

Ethnographic investigations of the emerging culture on departmental teams: Evidence of transforming physics faculty's practices and values around departmental change

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Many organizations and researchers within the physics community have highlighted the need to improve undergraduate programs in areas such as pedagogy and the representation of marginalized students. Although many physics programs have actively attempted to address these challenges, the impact of these efforts has yet to be reflected broadly in the physics community. Our previous work highlighted standard cultural practices around the approach of physics faculty to educational change. We found that physics faculty often initiate educational change in an individualistic way that is rushed and *ad hoc*, while ignoring the use of formal evidence. To address this shortcoming, disciplinary organizations have developed initiatives like the Departmental Action Leadership Institute (DALI). In particular, DALI was developed to support physics faculty in becoming better change agents and learning effective leadership and collaboration practices to pursue educational change in their local programs. In our investigations of this institute, we developed case studies of five DALI physics programs. Each case study program followed the DALI recommendations and built teams following the Departmental Action Team (DAT) model to pursue local change. In this project, we studied and documented the emerging idioculture within these five DATs. We used a multiple case study methodology and collected data from multiple sources. We found that the emerging idioculture was different from the departments' dominant cultures in ways that support collaborative approaches to educational change. We also found that these DATs take a deliberate and strategic approach to the change effort by taking time to consider the context and feasibility of the change effort. Finally, we found that these DATs center formal evidence and students' voices in their decision-making processes. We present the results and discuss how the emerging idioculture in these DATs is situated within dominant departmental cultures of educational change.

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I. INTRODUCTION

Policymakers, agencies, and disciplinary organizations highlight the need to improve higher education institutions [1–3]. Two main areas of change focus on improving (i) teaching and pedagogy [4,5] and (ii) recruitment and retention of marginalized students [1,6,7]. Changes such as implementing evidence-based instruction and broadening student participation are often demanding and imperative. There is a need to alter our institutional structures and

barriers to grant all students access to equitable and high-quality education, regardless of their backgrounds or personal characteristics.

To meet this need for social justice, an increasing number of physics leaders engage in change work to improve targeted aspects of their programs. Changes that span multiple department areas and are deep and pervasive (as the ones mentioned above) require cultural change [8–10]. In other words, to effectively broaden and retain a diverse student body, change leaders should not just alter specific program elements but also consider altering the local culture to make it more welcoming and supportive of marginalized students.

The leading disciplinary organizations in physics, the American Physical Society (APS), the American Association of Physics Teachers (AAPT), and the

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American Institute of Physics, offer support and resources to interested physics faculty for engaging in educational change through workshops, disciplinary initiatives, and professional development programs [6,7,11]. Research and evaluation on these disciplinary resources have documented positive outcomes. For example, APS and AAPT developed the Physics and Astronomy New Faculty Teaching Institute (formally referred to as the New Faculty Workshop) (FTI) [11]. Studying the effects of the FTI, Chasteen and Chattergoon [12] documented a shift in norms in the physics community from a teacher-centered approach (traditional lectures) to student-centered instruction.

Higher education scholars have developed several models for professional development (e.g., communities of practice [13,14] and faculty learning communities [15,16]). In this study, we focus on a particular resource for professional development that is designed to expose physics faculty in an alternative framework around educational change, the Effective Practices for Physics Programs (EP3) Initiative. EP3, among other supports and resources, includes a community engagement component offered through the Departmental Action Leadership Institutes (DALIs) [17]. The DALIs are designed to prepare physics faculty to become effective change agents. Through this leadership institute, physics faculty learn how to pursue change efforts that will lead to sustainable improvements in undergraduate education and to a stronger culture of self-reflection and action. This study investigates the impacts and outcomes of the leadership institute on participating departments.

A. The departmental action leadership institutes

The DALI was developed in 2021 by Joel Corbo, one of the co-creators of the Departmental Action Team (DAT) model [18], and David Craig, a member of the EP3 leadership team [19]. DALI was created as a scaled-up effort of the DAT model under the idea of supporting institutional change at a national level [20]. Physics faculty apply to DALI to receive support in responding to challenges and/or engaging in opportunities to improve areas in their programs. Those selected are asked to nominate a pair of physics faculty (change agents) representing the physics program in the yearlong DALI sessions. Each cohort includes five physics programs. DALI accepted its first cohort of five departments in Spring 2021. Since then, DALI has worked with four additional similarly sized cohorts of departments, a total of 25 physics programs. In particular, DALI starts with a two-day in-person kick-off workshop (virtual during the pandemic) and continues with biweekly virtual DALI sessions. Two experts in departmental change facilitate the kick-off workshops and biweekly sessions (see Fig. 1). Through participation in DALI, the pair of physics faculty builds its capacity as change agents. Concurrently to DALI participation, each pair of physics faculty create and lead a local team with multiple stakeholders following the Departmental Action Team (DAT)

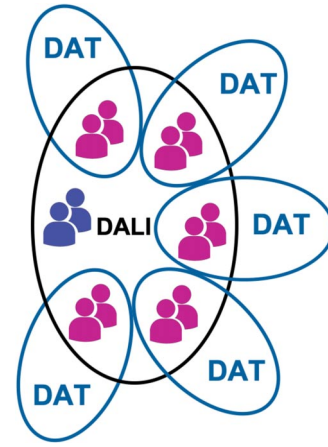


FIG. 1. DALI structure: In each cohort, two experts in departmental change (in purple) facilitate the yearlong DALI sessions. Each of the five participating departments is represented by two faculty members (in pink) who, in turn, form and facilitate the local DATs that are charged with carrying out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

model [8,18,21]. The local DAT is responsible for pursuing the department's change effort. Key elements of the DALI design include pairing participants as change agents; incorporating a Just-in-Time Teaching (JiTT) professional development model [22] while leading local teams; providing social-cognitive opportunities for sensemaking with other change agents; employing a deliberately scaffolded curriculum that builds from month to month; modeling effective team activities through DALI facilitators that connect theory to practice; and maintaining accountability through regular progress updates.

Each local DAT is responsible for visioning, designing, implementing, and assessing the change. Each DAT is led by a pair of DALI participants, who translate the ideas about change into practice in their DATs. The DATs include multiple and diverse department stakeholders (e.g., faculty, students, staff, and alums) who work with the pair of change agents to carry out the DAT's work. Each DAT is embedded in a specific departmental and institutional context, which influences how the DAT performs its work (see Fig. 2).

In this study, we focus on these DATs through a case study analysis of five focal DATs. We conduct an ethnographic investigation using multiple sources (interviews, field notes, and artifacts) to document how a new culture around assessment and educational change emerges within these five DATs and discuss how it differs from the department's dominant culture as previously documented.

B. The DALI principles

The DALI structure and curriculum were developed around a core value of “cyclic self-reflection of change processes and outcomes to guide decisions and actions” [17]. In this section, we briefly introduce the principles

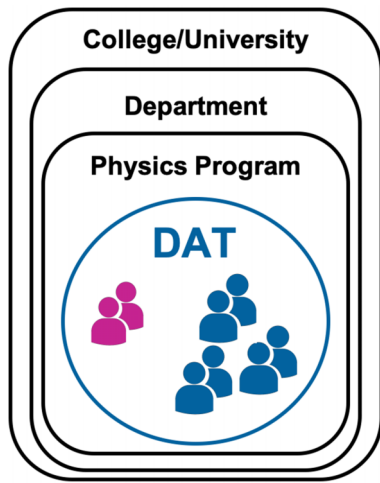


FIG. 2. DAT structure: The DATs “do the work” of visioning, designing, implementing, and assessing the change. Each DAT is led by the respective DALI participant pair, who translate the ideas about change from the DALI sessions into practice in their DATs. The DATs include other department members (e.g., 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.

of the DALI approach to change. These are based on organizational change literature and tuned more directly to the higher education context [23–25]. For more detailed descriptions of these principles, see previous work describing the development of DALI [26–28]. 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 [29,30].
- context-dependent: driven by local goals, challenges, and contexts, rather than external mandates [31,32].
- 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 [33,34].
- 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 [35,36].
- grounded in evidence, including an accurate understanding of the available evidence about the problem and decision making based on appropriate interpretation of the evidence [37–39].
- 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 [40,41].

