.d.) EP3 Philosophy of Effective Departmental Change, <https://ep3guide.org/about/philosophy-effective-departmental-change>.
- [51] S. T. Skidmore, H.-Y. Hsu, and M. Fuller, A person-centred approach to understanding cultures of assessment, *Assessment and evaluation in higher education* **43**, 1241 (2018).
- [52] M. B. Fuller and S. T. Skidmore, An exploration of factors influencing institutional cultures of assessment, *Int. J. Educ. Res.* **65**, 9 (2014).
- [53] P. Baxter, S. Jack *et al.*, Qualitative case study methodology: Study design and implementation for novice researchers, *Quality control reports* **13**, 544 (2008).
- [54] K. M. Scharp and M. L. Sanders, What is a theme? Teaching thematic analysis in qualitative communication research methods, *Commun. Teach.* **33**, 117 (2019).
- [55] V. Braun and V. Clarke, *Thematic Analysis* (American Psychological Association, , Washington, DC, 2012).
- [56] P. J. Mulvey and S. Nicholson, Physics bachelor's degrees: 2018. Results from the 2018 survey of enrollments and degrees. focus on, AIP Statistical Research Center, College Park, MA, 2020.
- [57] D. Hestenes, M. Wells, and G. Swackhamer, Force concept inventory, *Phys. Teach.* **30**, 141 (1992).
- [58] G. M. Quan, J. C. Corbo, S. Wise, and C. Ngai, Unpacking challenges in student-faculty partnerships on departmental action teams, presented at PER Conf. 2021, virtual conference, [10.1119/perc.2021.pr.Quan](https://doi.org/10.1119/perc.2021.pr.Quan).
- [59] D. L. Reinholz, M. E. Pilgrim, J. C. Corbo, and N. Finkelstein, Transforming undergraduate education from the middle out with departmental action teams, *Change* **51**, 64 (2019).
- [60] K. Q. Fisher and C. Henderson, Department-level instructional change: Comparing prescribed versus emergent strategies, *CBE Life Sci. Educ.* **17**, ar56 (2018).
- [61] L. Baas, J. C. Rhoads, and D. B. Thomas, Are quests for a “culture of assessment” mired in a “culture war” over assessment? A q-methodological inquiry, *Sage Open* **6**, 2158244015623591 (2016).
- [62] R. Boice, *Advice for New Faculty Members: Nihil Nimis* (Allyn & Bacon, Boston, MA, 2000).
- [63] L. E. Reybold and K. W. Corda, Faculty identity and the ‘lesser role’: Service to the academy, *J. Professoriate* **5**, 121 (2011), https://caarpweb.org/wp-content/uploads/2016/11/5-1_Reybold_p.121.pdf.
- [64] E. M. Bensimon, K. Ward, and K. Sanders, *The Department Chair's Role in Developing New Faculty into Teachers and Scholars* (Anker Publishing Company, Inc., Bolton, MA, 2000).
- [65] J. M. Bartunek and M. K. Moch, First-order, second-order, and third-order change and organization development interventions: A cognitive approach, *J. Appl. Behav. Sci.* **23**, 483 (1987).
- [66] S. Gehrke and A. Kezar, The roles of stem faculty communities of practice in institutional and departmental reform in higher education, *Am. Educ. Res. J.* **54**, 803 (2017).
- [67] A. E. Austin, Promoting evidence-based change in undergraduate science education, in *Fourth Committee Meeting on Status, Contributions, and Future Directions of Discipline-Based Education Research* (National Academies National Research Council Board on Science Education, 2011), https://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse_072578.pdf.
- [68] L. Mercer-Mapstone, S. L. Dvorakova, K. E. Matthews, S. Abbot, B. Cheng, P. Felten, K. Knorr, E. Marquis, R. Shammass, and K. Swaim, A systematic literature review of students as partners in higher education, *Int. J. Stud. Partners* (2017), <http://hdl.handle.net/10453/162694>.
- [69] M. Healey, A. Flint, and K. Harrington, *Engagement Through Partnership: Students as Partners in Learning and Teaching in Higher Education* (Higher Education Academy, York, 2014), Vol. 12, p. 15.
- [70] A. Cook-Sather, Student-faculty partnership in explorations of pedagogical practice: A threshold concept in academic development, *Int. J. Acad. Dev.* **19**, 186 (2014).

- [71] C. Bovill, A. Cook-Sather, P. Felten, L. Millard, and N. Moore-Cherry, Addressing potential challenges in co-creating learning and teaching: Overcoming resistance, navigating institutional norms and ensuring inclusivity in student-staff partnerships, *Higher Educ.* **71**, 195 (2016).
- [72] E. Marquis, V. Puri, S. Wan, A. Ahmad, L. Goff, K. Knorr, I. Vassileva, and J. Woo, Navigating the threshold of student-staff partnerships: A case study from an ontario teaching and learning institute, *Int. J. Acad. Dev.* **21**, 4 (2016).
- [73] K. E. Matthews, L. Mercer-Mapstone, S. L. Dvorakova, A. Acai, A. Cook-Sather, P. Felten, M. Healey, R. L. Healey, and E. Marquis, Enhancing outcomes and reducing inhibitors to the engagement of students and staff in learning and teaching partnerships: Implications for academic development, *Int. J. Acad. Dev.* **24**, 246 (2019).
- [74] K. Harrington, A. Flint, M. Healey *et al.*, Engagement through partnership: Students as partners in learning and teaching in higher education (2014).
- [75] P. Felten, A. Cook-Sather, and C. Bovill, *Engaging Students as Partners in Learning and Teaching: A Guide for Faculty* (John Wiley & Sons, New York, 2014).