

Supporting first- and second-order departmental change with the Effective Practices for Physics Programs (EP3) Guide

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Many reports, research, and initiatives have presented evidence-based strategies to create strong departments. The Effective Practices for Physics Programs (EP3) Initiative is a collaborative effort between the American Physical Society (APS) and the American Association of Physics Teachers (AAPT) to compile and curate such resources in an online “Guide” for departments to empower high-quality physics education. To ensure the Guide helps improve physics education, this work aims to understand whether the Guide (a written document) can effectively support departmental change efforts (which can be complex). We draw from findings from a 2020 survey (N=310), 2022 survey (N=239), and 2022 interviews (N=8) of physics department chairs at colleges and universities in the US. In the survey, 22% of respondents had used the Guide and 18% had plans to use it, e.g., for strategic planning. Our interviewees spoke about their limited ability to engage in anything that is not immediately urgent and/or requires a significant investment of time. However, many also talked about getting good ideas from the EP3 Guide and using the EP3 Guide in a strategic way, such as during faculty meetings to spark discussion. We find that among EP3 Guide users, the Guide is a potentially effective tool to support first-order change, i.e., change that works within existing systems and worldviews, since interviewees reported using content from the EP3 Guide to understand, frame, and promote their departmental change efforts. These successes can also be leveraged to potentially engage the EP3 audience in second-order change, i.e., change that requires reframing goals and/or values, developing new structures, or other transformational processes. However, additional active supports such as webinars, short courses, or leadership institutes may be necessary for effective and sustained second-order change.

I. INTRODUCTION

A long-standing challenge faced by academic departments in higher education is how to create and sustain thriving programs that effectively educate diverse students. For physics departments, these challenges can have added urgency due to resource limitations (e.g., those generated by the coronavirus pandemic) or existential threats of being closed or merged with another department [1, 2].

Identifying strategies to help physics departments thrive is not a new effort. The Strategic Programs for Innovations in Undergraduate Physics (SPIN-UP) report [3] emphasized that strength arises from within: thriving programs take responsibility for their own growth, continuously evaluate their progress, and provide a strong education for their students. While the SPIN-UP report was transformative for many in the physics community and thus is an important milestone, one major drawback is its static nature. In the 20 years since its publication, the landscape of physics education has continued to change. Departmental growth has slowed, new teaching needs such as computational physics have arisen, and departments are under increasing pressure to more effectively and comprehensively address equity, diversity, and inclusion (EDI) [4].

To meet these needs a new initiative has been spearheaded: the Effective Practices for Physics Programs (EP3) Initiative. EP3 is a collaborative effort between the American Physical Society (APS) and the American Association of Physics Teachers (AAPT). The foundational product is the EP3 Guide (ep3guide.org), which is a comprehensive living document that compiles evidence-based strategies. The Guide currently includes 25 sections on topics including recruitment, retention, EDI, computational skills, and more. Each section was written and reviewed by members of the physics community including physics faculty (including PER), university administrators, and industry professionals; to date, over 240 people from more than 140 institutions have been a part of the Guide development process. Guide content will be regularly revised to ensure it remains current, with new sections added as appropriate. The Guide also emphasizes using a cycle of reflection and action, which encourages users to be intentional as they navigate the nonlinear nature of departmental change.

In addition to the written Guide, the EP3 Initiative has also developed programming designed to actively engage departments in change efforts. For example, EP3 has created the Departmental Action Leadership Institute (DALI), which has led 4 cohorts of physics faculty from 19 departments to engage with change leadership skills and practices. Participants reported that DALI increased their motivation and confidence in enacting change efforts and led to more measured approaches that included broad stakeholder involvement [5].

However, DALI can only serve a small portion of all physics departments at a given time. A written Guide has the ability to reach a larger audience to support additional change efforts, and so we seek to understand whether and how a written Guide – regardless of whether it is a static publication or

updated online content – can lead to deep change, and if so, whether some kinds of changes are better supported by the written document. After all, students don't learn physics from a textbook without a lot of support, so how can departments learn effective change strategies just from written advice?