We must note that DALI participants are not required to adopt these principles and values when pursuing their local

change efforts to continue their participation in DALI. None of the DALI principles or ideas are mandates; DALI facilitators only try to expose participants to these ideas. For example, it is up to the participants whether they choose to form teams to pursue their local change efforts. In DALI, these ideas are explored through reading and discussing relevant literature on organizational change or organizational leadership, modeling inclusive facilitation and organizational strategies, and learning from each other’s shared experiences of past change efforts, among other topics.

This work is part of a broader study that focused on five focal physics programs from cohorts 1 and 2. In our first paper, we focused on examining the dominant culture around assessment and educational change (through the accounts of DALI participants). In this study, we document the emerging idioculture within these five DATs around assessment and educational change and discuss this idioculture in relation to the DALI principles. In particular, we aim to address the following research question: *What does the culture around assessment and educational change look like in these DATs?*

II. BACKGROUND

In our first publication as part of this broader study, we documented aspects of the dominant department culture around assessment and educational change [26]. In particular, we identified three themes:

- rushed and *ad hoc* approach to departmental change ignoring formal evidence,
- individualistic and siloed approach to 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.

This paper documents the emerging culture within these five DATs around assessment and educational change. We discuss the present findings in relation to both the dominant culture (as previously documented) and the DALI principles. While we do not make causal claims *per se*, as other experiences parallel to DALI may have enabled a cultural shift, we note instances of particular connections to DALI participation when our participants explicitly do so.

III. THEORETICAL FRAMEWORK

In this study, we continue to build our claims drawing from the cultural dynamics theory. Cultural dynamics theory is grounded in Schein's framework of organizational culture [42,43] combined with ideas from symbolic-interpretive perspectives [44]. 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 [42–44]. Hatch [44] extended 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 distinct elements from artifacts, arguing that symbols are artifacts with meaning.

In the present study, DAT members describe the teams' approach to assessment and educational change. Many faculty members with prior experience in change efforts often situated their narratives within these past experiences. Our early interviews with DALI participants focused on the dominant cultural elements around assessment and educational change. Due to their concurrent participation in DALI, participants could articulate the underlying values and assumptions of their cultural communities. In follow-up interviews focusing on the emerging culture within DATs, many participants (namely the DALI participants) continued to reflect on these levels of culture (underlying values and assumptions).

Hatch identified the processes by which the cultural elements are related and, thus, how culture is constituted (see Fig. 3). She proposed four processes—*manifestation*, *realization*, *symbolization*, and *interpretation*—continuously co-occurring in cultural periods of stability

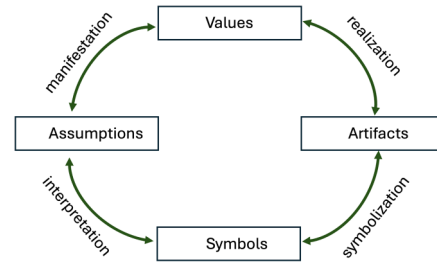


FIG. 3. The Cultural Dynamic Model: The model has its roots in Schein's framework of organization culture and the ideas drawn upon symbolic-interpretive perspectives. Figure adapted from [44].

and change. More specifically, she argued that manifestation is the process by which cultural assumptions translate into people's espoused values (proactive manifestation) or by which values influence assumptions (retroactive manifestation). Cultural realization translates expectations and values through actions in artifacts (proactive realization) or alters values by producing artifacts (retroactive realization). Symbolization is the cultural process that gives tangible artifacts a symbolic meaning (prospective symbolization). Retrospective symbolization refers to the process through which literal aspects of an artifact become more central to organizational members than their symbolic meaning. Finally, interpretation is the process through which a cultural frame is used to contextualize symbols by giving them meaning (proactive interpretation) or through which new symbols influence cultural assumptions (retroactive interpretation).

In this study, we make claims about artifacts, espoused values, and symbols, which can be observed through participant accounts and observed behaviors. While we acknowledge that Hatch's model also links these elements to underlying assumptions, such assumptions are deeply tacit and difficult to access directly. As such, our analysis focuses on the observable cultural dynamics while pointing to possible implications for assumptions where appropriate.

In the present study, we use Schein's cultural levels and Hatch's processes to examine how cultural change is enacted and understood within these teams. We analyze these connections in Sec. VI.

IV. METHODS

A. Study design and context

This paper is part of a larger, multiyear research project (2021–2023) investigating physics departments participating in DALI. We launched case study investigations of the five participating physics programs across two DALI cohorts. Using a multiple-case-study design [45], we collected a variety of data sources to capture how local DATs formed and enacted programmatic change.

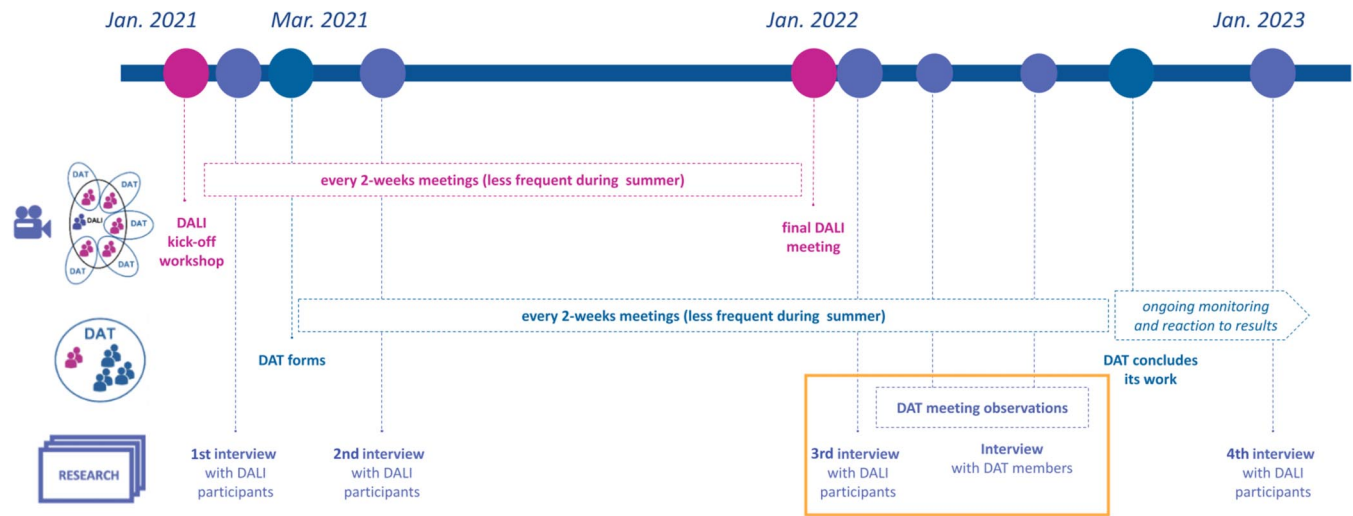


FIG. 4. Timeline of the DALI activities, DAT milestones, and research activities. Example from cohort 1 (2021–2023). In this paper, we draw results from the third interviews with the DALI participants, interviews with DAT members, and artifacts and field notes from a subset of DAT meetings.

The broader dataset includes video recordings of the DALI early kick-off workshops, biweekly DALI meetings, progress reports, and longitudinal interview data with program representatives. For the present study, we analyze a focused subset of these data: (i) interviews with DALI change agents and additional DAT members, (ii) field notes from DAT meetings, and (iii) artifacts (e.g., agendas, notes, and shared resources). These data sources allow us to analyze the emerging culture within DATs, guided by frameworks of cultural dynamics [42–44]. Figure 4 presents the timeline of the DALI activities, DAT milestones, and research data collection events, with the subset of data used in this paper highlighted.

B. DEVELOPING AND PILOTING OF INTERVIEW QUESTIONS

Interview protocols were designed to elicit participants' perspectives on the structures, practices, and culture of their DATs. Questions focused on four main areas: (i) assessment practices (e.g., *What sort of information or evidence has your local DAT been looking at or gathering as part of its work? How do you imagine data or info mattering in your decision-making process or in your team's approach?*), (ii) decision-making processes (e.g., *What kinds of decisions has your local DAT made so far? What did that decision-making process look like?*), (iii) team interactions, and (iv) student participation. For example, faculty and staff were asked: *[Name of the change agent] mentioned that your DAT includes students. How is this playing out?* Students were asked: *To what extent do you feel that your role as a student influences how others perceive and value your input in the DAT? Can you provide an example of when your opinion influenced (or was overlooked) in DAT discussions?*

The protocols were informed by our *in situ* understanding of DALI and DAT contexts, including the shared language and norms we observed during DALI workshops and DAT meetings. The interview protocols were initially drafted by CT and RD and refined collaboratively by the research team. After conducting the first interview with a participant, we identified a few questions that needed minor adjustment for clarity. In this way, the first interview served as a live pilot, allowing us to refine the protocol while maintaining comparability across interviews.

