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Integrating a DEI Focus in a CURE Development Model Across STEM Departments

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Abstract

The Howard Hughes Medical Institute's Inclusive Excellence initiative funded 57 institutions to improve capacity to include all students in STEM education and research activities. At Towson University, a professional development (PD) program funded by this initiative helped STEM faculty design course-based undergraduate research experiences (CUREs) and incorporate inclusive approaches in class instruction. Core components of the PD centered around training in diversity, equity, and inclusion approaches. An overview of the PD program is presented along with common barriers to creating CUREs and potential solutions for sustaining these pedagogical changes. Over five years, 35 faculty developed 25 CUREs in biology, chemistry, computer science, math, and geosciences. Many aspects of this PD can be maintained without external funding and can be replicated elsewhere.

Keywords: *course-based undergraduate research experience (CURE); diversity, equity, and inclusion (DEI); faculty development; STEM*

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Multiple studies show that undergraduate student participation in research promotes student achievement and persistence in their academic career (Bauer and Bennett 2003; Hernandez et al. 2018; Lopatto 2004, 2007; Thiry et al. 2012). Under a traditional "apprenticeship" system, students conduct research in a faculty member's laboratory. In many cases, these opportunities disproportionately go to students who early on express a desire to conduct research, have superior grades, and may be already familiar with research being conducted at the university (Bangera and Browell 2014). There is a substantial disadvantage to pursuing research for students who transfer from other institutions, struggle during their transition to higher education, have significant jobs or family responsibilities, are unaware of research opportunities and the advantages to engaging in research, or are from historically underrepresented groups in STEM fields (Estrada et al. 2011; Maton and Hrabowski 2004). This system therefore can be inherently exclusive.

From the faculty perspective, mentoring undergraduates in their research programs also comes with substantial barriers and costs (e.g., Ferguson 2023; Johnson et al. 2015, Morrison et al. 2019). This may be particularly challenging at institutions that are not R1, where faculty rarely have postdoctoral scholars or PhD students to assist with undergraduate student mentoring. In these situations, the faculty member must often devote considerable time to training and supporting the undergraduates who may only participate in the research for a year or two, in stark contrast with a PhD student who could be assisting with the faculty's research for much longer. In addition, depending on the institution, mentoring undergraduates may not be valued for promotion and tenure (Ferguson 2023). These barriers to faculty mentoring undergraduates contribute to an unequal playing field for students seeking out research opportunities, particularly those who may not have a stellar academic record or are unwilling to approach an instructor directly due to cultural norms, inexperience, or insecurity.

One high-impact pedagogical approach that is successful at engaging large numbers of students in research and

may avoid some of the issues discussed above comprises course-based undergraduate research experience (CURE) classes (e.g., Auchincloss et al. 2014; Bhattacharyya et al. 2020; Shaffer et al. 2010). CUREs also are a mechanism for increasing opportunities for students who are traditionally underrepresented in research, because a CURE may be taken as part of a student's required courses rather than an add-on, which an independent research (IR) opportunity might be considered. A recent study shows that participation in CUREs may decrease (although not eliminate) the achievement gap between historically underrepresented minority and majority students (Theobald et al. 2020). As many undergraduate institutions introduce diversity, equity, and inclusion (DEI) programming, coupling CURE support with professional development for faculty in DEI issues may help institutions change the academic environment and become more inclusive.

Although an abundance of evidence demonstrates that CUREs can result in student benefits as a high-impact practice comparable to IR opportunities (Corwin, Graham, and Dolan 2015; Olimpo, Fisher, and DeChenne-Peters 2016; Rowland et al. 2012; Shaffer et al. 2010; Shapiro et al. 2015), recent attention has been placed on understanding the faculty experience and associated barriers to implementation of CUREs (DeChenne-Peters and Scheuerman 2022; Govindan, Pickett, and Riggs 2020; Shortlidge, Bangera, and Brownell 2017). Not surprisingly, reported faculty experiences differ based on the specific CURE content, institution and class size, and available support systems (DeChenne-Peters and Scheuerman 2022); however, commonalities among challenges faced while implementing CUREs exist (DeChenne-Peters and Scheuerman 2022; Govindan et al. 2020; Lopatto et al. 2014; Shortlidge et al. 2017). Govindan et al. (2020) reviewed perceived barriers and proposed solutions based on experiences learned through various CURE implementations. The barriers discussed included cost, workload/scale, measurements of success, and faculty and institutional resistance, all of which may have equity implications if they prevent engaging more diverse undergraduates in research.