The analysis presented here draws on findings from EP3's external evaluation. In §II, we briefly review departmental change literature to provide an interpretive framework. We describe the evaluation activities in §III and present the findings in §IV. In §V, we discuss implications and recommendations for EP3 and other departmental change efforts.

II. LITERATURE REVIEW

Scholars have proposed many different frameworks to describe change efforts, including within the context of higher education. One common classification scheme is to differentiate between first-order and second-order change based on what is being affected by the change effort. First-order change refers to change that works within existing systems and worldviews. Second-order change can be seen as transformational or radical change because it involves a fundamental shift in values, goals, worldviews, missions, and/or structures [6]. For example, imagine a physics department determines that students in the introductory physics courses are struggling when taking calculus at the same time. A first-order change might be to connect students with on-campus tutoring options so that they can receive additional instruction outside of class. Second-order changes, on the other hand, would include reforming introductory courses so that they provide opportunities for students to learn and practice math skills.

Researchers have applied the framework of first- and second-order change to STEM and physics change efforts. For example, [7] reflected on efforts to implement active learning practices, noting that while many instructors are aware of these practices, many instructors do not use or discontinue use of active learning [8, 9]. They critiqued efforts that largely relied on the inherent value of active learning rather than addressing “deep-rooted institutional structures and cultural norms” that discouraged its use; they argue second-order change is critical. Similarly, [10] critiqued change efforts that focus on individual faculty practices as “overly simplistic” and unable to create widespread sustained change. Separately, [11] summarized the TEAM-UP report's [12] argument that cultural change is necessary to address why the number of physics bachelor's degrees has more than doubled for all federally reported racial and ethnic groups except Black or African Americans (as well as American Indian and Alaskan Natives). Because the physics community needs to grapple with its own culture, value, and norms, using only first-order methods is likely to end in failure [11].

In this paper, we use this framework of first- and second-order change in our examination of data on EP3 Guide use to explore whether and how a written guide can support change.

III. BACKGROUND AND METHODS

This paper draws from data collected for the external evaluation of the EP3 Initiative in 2020-2023. We focus on findings from interviews with department chairs, which builds from the results of surveys of physics department chairs.

A. 2020 and 2022 surveys of physics department chairs

In May 2020 and again in June 2022, a survey was distributed to all physics department chairs in the US. The 2020 survey focused on departmental challenges and culture [1] and received 310 responses (41% response rate; 30% of respondents were from Ph.D.-granting, 9% M.S.-granting, and 61% B.S.-granting institutions). The 2022 survey focused on use of the Guide [2] and received 239 responses (32% response rate; 25% of respondents were from Ph.D.-granting institutions, 8% M.S.-granting, and 66% B.S.-granting institutions). These fractions were generally representative of the institutions invited to participate. In the 2022 survey, the top problem reported by departments was low enrollment in the major (71% of respondents), but this was less commonly a challenge for Ph.D.-granting institutions (47% cited low enrollment as a challenge). Other problems cited in both surveys were inadequate preparation of incoming students and low enrollment or retention of historically marginalized groups. Additionally, in 2022, the majority (76% of respondents) reported facing a moderate threat in the last 2 years, such as low enrollments (55%) or a reduction in faculty lines (32%); these rates were higher than the 2020 survey [1]. Further, 19% reported facing a severe threat, such as a department merger or closure. B.S.-granting departments were more likely to report severe threats. Additionally, most (72%) of respondents said they were aware of the EP3 Guide, and 31% of these reported that they used it in some way (22% of all survey respondents). For those who have used or plan to use the Guide, nearly half describe strategic uses, such as to guide strategic planning or program review [2].