C. Participants

Two faculty members represented each participating program in the DALI setting. These DALI change agents were interviewed 3 times across the study period (10 agents $\times$ 3 interviews). Additionally, we conducted one-time interviews with the remainder of the DAT members in each program. DAT members represented diverse roles: faculty, staff, students, and alumni. We invited all DAT members to participate in the interviews.

All interviews were conducted via Zoom, recorded with participant consent, and transcribed verbatim. Field notes were also taken during DAT meetings (approximately three per program). Most cohort 1 DAT meetings were virtual, although some cohort 2 programs transitioned to in-person meetings with hybrid access for researchers and alumni.

We introduce each case study by presenting institutional characteristics, the size of each DAT, identifying the two participating DALI change agents and the remaining DAT members, along with the roles and positions of interviewees. To protect anonymity, all participants were assigned pseudonyms. Each pseudonym begins with the same letter as the pseudonym of the participant's institution, helping readers make associations (e.g., institution: *Maple College*,

TABLE I. Characteristics of the five case study physics programs. Note: T/TT stands for tenured/tenure track.

Institution	Physics program within	Department size
Maple College	Physical Sciences Department	12 T/TT faculty, 1 office assistant
Hemlock University	Department of Physics and Engineering	11 T/TT faculty, 2 adjunct, 1 office administrator, 1 lab technician
Palmetto University	Department of Biological and Physical Sciences	4 T/TT faculty, 1 adjunct
Ironwood University	Physics and Optical Engineering	16 full-time faculty, 1–2 visiting faculty, 3 technicians
Basswood University	Department of Physics	9 T/TT, 2 lecturers, 2 research scientists, 1 administrative assistant

change agents: *Morgan* and *Misha*, remaining DAT members: *Mike*, *Matias*, *Marcus*, *Megan*, and *Manuel*).

Institutional and program characteristics were obtained from multiple sources, including DALI applications, university website, and interviews with change agents. Almost every physics program was situated within a larger multidisciplinary department (all but one). Table I presents the larger departments in which these physics programs are housed along with departmental faculty size. Table II summarizes the institutions, pseudonyms of the interviewees, and the roles or positions of participants within their departments.

D. Analytical approach

Our analysis focused on the emerging idiocultures of the five DATs as they enacted programmatic change. We drew on the framework of cultural dynamics [42–44], identifying cultural elements across four dimensions: artifacts (observable behaviors and tools, such as meeting routines, protocols, or reports), symbols (artifacts carrying cultural meaning, e.g., data materials as indicators of assessment culture or compliance), espoused values (participants' beliefs around change, such as valuing data-informed decision making), and underlying assumptions (taken-for-granted norms, such as faculty authority in decision making).

Interview data with change agents and DAT members served as our primary source, supplemented by field notes and artifacts (e.g., agendas and notes) from three consecutive DAT meetings per program. Interviews provided in-depth accounts of DAT structures, processes, and norms, while field notes and artifacts contextualized the meetings. Consent was obtained from all present DAT members. Because meeting observations were virtual, we may not have fully captured the dynamics and interactions of DAT members.

We used thematic analysis [46,47] to identify and refine patterns in the data. Thematic analysis is a qualitative method for identifying, analyzing, and reporting patterns in the data [47]. The analysis followed the six phases of familiarizing oneself with the data, generalizing initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report [46]. Specifically, we first identified transcript segments relevant to the accounts of the culture and norms within the DATs. Within this broader focus, we identified themes related to the DAT approach to (a) using data or evidence, (b) who is involved in discussions around assessment of student learning and what they look like, and (c) DAT students' role in the DAT's change work. We then revised the original themes accordingly by combining themes under a single one that tell a story for each case study physics program.

TABLE II. Summary of case study participants per physics program. Note: Bolded participants' names represent the change agents (DALI participants). The average size of each DAT ranges from 8 to 10 members (including change agents). The only private institution is Ironwood University. The only Ph.D. granting physics program is Basswood University, all others are primarily undergraduate physics programs. One institution is a Hispanic Serving Institution and one is designated as a Historically Black College and University.

Institution	Participants interviewed	Participants' role/position
Maple College	Misha , Morgan , Mike, Matias, Marcus, Megan, Manuel	Three faculty (physics), one faculty (science education), three alumni/students
Hemlock University	Harold , Henry , Helen, Harris, Hugo, Henrietta, Hector	Four faculty (physics), one faculty (math), two alumni/students
Palmetto University	Paul , Pradeep , Penelope, Patricia, Paris, Prince, Philomena	Five faculty (physics), two alumni/students
Ironwood University	Ian , Isaac , Iker, Ivo	Two faculty (physics), two alumni/students
Basswood University	Ben , Bill , Blake, Bella, Bridget, Brandon	Three faculty (physics), one instructor, two students/alumni, one university administrator

TABLE III. Summary of main themes, definitions, and case-specific illustrations. Note: Themes were highly prevalent across all five case studies. Subthemes illustrate how each theme was enacted in Maple College and Hemlock University, which are presented in detail in the results.

Main theme	Definition	Illustrative subthemes
Collective approach to change	DAT members engage in collaborative processes, co-constructing goals and actions rather than relying on individual leaders.	<i>Hemlock</i> : collectively maps goals, resources, and action plans. <i>Maple</i> : shifts goals and priorities based on collective deliberation.
Deliberate and strategic	DATs slow down to intentionally reflect, plan, and align actions with long-term goals.	<i>Maple</i> : deliberate reflection on values and preconceived notions. <i>Hemlock</i> : strategic planning of timelines and resource use.
Centering data	Data are used as a basis for decision making, often contextualized through participants' interpretations.	<i>Hemlock</i> : students translate quantitative data into faculty-relevant context. <i>Maple</i> : shifting priorities after interpreting student needs through discussion.
Partnering with Students	Students are recognized as essential contributors, shaping both processes and outcomes of DATs.	<i>Maple</i> : incorporating student perspectives to understand needs. <i>Hemlock</i> : prioritizing student input to guide decisions.

Analysis was conducted collaboratively. D. S. and C. T. led coding and initial interpretation, while the full research team iteratively refined coding schemes and thematic structures through weekly discussions. This process ensured that multiple perspectives were incorporated and strengthened the findings.

For reporting, we present findings from two focal case studies—*Maple College* and *Hemlock University*—which illustrate the range of goals and motivations to pursue change represented in the larger dataset. These cases highlight typical patterns as well as minor variations observed across the five DATs.

We report our themes with accompanying definitions (see Table III). These themes were prevalent across all five case studies, but our analytic focus is not on their relative frequency or prominence. Instead, we examine how these broader ideas, such as data use, partnering with students, and approaches to decision making, took shape in context and what cultural meanings they carried with each DAT.

E. Limitations

Our understanding of the emerging cultures within these DATs is based on partial access to their spaces. Because we relied on interviews with a subset of DAT members, our data capture only some perspectives rather than the full range of experiences. Observational field notes were taken virtually via Zoom, which limited our ability to observe in-person dynamics and nonverbal interaction. This was particularly notable when student members kept their cameras off. In addition, we attended only a small number of meetings relative to the total held by each DAT. As such, our observations provide a valuable but necessarily incomplete snapshot of DAT processes and norms.

V. RESULTS

A. Making cultural shifts within departmental teams around educational change

DALI participants are exposed to ideas around effective change, such as building diverse and high-functioning teams, developing a shared vision, and relying on data to make informed decisions. These are not mandated, and DALI participation is not contingent on adapting these ideas. However, across every physics program represented in DALI, we saw elements of these ideas reflected in their efforts within a few months.