B. Interviews of physics department chairs

To learn more about Guide use, 2022 survey respondents were invited to participate in follow-up interviews. Out of the 39 who volunteered to participate, 11 were excluded because they had not heard of the Guide or had served as Guide contributors. From the remaining 28, nineteen potential participants were selected, prioritizing those who had actually used the Guide. Eleven declined or did not respond to the request; thus a total of 8 department chairs were interviewed over Zoom between December 2022 - February 2023. Because few Ph.D.-granting institutions reported using the Guide, and several of those who did declined the interview request, these criteria resulted in an undersampling of Ph.D.-granting institutions. Of these 8 chairs, 5 had used the Guide and 3 had concrete plans to do so; 7 had experienced moderate threats,

and only 1 reported a severe threat. Five were at B.S.-granting institutions, two were at M.S.-granting institutions, and one was at a Ph.D.-granting institution. All were at institutions of $\sim 10,000$ or fewer students, and 5 were at institutions with fewer than 5,000 students. We did not collect personal demographic data, but the majority of participants presented as white men.

Interviews followed a semi-formal protocol covering use and perception of the Guide, experience of departmental threats, and advice for the EP3 Initiative. Guide users were asked to describe their latest or most extensive experience with the Guide in detail, including where they began, who was involved, and how ideas were captured. Interviews were conducted by Author SVC, with Author CO attending most interviews; both participated in interpretation of findings. While a fuller discussion is beyond this paper's scope, we recognize that our positionalities inherently influence all interactions we have, including these interviews. Author CO is a Program Manager on the EP3 Initiative with a background in PER/DBER and presents as a White-passing cis-woman. Author SVC serves as the External Evaluator of the EP3 project and identifies as a physicist, consultant, and white woman.

IV. INTERVIEW FINDINGS

Here we present major findings from our interviews. In the following section (§V), we analyze these findings and connect them to the framework of first- and second-order change.

A. Interviewees experienced situational overwhelm

Many (N=3) of the interviewees, especially those at small institutions, were completely overwhelmed. Additionally, several declined the interview request due to time constraints despite a desire to help the project. We heard from chairs who felt shame over having to focus only on immediately urgent issues rather than also being able to address important but non-urgent issues in their department. Some of these chairs were at universities with fewer faculty lines yet having to teach just as many courses, leading to overwork for themselves and their colleagues. Any change efforts will need to account for the situational overwhelm that some chairs face.

B. Regular reminders help with busy professional lives

Three interviewees, whether or not they were overwhelmed, indicated that they benefit from regular reminders. There are many initiatives in physics and education, and reminders were welcomed to keep resources on the top of their minds. Four interviewees expressed a need for small, manageable, and targeted opportunities to engage with EP3 ideas without inundating them. Thus, email reminders, newsletters, and webinars, along with specific examples of how others have used resources, may increase Guide uptake.

C. The Guide content and headings serve as a gateway to understanding a topic

A few interviewees indicated that they perused the Guide content, or heading structure, to learn about the topic (e.g., self study). For example, one interviewee talked about using the Guide structure to understand the taxonomy or dimensions of recruiting students. The Guide “[broke] it down into some sort of big categories for you.” They also used the Guide to understand the specifics of these practices, mentioning that “for me, one fear is that we’re going to do something and forget some key element of it,” and the Guide helped to alleviate this concern. This orientation was valuable for interviewees, but they did not capture ideas systematically (e.g., in notes) and did not seek a way to do so; instead, they expressed that the Guide content went into their general pool of knowledge. This pool of knowledge enabled them (in some cases) to plan their future action or engagement with other faculty. We recognize, however, that the lack of systematic capture of ideas reduces the potential for circling back to possible action items, reflecting on how efforts went, or gaining new (second-order) perspectives on the program.