In particular, we see that every pair of DALI participants formed teams following the Departmental Action Team (DAT) model, taking a collective and collaborative approach to the change effort. Each DAT consisted of 9–10 team members (including the change agents). Although including students as members of the DAT was a novel idea for the change agents [26], each DAT embraced this approach and included two or more students on the team. This included both current and former students and they were seen as partners in working on the intended change effort. Each DAT centered data collection or consulted and relied on previously collected data to better understand the context in which the DAT operates. Moreover, we have accounts of change agents (who had a facilitating role in these DATs) spending time helping the DAT establish norms and develop a shared vision, as well as developing practices for people to share their ideas and develop consensus in decision making. Four of these concepts—*collective approach to change*, *deliberate and strategic*, *centering data*, and *partnering with students*—are expounded upon next.

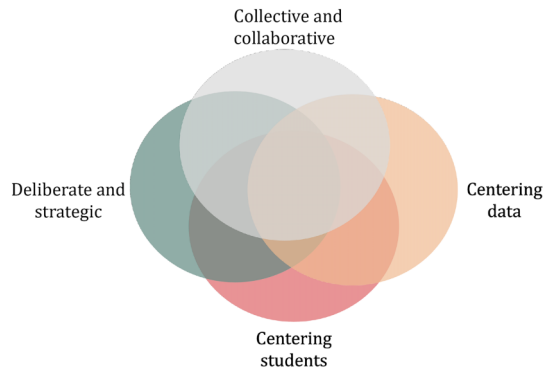


FIG. 5. The Venn diagram (above) illustrates the relationship (overlap) between the four main approaches to the change process taken within these five DATs. DALI participants took a collaborative, team-based approach to the change process by forming and facilitating local DATs. Within these five DATs, we found evidence of a deliberate and strategic approach to the change process, centering data and centering students' voices. The cultural practices that stem from these four themes are discussed in Secs. V and VI.

These four concepts or themes capture various cultural practices emerging within the idioculture of these five DATs. These cross-cutting themes were present in all five case studies, suggesting that DAT principles are being meaningfully taken up.

The terms “deliberate” and “strategic” refer to DAT members engaging in collaborative discussions regarding values, ideal visions for their programs, what program changes are needed, what to measure, how to measure it (tools), and for what purposes. Connected to this theme, DALI participants consistently refer to a DALI phrase, “going slow to go fast,” which conveys the importance of cultivating trust and deeply understanding each other and the logic behind the joint work. This sets the foundation for moving more quickly later. By “centering student voices,” we refer to activities where students are encouraged to share their ideas, experiences, and feedback in the DAT. Student input is then utilized to shape the DAT’s conversations and decision making. Finally, by “centering formal evidence,” we refer to activities such as collecting data (or using existing data), reading data critically, collectively discussing it toward building robust interpretations, and surfacing taken-for-granted assumptions.

The Venn diagram (Fig. 5) shows the relationships between the themes of cultural practices that emerge in this study. We found that DALI participants took a collaborative, team-based approach to the change process by forming and facilitating local DATs. Within these five DATs, we found evidence of a deliberate and strategic approach to the change process, centering data and centering students' voices. These approaches to the change process often overlap. This overlap is an important feature of our model as cultural practices mutually reinforce each other.

In the following paragraphs, we expound on the prevalent overlaps among the themes using exemplars from two case studies, *Maple College* and *Hemlock University*.

B. Cultural change at Maple College: A case study

Physics faculty at Maple College oriented to two possible areas for programmatic change: (i) student recruitment and retention and (ii) curriculum. Concerning the former, the physics program was striving to sustain a critical mass of physics majors, despite past efforts to meet students' needs and make their program attractive to students' interests. With respect to the latter, with the program review approaching at the time, the college decided to pivot toward a heavier emphasis on health sciences by introducing courses in biophysics and medical physics. The physics faculty needed support in understanding how to incorporate this focus under the existing recruitment and retention challenges.

In these DALI sessions, the change agents were introduced to ideas on effective approaches toward institutional change. Some of those discussions were “eye-opening” for both Misha and Morgan. They chose to adopt many principles and ideas on leading teams and to pursue effective change in their work, forming and leading the Maple DAT. In our interviews with Maple change agents and DAT members, we find robust evidence of an emerging idioculture within the DAT in taking a deliberate approach to change by centering evidence-based decision making. Figure 6 summarizes the emerging cultural practices in the Maple College’s DAT.

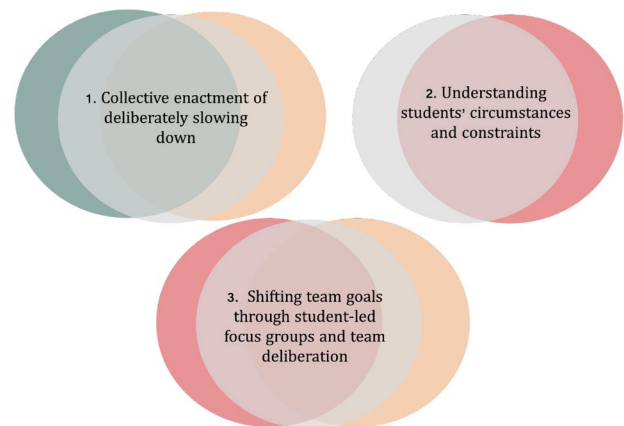


FIG. 6. This figure illustrates the cultural practices of Maple College that stem from the overlap of the four main themes identified across case studies. Maple College (1) deliberately slows down to reflect on its values and preconceived notions about the issue. We also find that members at Maple (2) take time to bring students' perspectives into the discussion by trying to understand their unique circumstances and constraints to infer the needs of Maple's student body. Finally, we find that they (3) shift team goals and priorities based on new understandings of their students and team deliberation.

The DAT idioculture is strongly built around practices that reflect the value of using evidence for decision making, as assessment has become an integral part of the DAT's change effort. The DAT worked together for almost a full academic year to develop assessment tools and collect and interpret data to decide on the DAT's action items. In particular, the DAT collected and used four types of artifacts to decide the direction of their work, (i) EP3 guide, (ii) student focus groups, (iii) student surveys, and (iv) interviews with potential local employers.

1. Collective enactment of deliberately slowing down

As opposed to the aspects of the dominant culture around quickly converging on solutions to problems at hand [26], the DAT takes a deliberate and slow approach by first understanding in depth what the sources of the problem(s) are. Misha describes below the value of taking the time to understand the issue at hand before rushing to conclusions.

I think this idea of stepping back and 'going slow to go fast' that's going to stick with me. [...] So I think putting in the effort to listen to people before jumping to conclusions.—Misha

Misha later stated that she naturally tends to jump into action, however, she deliberately tries not to as she has begun to understand the value of taking a slow pace at the beginning to get a holistic understanding of the problem at hand. Morgan corroborates on Misha's tendency toward rushing into action, stating that on many occasions she invites Misha to redirect her focus toward thinking about an idea in depth before drawing conclusions.

I think we are complementary. Misha tends to get ahead of herself a little bit sometimes because she is so enthusiastic whereas I'm more like 'no no no no, we have to stop. We have to think about this for a minute'.—Morgan

In our field notes of Maple's meetings, we observed an occasion where the discussion tended to quickly jump into identifying action items. In particular, during that meeting, Misha presented the outcomes from her interview with a potential local employer to understand how Maple College could prepare students for success internships. After Misha spent about 10 min on her powerpoint presentation, the DAT engaged in a long discussion. We noticed that at a few occasions where there was some initial agreement among a few DAT members, Misha started typing action items in the shared online agenda document. Morgan, who was facilitating the meeting, seemed to be attempting to slow Misha down by saying that they probably need to gather additional information from more potential employers before identifying the action items. Misha and other DAT members were importantly receptive to slowing down.

The collaborative aspects of the Maple DAT is emphasized by every Maple interviewee. Matias, an alumnus member of the DAT, described the democratic nature of the DAT which illustrates that the DAT values the input from not only faculty within the DAT but also students and alumni.

It's very democratic. We all meet up. We respect each other, we respect what everybody brings into the DAT meetings, and we really talk these things out together and kind of decide where we want to go.—Matias

The DAT used specific activities to ensure that everyone, especially, students have an equal say in shaping the DAT's ideas. One of these activities was the shared online document where everyone contributed their ideas. These type of strategies illustrate the DAT's emphasis on collaboration and open communication, as shown in Megan's, a student member's, quotation below:

We always refer to the [Google] document. So we have that shared document where we just do bullet points of each idea. So I will do mine in a different color, my ideas and my concerns, and then we all go through them, we all discuss them. We all give opinions on each bullet point. Perhaps we all agree or disagree on a course of action, and we follow through it like if we decide, for example, to do the surveys. And Mike was like, 'Oh, I can make it,' and somebody was like, 'Oh, I can share it with the people,' and I was like, 'Oh, I can make sure that my friends do it,' and stuff like that. So we just kind of all work as a team to make sure that whatever we decide happens.—Megan

As shown above, the DAT adapted activities to ensure that each DAT member can shape the discussion by openly contributing their opinions and perspectives. The Google document that Megan mentioned above is an artifact that symbolizes the openness in communication and collaborative nature of the DAT in welcoming every member's perspectives regardless of their role and power in the department.

2. Understanding students' circumstances and constraints

An aspect of the emerging DAT idioculture of *Maple College* that was influential on how it operated and its outcomes is its collective approach with substantial student engagement and central roles for students within the DAT's use of data. As opposed to the department's dominant culture, the DAT takes an inclusive approach to partnering with current and former Maple undergraduate students. The idea of partnering with students was generated in the DALI, where Misha and Morgan thought that it was a very

reasonable approach to take since the change effort concerns the students themselves. Morgan had some initial skepticism and concerns about how much decision-making authority students should be given on the DAT. Because Maple and the other case studies in this project were small, the pool of students available to participate in the DAT was limited. Maple in particular had only six physics majors; two students and one alumnus ultimately participated in the DAT. Megan, one of the student participants, noted that she believed she was invited to join because she had been especially vocal about both her enthusiasm for and concerns about the physics program.

On many occasions, Maple DAT students did have a central role in many of DAT's activities, especially those that included data collection and interpretation which opened up opportunities for the DAT to better understand students' circumstances and constraints. Morgan and Misha described that within the DAT students have a lot of input and contribution in the activities. In both separate activities (conducting focus groups and survey development), DAT students had a major role. They particularly described that the DAT students were given the authority to lead the student focus group and report back, and on the second activity (survey development), students were sharing their ideas in generating survey questions equally with the rest of the DAT members.

DAT students' and alumni's participation in the team was unique in the sense that they bring the "student" perspective to the table that is different from the faculty members' and it helped the DAT move forward on many stages of the data collection and interpretation process. More specifically, Megan, as student member, described that there is an implicit assumption that the ultimate decision making is up to the change agents, Morgan and Misha. However, as she explained, the faculty DAT members are open to shifting their opinions after listening to the student-DAT members' input.

The faculty, although they do hold that last decision, they are always very open to like [change their minds]. If we disagree at first they're open to discuss and they're open to change their mind. They're not close on that like "No, we're not doing that" like they're always open to listen to our concerns, and to ultimately change their mind if we make them change their mind. They're not close to their mind, they are always open to new ideas, new perspectives.—Megan

Similarly, Marcus, a faculty DAT member stated that students have less say than faculty members on decision making. He explained that the extent to which students' input affects the DAT's decision making varies and is dependent upon the topic at hand.

They [students] have sort of the 49% [say in the] decision [making]. So they're not able to veto the faculty on things, but they also are aware that they're students. [...] For the things that student input made sense, absolutely. There are things they don't know about, like they've never been on a faculty search, and so they just don't have a lot to say about what it's like to be on a search committee to hire a faculty member. They've never done it. But when it comes to picking classes, choosing a major, coming up with course descriptions, talking about what classes were useful to them, all of that information was found to be very interesting, and it was, I think it was all used.—Marcus

In one of our field notes of Maple DAT meetings, Morgan, who facilitates the meeting, specifically invites students' feedback when they have been quiet for a while. The conversation concerned student internship and how to make them more appealing to students based on their needs. One faculty member suggested that the program offers course release time for students who do the internships. Morgan then asks student members to think if this is a feasible plan since students are not compensated and since this covers only one course credit. The students were actively engaged from that moment on, sharing their own personal experiences to help inform the rest of the DAT on the student perspective around the topic at hand. The conversation was as follows:

- Megan (student): It's hard because I have several time commitments.
- Misha: What if the summer internships are paid, around \$3000?
- Megan (student): I can make up to \$40/hr in my summer work so this is not enough motivation. The main question is will this benefit my career, shall I leave my job that pays well and supports me through the winter to do the internship?
- Morgan: Would giving more course credits for working 20 hrs/week be more or less feasible?
- Megan (student): More feasible—maybe not similar for doing research which does not pay at all.
- Morgan: So it's a better idea if it's during the course year as opposed to the summer since students work outside of campus in jobs that pay well?
- [Both students agree.]

The DAT overall valued student input by following up on their suggestions. In several other occasions, students were commenting on the ongoing conversation in the chat

feature of Zoom and the DAT was reacting to these comments.

3. Shifting team goals through student-led focus groups and team deliberation

In each stage of the *Maple* DAT's work, the team used formal sources of evidence (EP3 Guide, student data, and information from local employers) to guide their understanding of the issue at hand and their decision making. Morgan later described in detail what that process looked like in practice.

So we all read through that [transcripts from focus group] the entire DAT, and then we kind of picked out what we thought were the main themes from that. We've just been looking at sort of what are the responses that are really floating to the top, in terms of number of responses. Most of them are multiple choice type questions. And just like seeing again if there are themes, big themes emerging in the more open ended responses.—Morgan

As shown in Morgan's description above, the DAT was working together to identify the emerging themes in student focus groups as well as the open-ended survey responses. One of the emerging themes that came up in the data was the focus on a particular aspect of the program's curriculum, one the DAT had not previously considered. More specifically, Morgan described that the state of curriculum had came up at the very early stages of the DAT's lifetime, but the faculty initially considered it to be at a decent state so there was no need for revision. However, as shown below, the student data contradicted DAT members' initial perspectives on the state of the curriculum. In light of this outcome, the DAT reconsidered and redirected its focus. Morgan's quotation below describes this process:

I would say that the focus group really made us think more about our curriculum. Because we kind of thought that this DAT wouldn't focus much on the curriculum. We thought our curriculum was in at least a decent place. And we weren't really too interested in tinkering much with it. But when we listened to the focus group students, we really got the idea that they do find the curriculum a bit inflexible, and they feel that that makes it difficult to graduate in four years, especially if they're transfer students or other nontraditional students. They've talked a lot about feeling that the math that they learned in the math classes, they don't understand how it translates into the physics classes.—Morgan

The above quotation shows the extent to which the DAT valued and respected the outcomes resulting from student

assessment by redirecting their focus toward designing a flexible curriculum to meet students' needs. As we describe in more detail in the following subsection, in many cases, the DAT delegated subtasks related to collecting and analyzing data to subsets of team members who collaborated and then brought synthesized results back for the entire DAT to collectively reflect upon.

C. Cultural change at Hemlock University: A case study

Harold and Henry, two physics faculty members at *Hemlock University* applied to participate in DALI hoping to learn how to become effective change agents as they move into leadership positions as Chair and Interim Chair, respectively. With a program review upcoming, the Department was under a self-reflection period, with one area of focus being the improvement of student retention.

Similar to *Maple College*, change agents at *Hemlock University* chose to adopt many principles and ideas on leading teams and to pursue effective change in their work, forming and leading the Hemlock DAT. In our interviews with Hemlock change agents and DAT members, we find robust evidence of an emerging idioculture in the DAT that centers students as partners in many prominent ways. Figure 7 summarizes the emerging cultural practices in Hemlock University's DAT.

The DAT idioculture is strongly built around practices that reflect the value of taking a strategic and slow-paced approach to understanding the sources of the issue by centering students' input. The use of data guided the DAT's decision making. DAT students' voices were elevated in

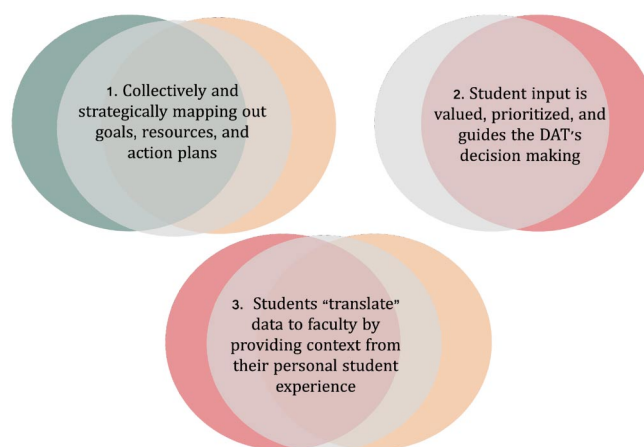


FIG. 7. This figure illustrates the cultural practices of Hemlock University that stem from the overlap of the four main themes identified across case studies. Hemlock University (1) collectively and strategically maps out goals, resources, and action plans. We also find that people at Hemlock (2) value and prioritize student input in a way that guides the DAT's decision making. Finally, we find that (3) students translate data to faculty by providing context from their personal student experience.

this process as they added a unique context to the data interpretation process that stemmed from their personal experiences in the department.