D. There is a tendency to use the content “just in time”

Several interviewees reported that they used the Guide because of specific initiatives:

- 2 interviewees used the Guide for curriculum reviews,
- 1 interviewee used the Guide while developing a new degree track in engineering physics and planned to use the Guide when reviewing upper-level courses,
- 1 interviewee was a new chair and read the section on how to be an effective department chair,
- 1 used the Guide to serve as an external reviewer for another physics department, and
- 1 used the Guide to prepare for a College-wide presentation about EDI to fellow science faculty.

These situations can be leveraged as starting points for engaging Guide users. These common needs for “just in time” resources also underline the value of regular reminders of resources like the Guide, so that a chair is reminded of key resources at opportune moments such as the start of a new grant. At the same time, “just in time” use is not necessarily geared to addressing strategic priorities or program gaps.

E. Many focused on familiar ideas and current practice

Many interviewees described Guide use that seemed to focus on identifying ideas that aligned with what they were already doing or planning to do. For example, one interviewee focused on Guide headings that related to a recruitment strategy they were already using. Another interviewee read the Guide to confirm whether they were on the “right track” and should continue doing certain efforts. Additionally, because the content in the Guide can be overwhelming, starting with

familiar content was a way to reduce that overwhelm. Lastly, for a busy chair, a focus on improving the things they are already doing could be more manageable than trying to start something completely new. Unfortunately, that means many of our interviewees were not using the Guide as a way to find new strategies and become exposed to new ideas. This behavior also limits the ability of the Guide to lead to second order change.

F. The Guide was sometimes used in strategic planning for the department, driving faculty conversations

In both our survey and interviews, respondents used the EP3 Guide to support long-term strategy and planning. Two interviewees plan to use the Guide to support their future program reviews. Additionally, one interviewee described plans to use the Guide to implement priorities from a new departmental strategic plan. We also heard from several interviewees who used (N=4) or plan to use (N=1) the Guide to support faculty discussions. One person said the Guide was an effective “jumping off point”, with another interviewee describing the discussion as a generative exercise that used the headings in the Guide section about recruitment as “major bullet points”. These methods allowed them to use the Guide as a tool for generating action items for the department. Furthermore, two interviewees specifically mentioned the enhanced clout of resources promoted by organizations like APS and AAPT, and one interviewee specifically shared the Guide with their faculty as “[the Guide is] supported by APS as the ‘right way’ to build an effective physics program.”

These findings mirror findings from the 2020 survey [1] that departments do engage in productive strategic planning. In the 2020 survey, between 63% and 70% of respondents agreed that changes to the undergraduate program were driven by departmental goals (as opposed to outside threats); were driven by the department’s purpose; were seen as ongoing processes; were driven by shared responsibility among the faculty; and were supported by an innovative, experimental, and learning-oriented departmental culture. Additionally, the majority agreed that program review is approached as an opportunity for improvement (90%) and resulted in positive change (79%). However, there was room for improvement in such strategic change processes: only 37% agreed that program changes involve multiple stakeholders, and only 42% agreed that program changes are supported by data and/or assessment results, even though they would like them to be. Lastly, only 65% indicated that external review results were revisited periodically to guide the department [1].

In one interview, we discussed how we can better support their use of the Guide for strategic planning, e.g., by providing reflective prompts for faculty as they read the Guide. These findings can inform future resources created by the EP3 Initiative. Additionally, a request that came up in both the survey and in two interviews is for the Initiative to provide case studies about Guide uses. The EP3 Initiative should make sure Guide case studies include these strategic uses.

V. DISCUSSION AND CONCLUSIONS

Although many of our interviewees were facing situational overwhelm, they generally wanted regular reminders about the resources available through EP3. Those who had used the Guide (as well as the larger set of survey respondents) found it helped them to build out their understanding of a topic’s dimensions, and they tended to use guide content “just in time” and for strategic planning. We also note the particular positioning of the EP3 Guide – a document backed by APS and AAPT that was developed with broad involvement of the physics community – gives enhanced clout to its recommendations. In the 2022 survey, most respondents “moderately” or “strongly agreed” that the Guide is relevant (62%) and valuable (61%) to their departments; they also generally reported that “some” or “most” of their faculty would agree as well (72% for relevance and 73% for value) [2].