1. Taking collectively strategic steps to map out goals, resources, and plans of action

Hemlock University's DAT took a deliberate and strategic approach to the change process. The initial phase of the DAT's work focused on brainstorming around the DAT's focus. Harold's quotation below shows their approach to taking as much time as needed to think about the whole process, checking that they have all the necessary tools and processes identified to move on with the change effort.

We don't have the sense of urgency that others [DALI participants] have, which allows us to kind of sit back a little bit more and really think about taking our time and doing it slowly. Just making sure that our pieces fit together, like a tetris puzzle, very nicely and that we're doing it and getting the experience of doing this sort of thing. So that when things come up and then if we do have an urgency then we have the tools and the ability to proceed in the same sort of fashion with another data of some sort if need be.—Harold

As shown above, Harold also pointed out that this change effort will also work as practice for them to learn and be ready to proceed with any other need to emerge.

Hector, a student DAT member, described the slow and deliberate approach to identifying the plan of action, saying:

Generally in the decision-making process, we usually begin by brainstorming a lot of ideas. And [...] we all kind of sat down coming back from the summer and kind of set out to see what our goals for this following school year would be. And so we all usually go into breakout rooms, kind of start brainstorming ideas, and then eventually we would come back. Everybody would kind of share the ideas they had come up with, they would put it all on a list for everybody to see on screen, and we would kind of start mapping them out and seeing which ones are more achievable versus which ones might seem like a little bit more stretch. The [way] we came up with our decision, it usually ended up being which one [plan] did we see is having the biggest effect possible but was also achievable.—Hector

As shown above, the DAT had a deliberate and collective approach to decision making which was based on the impact and feasibility of the intended course of action. As

we expand in the following paragraph, students had a pivotal role in decision making, given the unique lens they bring into the DAT.

2. Student input is valued, prioritized, and guides the DAT's decision making

Partnering with students in DATs is a principle that we observe across all the case studies. However, in *Hemlock's* DAT, partnering with students is at the spotlight of this collaboration. Students developed agency over the DAT's goals and its processes. More specifically, the DAT was formed to support students who are underrepresented in physics. To narrow this down, an early DAT activity had each member read a report about the persistent underrepresentation of African American students in physics and astronomy in the United States [48]. The report outlined five factors that impede African American student retention, including belonging, physics identity, academic support, personal support, leadership, and structures. In the early stages of the DAT's formation, the team worked to identify a plan of action. In one of these meetings, each member ranked the five factors (from the report) in order of perceived priority for the DAT's change effort focus. However, rather than averaging all the rankings, the change agents chose to prioritize the factor that students had unanimously voted for ("belonging"), despite faculty members voting differently and constituting a majority. Harold says of this decision:

All the students [ranked belonging] number one or two. There are a couple faculty members that put it further down not realizing that's such an important; you need to feel that you belong. Some of the faculty members kind of, I think, have an idea that we're already doing a good job on that, let's focus on some other things. And I think the students were generally in agreement with that, but they said. The very first thing [students need] is to feel they have a mentor, feel they have somebody to talk to you, feel that they have classmates they can talk to, and feel like they're a part of the community before they can go any further. So I think [the students] were instrumental in making that the thing that we were focusing on. —Harold

As opposed to the *Maple College* case study, in *Hemlock*, students' voices are prioritized despite the fact that their input does not represent the majority perspective in the room.

Hugo, a student DAT member, expressed his initial concerns about his role when he was first asked to participate in the DAT. He later realized that his role and input were more important to the DAT than he could think of.

So I guess going into the DAT, I was worried that from a student's perspective that my input may be a little washed out. As it progressed, I definitely learned that wasn't the case. It quickly became evident that my input was as important as someone else's, especially being the only black person on the group. So my perspective really matters because it's not, it's, my perspective is very unique to the group, as everyone else's is as they choose the teachers, all the group members, for a reason. So I think that as a student it feels like my input isn't just important, but it's needed.—Hugo

Hugo shared an example to emphasize that the student input was instrumental to the DAT's decision making. He particularly described that his suggestions that stem from his experience were immediately taken up by the whole DAT.

When we were trying to think of things that we could do—and I can't remember if Dr. [Harold] had originally thought of the mentoring program or if it was me who originally mentioned it—but me mentioning it, mentioning that I had been in a mentoring program, that I knew what the blueprint looked like, that I know that it's worthwhile to look into, my input on that alone pretty much gave us the green light to go ahead and try to start this mentoring program. So just from that, alone, I know that my input, like I've been saying, my input is important.—Hugo

As shown above, in Hugo's words, "my input on that alone pretty much gave us the green light to go ahead and try to start this mentoring program" shows the extent to which students' input was prioritized in the decision-making process.

3. Students "translate" data to faculty by providing context from their personal student experience

Recruitment and retention rates were used primarily to determine the goal of the DAT. After establishing the goal of the DAT, more data were collected to understand what may be causing low retention and recruitment rates in the first place. These data mainly took the form of student surveys, which were collected from current physics students as well as students who have transferred out of physics into a different department. The DAT found that the physics students—especially the younger students—felt a lack of belonging and community within the department.

The DAT students had a central role in analyzing and interpreting the data. In the example we share below, although exit surveys from students who had left the department were always collected over several years, nobody ever looked at them. The DAT decided to use

these data by assigning the analysis tasks to the DAT students. The students analyzed the data, identified themes, and brought them to the DAT's focus.

We spent a lot of time reflecting on the results and the data that we collected through the survey we did of the students. We looked up some numbers, retention and attrition numbers for the department, as well as for the college in general [...]. And we got access to these exit surveys, for every time a student had left the Department of Physics, they completed a paper exit survey, which was then just put in a drawer somewhere and no one looked at them, they just sat there. And so the two students on our DAT went through those surveys after they were kind of redacted for personal information and then analyzed and summarized the results.—Henry

Henry emphasized how intentionally the DAT decided to ask the students to engage with the data, since "they could speak to the student experience much better than we [faculty] could, and we might be looking at the exit surveys through a different lens than them."

Both Henry and Harold recognize the importance of not only collecting data from students but also including students in the data analysis process to interpret the issue at hand. Henry reflects on this process by saying: "When you partner with students you begin to hear their perspective on things, and that can really inform changing the way that you see your job from being one about teaching physics content to being more focused on helping students achieve their professional career dreams." This quote alone only shows the strong impact that partnering with students has had to the DAT's faculty members enabling them to shift perspectives and priorities in their interactions with students.

Harold, the other change agent, also emphasized the unique student input on the data interpretation:

So, I think they give [the DAT] a little bit of a different perspective. Coming from the students' side about how students view our physics TAs and our physics library, and [...] whether or not the advising helps, or how much they know about research opportunities and what things that they would want to hear about that might have helped them. [...] They've definitely given some input and things that we didn't think of as faculty members.—Harold

Hector, below, described that DAT students' emphasis on the need to focus on student belonging is also reflected in the exit-ticket survey data, showing that DAT students' input is another, more direct source of information.

So a lot of the work me and Hugo have done as the students has been looking through surveys. The original ones were specifically exit surveys, where we were going through and actually seeing what physics students, like their reasoning for leaving, and that's kind of why I said earlier, like some people felt like they were struggling and that they might have stayed if they felt they had like received a little bit more support from the beginning.—Hector

Data were heavily valued and used in the DAT's decision making. Hugo, a student member, shared an example where data from the student belonging survey informed the DAT's decision making and follow-up planning steps.

We sent out the belonging survey. That was just seeing how students felt about the department and things like that. We learned that a lot of students weren't exactly happy with how advising was handled, we learned that a lot of students are stressed about how much time they have to put towards the major in their time management, and things like that. So we're able to take that and kind of inform our decisions throughout this year.—Hugo

In our field notes of Hemlock's meetings, we observed that the DAT engaged in discussions around tools and processes for climate data collection, specifically by consulting the EP3 Guide on assessing diversity, equity, and inclusion (DEI) climate in physics. At the end of this meeting, the DAT generated several action items (e.g., proposing a DEI statement to the department, conducting a focus group with students and faculty to discuss the classroom climate) and designated them to team members.

VI. DISCUSSION

This study was conducted within the particular setting of the DALI. The findings of this study resulted from a multiple case study methodology [45,49,50] using multiple data sources, including DALI and DAT participant

interviews, field notes from DAT meetings, and documents and artifacts. DALI was developed based on a set of principles [17] that overlap with the Departmental Action Teams (DAT) model [8,18]. DALI participants engaged for about a full calendar year in the DALI professional practice, learning about effective leadership and organizational change theories and practices. DALI participants were encouraged to create and lead teams following the DAT model. Participation in the DALI was independent of their decision to adopt the DALI and DAT principles.

In our previous paper, we documented these five physics programs' dominant culture around educational change [26]. We found that the dominant culture includes *a rushed and ad hoc approach to departmental change that ignores formal evidence*. The tasks around educational change were prescribed and lacked internal motivation [51,52]. 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. We found a culture that espoused the value of student learning and a culture of compliance with external mandates around the use of data [23]. Finally, we documented evidence about the *isolated nature of departmental change that includes only faculty, ignoring the formal inclusion of any nonfaculty voices*.

This paper finds that all DALI participants formed DATs to pursue educational change. In particular, we find and focus on four primary cultural shifts in these spaces. First, people shifted from individualized approaches to taking a *collective and collaborative* approach to educational change. We also find that people take a *deliberate and strategic* approach to work together by slowing down to narrow the goals, resources, and action plans. Another emerging cultural practice includes *centering student voices* by developing formal partnerships in educational change spaces. Finally, we find that people heavily *center data* to inform their decision making. Table IV summarizes the main differences between the previously documented dominant department culture and the emerging idioculture in these physics programs' DATs.

TABLE IV. Summary of the main themes identified in the dominant departmental culture [26] vs the emerging idioculture within the DATs around educational change (same participating departments).

Dominant department culture	Emerging idioculture within DATs
Rushed and <i>ad hoc</i> , “kick and rush” approach to departmental change ignoring formal evidence	Deliberate and strategic, “go slow to go fast” approach to departmental change centering formal evidence
Individualistic and siloed approach to assessment of student learning	Collective and collaborative approach to data use
Faculty-only discussion around departmental change	Collective and collaborative approach to the change process centering student voices

A. Changing the culture: Collective and collaborative approach to educational change

Across all case study physics programs, we found a collective and collaborative approach to educational change. DALI participants chose to create teams following the DAT model [8,18], with attention to a diverse representation where team members can contribute to decision making. All DATs consisted of 8–10 members and partnered with students in meaningful ways. Meaningful member participation presupposes that members feel that their input is heard and valued and have the power to contribute to decision making [8]. We also found that these DATs deliberately developed team norms of collaboration, such as *placing ideas on the table* [53]. People often referred to adapting certain activities introduced in the DALI to support DAT members in sharing their ideas in a structured way. For example, we saw earlier that Megan, a student DAT member at Maple College, mentioned that the DAT used a shared online document where each member contributed their ideas and perspectives. Similarly, at Hemlock University, Hugo mentioned that the DAT developed ideas through breakout rooms where paired individuals generated ideas. Then, the whole DAT came together and shared the screen, going through each pair's generated ideas, mapping them out, and prioritizing them based on two criteria: impact and feasibility.

The cultural practices of a collective and collaborative approach to educational change are reflected in artifacts such as the shared online document (Maple College) and shared screen of the shared document (Hemlock University) that symbolize the openness in communication and access to contributing to the team conversation [44].

From a cultural dynamics perspective, these collaborative practices (e.g., using shared online documents, breakout brainstorming, collective mapping) exemplify *realization*, where the espoused value of inclusivity and democratic participation are enacted through concrete tools and behaviors. Over time, these artifacts could acquire symbolic meaning: the online document coming to represent transparency and shared ownership, while the Hemlock mapping process coming to symbolize a collective orientation toward strategic, evidence-based decision making. Through *interpretation*, these symbols could reinforce deeper cultural assumptions within the DATs—that effective change requires shared responsibility and valuing both student and faculty voices. In contrast, in the dominant department culture, people took a more individualistic approach in committee meetings that resembled more of a “winning an argument,” debate-fashion, where people come with their understandings of the situation solely based on preconceived notions and push toward their personal opinion [26].

In our interviews with DALI participants, we found that taking a collective and collaborative approach to educational change and establishing norms and structures were

among the most important outcomes of their DALI participation. People intend to continue using the DAT model in other spheres of departmental work. Follow-up work will explore the extent to which this movement occurs.

B. Changing the culture: Deliberate and strategic approach to educational change

Across all case study physics programs, we found a deliberate and strategic approach to educational change. In particular, we found that DALI participants often revoiced a motto that was used in DALI sessions, “go slow to go fast.” The deliberation and strategic planning were largely evident in the following practices: slowing down to discuss the context of the problem, taking an analysis-driven approach [8,33,54], assessing readiness for change (resources and capacity) [55,56], and mapping action plans based on data-driven decision making [54].

For example, in the Maple case study, we saw the tendency of Misha to rush into actions. However, the other change agent and facilitator of the meeting, Morgan, slows Misha down by suggesting the need to collect more data before identifying action items. This illustrates *realization*, where the DAT's espoused value of evidence-based decision making shapes the team's actions and artifacts (e.g., deferring immediate solutions until more data are gathered). The team interaction that we observed further supports the collaborative nature in which these teams work together where people listen to each other and welcome each other's feedback, reinforcing a potential assumption that collective deliberation produces more effective and meaningful outcomes. In the Hemlock case study, we see similar deliberation as the DAT identified priorities of actions based on established criteria, namely impact and feasibility. Here, the structured mapping of ideas is not only an artifact of the team's work but also becomes a symbol of a strategic and collective orientation toward change. Through *interpretation*, these processes could feed back into cultural assumptions that effective change requires moving deliberately and strategically rather than rushing toward quick fixes.

As opposed to the dominant department culture where people often pursued educational change in a rushed and *ad hoc*, “kick and rush” approach and relied on anecdotes and intuition to move on with action items [26], in this paper, we found an alternative culture around educational change that values deliberation and strategic, long-term thinking.

C. Changing the culture: Centering student voices in educational change

Across all case study physics programs, we found a cultural practice to partner with students. Quan *et al.* [8] define partnering with students as a practice where “students are empowered to make meaningful decisions about their own education and to impact broader decision making around undergraduate education. Faculty and staff actively

seek out student input on the group's activities and structure on an ongoing basis. Students see themselves as having a say in how the group's decisions are made. There is continuous student involvement to meet the needs of the current student population." At Maple College, students developed agency by leading data collection activities such as focus groups and survey design. For instance, when students shared their perspectives regarding the feasibility of a proposed internship program, faculty members listened and incorporated that feedback to guide their next steps. This illustrates *realization*, where the value of centering student voice was enacted through concrete artifacts and practices (focus groups and surveys), and *interpretation*, where students' contributions could potentially reshape the assumptions faculty hold about the feasibility of a proposed internship program.

At Hemlock University, students played a unique and pivotal role in the educational change process. In specific cases, the DAT prioritized students' perspectives over the faculty majority when narrowing the DAT's goal. For example, when students emphasized "belonging" as the most critical factor for retention, this input directly redirected the DAT's priorities. Here, student voices functioned as symbols of the DAT's cultural shift, where students' lived experiences were elevated to a guiding principle. Through *manifestation*, students' assumptions about the importance of "belonging" could be institutionalized as shared values among faculty and peers.

Taken together, these examples demonstrate that the culture of "partnering with students" in its full definition [8] (p. 4) was embraced and practiced in these DATs. As opposed to the dominant department culture, where faculty work either solo or with other faculty members, excluding broader voices—these DATs created collaborative idiocultures where students' input was not only heard, but also in some cases, prioritized.