Thus, we find that the written guides like the EP3 Guide are potentially effective tools to support first-order change, which can be more familiar to change leaders as an accessible first step towards navigating overwhelming and complex change processes. Similarly, the 2003 SPIN-UP report [3] was taken up by the community as a “call to arms” to address the challenges and opportunities faced by physics departments [4]. Our findings suggest the EP3 Guide can be the next iteration.

We also note parallels between these Guide uses and research-based principles about learning. For example, how learners organize information influences their ability to apply that knowledge [13]. The EP3 Initiative was very deliberate in the Guide’s structure to provide a clear organization. Interviewees talked about using the Guide to understand the dimensions of an issue (§IV C), and this kind of learning can be a valuable start for larger change efforts. Learning is also a social activity [13], and we observed a tendency to use the Guide to spark discussions (§IV F). However, [13] also emphasized that learners need to monitor and adjust their approaches to learning to become self-directed learners. None of our interviewees systematically captured the ideas generated from the EP3 Guide (§IV C), hindering their ability to return to these ideas. Thus, a limitation of a written Guide is its inability to support metacognition and reflection, both of which are necessary (though not sufficient) to create effective change efforts, particularly second-order change.

Additionally, these parallels also suggest potential obstacles for deeper, second-order change from Guide use. Learners’ prior knowledge significantly affects learning processes [13], and we observed that interviewees often started with content that aligned with current knowledge and initiatives. However, if a user filters Guide content based on their own opinions and worldviews about what is important or productive, they could unintentionally limit their ability to engage with second-order change. As a parallel example, on the 2020 survey [1], the vast majority of survey respondents (74%) indicated that low enrollment or retention of historically marginalized individuals was a top problem for their de-

partment. However, only about half of these respondents indicated that department climate and creating an inclusive learning environment was an issue, suggesting a gap between perceived problems versus the change efforts needed to address systemic and cultural barriers. A written guide has limited ability to address these gaps; the deeper learning and broader stakeholder engagement needed for second-order change cannot be addressed with only first-order methods [11].

That said, written documents like the EP3 Guide can be a gateway to engaging users in second-order change. Survey respondents and interviewees appreciated the EP3 Guide’s carefully organized structure, research- and community-based advice, and coverage of challenges that real departments have. Using content from a written guide can serve as an introduction to change efforts, growing individuals’ sense of competence and agency. For the EP3 Guide in particular, its backing from both APS and AAPT provides additional clout to related change efforts. Interviewees talked about using the Guide to confirm they were on the “right track”; we recommend that the EP3 Initiative develop case studies to recognize and celebrate Guide-aligned first-order change efforts.

Finally, we recommend that the EP3 Initiative should continue to leverage these uses to design and assess additional activities that support second-order change. For example, EP3-facilitated leadership institutes encourage users to adopt a cycle of reflection and action that involves broad stakeholders and cultural change [5, 14], and EP3 should explore whether workshops, webinars, or other formats can create similar outcomes. However, because we recognize some chairs and change leaders face significant situational overwhelm, the EP3 Initiative should be mindful of participants’ contexts when creating these activities. Further, these activities can be designed for departments at different stages of change efforts. For example, in the 2020 survey, 70% of respondents said they had a strategic plan [1], meaning workshops, etc. about developing a strategic plan could target the roughly 30% of departments without one. Furthermore, only 41% of those with a strategic plan said they felt that they used it productively, so another set of workshops, etc. could be focused on how to effectively use and evaluate strategic plan progress. By creating pathways that empower change leaders to begin with first-order change inspired by a written document and moves them towards more involved engagements that support second-order change, the EP3 Initiative and other departmental change efforts can effectively support departments to sustainably improve and provide high-quality physics education.

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