The cultural practice of partnering with students in the educational change process is not new in the international literature [24,57–63]. The majority of literature on "students as partners" focuses on instructional change, rather than program change more broadly. A meaningful partnership with students presumes that values and principles are embodied in practice in a way that allows all involved to work together through power sharing and dialogue [24]. Healey [58] mapped out a conceptual model of students as partners in four areas, including (i) learning, teaching, and assessment, (ii) subject-based research and inquiry; (iii) scholarship of teaching and learning; and (iv) curriculum design and pedagogic consultancy. The specific forms of collaboration between faculty and students within DATs may touch on these Healey domains (e.g., designing assessment efforts, designing changes to course sequences, conducting studies, etc.); however, they tend to take a more holistic focus on the program, rather than narrowly a specific course.

A widely spread example of students participating in educational change in physics programs is the learning assistant (LA) model [64]. In studying these spaces, Sabella *et al.* [65] identified three main types of partnerships between LAs and faculty: *mentor-mentee*, *faculty-driven collaboration*, and *collaborative*. This paper presents cases where students and faculty jointly work on data interpretation activities which align with the *collaborative* mode of partnership described by Sabella *et al.* [65]. Other domains of the DATs' work at times it falls within the *faculty-driven collaboration* [66]. The variability in the modes of partnership between faculty and students in DATs will be presented in future work.

Matthews *et al.* [24] reviewed the literature to document the positive and negative outcomes of such partnerships. The authors reported improved student-faculty relationships and learning and skills development among the positive outcomes for students. The authors discuss the common inhibitors to developing effective partnerships with students, which include relational (rigid power structures and poor communication) and resistance (risk-averse cultural structures, lack of recognition/reward). Exploring experiences and outcomes for students that result from partnerships in the particular context of DATs is a rich area for future work.

D. Changing the culture: centering data in educational change

Across all case study physics programs, we found a cultural practice to center data in educational change. As discussed earlier, Maple College collected multiple sources of data to inform its goals and generated action items, including student focus groups, student surveys, and interviews with potential employers and used literature and community resources (e.g., EP3 Guide [19]) as data sources. At Hemlock University, the DAT collected existing exit-ticket surveys and a survey on student belonging. The Hemlock DAT also treated the literature and resources, such as the EP3 guide, as data sources.

However, data collection is only one aspect of what is called "data culture." Data culture includes components of motivation and purpose (why data are used) [23,67], social dimensions (who participates in making meaning from data) [68,69], and interpretation (how data are used to construct meaning) [69,70]. Starting with motivation/purpose, the Maple College DAT was driven by the existential threat to the program's sustainability, which led members to realize that success required adopting a data-driven approach.

At Hemlock University, the DAT was motivated by its values of inclusivity and equity, centering data to guide changes aimed at improving student representation. These examples could potentially reflect *manifestation*, where taken-for-granted understandings were translated into shared values. At Maple College, the underlying assumption

that the program's survival was at stake manifested in values of evidence-based decision making and collective deliberation. At Hemlock University, the underlying assumption that equity and inclusion are inherently necessary and manifested in values of inclusion and student representation. In both cases, data were positioned as central to change.

The ideas around why data are used (motivation and purpose) and how data are used to construct meaning (interpretation) were especially prominent in our study. At Maple College, we observed faculty recognizing that their preconceived assumptions about the adequacy of the curriculum were challenged by student focus group data, which indicated otherwise. This is a case of *interpretation*, where artifacts (focus group transcripts) generated new meaning that reshaped assumptions about curriculum quality.

At Hemlock University, students played a crucial role in *realization*, not only collecting and analyzing data but also contextualizing it through their lived experiences. Students effectively translated data for faculty, turning raw numbers into situated insights about belonging. In this way, students' perspectives operated as symbols of the program's culture signaling that authentic student experience was not only relevant but also essential to guiding departmental change.

Through these processes of manifestation, realization, symbolization, and interpretation, the DATs built idiocultures where data became both a practical tool and a symbolic tool of shared meaning. This stood in contrast to the dominant departmental cultures, where data were either not used (e.g., exit surveys "sitting in a drawer") or treated individually rather than as a collaborative basis for shared interpretation [26].

The literature on "data culture" is growing increasingly over the last years [23,54,67–71]. One of the areas that requires more attention is how teams or groups of stakeholders come together to make meaning from the data. The dominant approach to data use in higher education still involves solo instructors working on their courses [54]. Decision making should be data-informed; therefore, a "data culture" needs to be woven into the standard routines and norms of institutional operations [71].

VII. IMPLICATIONS

The findings from this study suggest several key implications for departments seeking to cultivate sustainable, meaningful educational change.

1. Cultivate a collective and collaborative approach to the change process

Departments and change leaders aiming to foster educational change should move away from individualistic top-down approaches to change and instead turn to a collective and collaborative model. A collective model is more likely to develop greater autonomy [72], eventually to lead to better performance [73,74], and to promote the

sustainability of outcomes [75]. Establishing a team based on the Departmental Action Team (DAT) model can help provide space for diverse voices (e.g., faculty, staff, and students) to contribute to the decision-making meaningfully.

2. Take a deliberate and strategic approach to departmental change

Departments should resist the tendency to rush into solutions driven by intuition or past experience. Instead, they should adopt a slow and deliberate approach that prioritize developing a deep understanding of the local context and identifying the root causes of the issues before determining specific areas of focus for change [76]. It is equally important for departments to assess and/or build readiness for change by examining existing resources, capacities, and potential challenges [77,78]. The principle of "go slow to go fast" underscores that deliberate ground-work and strategic planning can lead to more effective change over time.

3. Engage students as partners in the change process

Departments often pursue change initiatives aimed at improving the student experience (e.g., curricula reform). However, students should not be viewed solely as the recipients of these outcomes, but rather as partners in the change process itself. Because educational change ultimately centers on students' experiences, involving them meaningfully in the process can provide critical insights and perspectives that might otherwise be overlooked by nonstudent members. Departments can invite student participation by advertising their approach to educational change and encouraging interested students to apply as partners, submitting a brief statement of interest from which two to three representative can be selected. It is essential to communicate that all members (faculty, staff, and students) will have equitable opportunities to contribute and voice their perspectives. Such partnerships benefit both students and departments: students gain valuable experience in academic decision making and a formal role that can be included on their CVs, while departments gain authentic, experience-based perspectives that enhance the change initiative goals.

4. Center data as a foundation for educational change

Meaningful change must be data-informed. Data play a critical role in the early stages of the change planning process by helping departments reflect on the current state and identify areas that require attention. Departments should also establish systematic approaches for collecting and interpreting data to assess and monitor the effectiveness of change initiatives over time. It is important to emphasize that, contrary to positivists views, data "do not speak for themselves." Rather, data sensemaking [79] is a key interpretive process through which individuals draw on their own experiences, values, and assumptions to construct meaning from data [33]. Engaging students as partners in these sensemaking processes is therefore essential, as they

bring valuable insights and lived experiences that enrich the collective interpretation and enhance the relevance and impact of departmental change efforts.

VIII. CONCLUSIONS

Disciplinary organizations offer various types of support to help physics faculty pursue effective educational change to improve critical aspects of their programs. The unique feature of the DALI is that it is a yearlong institute with high engagement. Participants get to implement the knowledge they gained and practice the skills in real time, concurrent with participating in the DALI. This way, they can continue building their skills and receive feedback on challenges as they emerge.

Our study provides empirical evidence about the efficacy of leadership institutes such as the DALI. While we do not claim *per se* that all the positive or negative aspects of collaboration in DATs result from their participation in the DALI, we cannot overlook the fact that participants largely attributed specific elements of their collaboration to DALI participation. For example, DAT's emerging idioculture differs from the dominant departmental culture in collaborative ways, including the inclusion of diverse stakeholders and voices, deliberate and strategic, and centers of formal evidence that guide decision making. These cultural practices align with the DALI principles.

This study is the culmination of an extensive investigation of DALI as a professional development resource. In the future, we intend to study more physics programs in further cohorts and collect longitudinal data about the threats and resources for sustaining collaborative cultural practices in educational change. We urge additional studies of professional development supports built around inducing cultural change as this will advance our understanding of effective organizational and cultural change models.

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