The commonality in barriers to CURE development and implementation suggest a need for professional development (PD) for faculty considering CURE teaching. Networked CUREs, in which one research project is conducted at multiple institutions, can overcome some of these obstacles by providing centralized support to CURE instructors (e.g., Connors et al. 2021; Genné-Bacon, Wilks, and Bascom-Slack 2018; Hanauer et al. 2022; Lopatto et al. 2014). Similarly, many STEM faculty wish to adopt active learning and inclusive techniques in their classes, but without appropriate PD and infrastructure that set aside time for this work, the barrier to such changes is quite high (e.g., Kennedy et al. 2022). This paper describes a PD program created to support faculty members in DEI and the development of STEM CUREs by supporting their learning about inclusive approaches and CURE pedagogy and how to integrate the two. Core components of the PD program, evolution of PD based on faculty feedback, and current efforts to sustain CURE development without external funding are reviewed.

Overview

The Towson University Research Enhancement Program (TU REP) was created with support from the Howard Hughes Medical Institute (HHMI) through their Inclusive Excellence (IE) program. HHMI's IE program goal is for institutions to increase "capacity for inclusion of all students in science." Although individual projects took different approaches, all were tasked with improving their DEI culture, which in most cases meant helping faculty become more inclusive in their teaching and mentoring. The central focus of TU REP was to provide PD to assist STEM faculty in developing CUREs and to help faculty understand their own personal biases and learn new pedagogical approaches to including all students in their classrooms. Faculty PD was a critical aspect of this grant because PD can help faculty learn and implement new pedagogical techniques, including inclusive strategies (e.g., Biswas et al. 2022; O'Leary et al. 2020), particularly when using a professional learning community or communities of practice approach (e.g., Gehrke and Kezar 2018; Kezar, Gehrke, and Bernstein-Sierra 2017), as done here. At the time of funding, three faculty in biology were teaching CUREs, with the first one developed with funding from a National Science Foundation (NSF) CAREER award. A PD program was assembled that incorporated the expertise of those already teaching CUREs and colleagues in several departments and offices at TU. Partnering with the newly created Office of Inclusion and Institutional Equity (OIIE) to incorporate DEI training into faculty PD ensured that faculty had the space and time to consider how CUREs are inherently inclusive and how their approach to students could better support success of all their students.

Cohort-Based PD

A cohort-based PD model was implemented to encourage community and collaboration throughout faculty development of CUREs. Faculty from across the Fisher College of Science and Mathematics (FCSM) were recruited to participate in a yearlong faculty cohort through visits to faculty meetings and an FCSM-wide email that included a link to an application form. Interested faculty completed a simple proposal to apply to the program. Each faculty participant, in consultation with their department chair, could choose either one month of summer salary or a one course (3 credit hour) release during the academic year. In addition, funding was provided for new equipment needed to teach the course, as well as supplies for consumables, field trips, and other course activities. Finally, travel funds

TABLE 1. Structure of Towson University Research Enhancement Program (TU REP)

Month	Session duration/timing	Activities	Speakers
December	3.5 hours *Held during Reading Day (day free of classes when students prepare for finals)*	• Implicit bias and inclusive teaching activities • Elements of a CURE overview • Panel of CURE instructors	• TU OIIE training expert • TU REP facilitator • Previous cohort members
January	3.5 hours *Held prior to the start of spring semester classes*	• Continued inclusive teaching activities • CURE spotlight • Panel of CURE instructors	• OIIE training expert • Previous cohort members
February	2 hours	• Two CURE spotlights • Lunch	• Two previous cohort members
March	2 hours	• One CURE spotlight • One pedagogical paper on CUREs	• Previous cohort member
April	2 hours	• One CURE spotlight • One paper discussion	• Previous cohort member
May	2 hours	• Paper discussions	
June	HHMI IE regional meeting	• Updates from partner institutions • TU REP progress reports	• Keynotes focused on IE, high-impact practices, and related topics
July	3.5 hours	• Discussions and literature focused on assessments, group work, and backward design	• Outside collaborators
August	2 hours	• Faculty presentations of CURE plans	• Current cohort members
October	1 hour	• Lunch panel and Q&A	• Previous cohort members

Note: General structure of TU REP professional development activities. Depending on the cohort and their disciplines, some of the content of the spring sessions differed across years. At all sessions members of the previous TU REP cohorts were invited and specifically asked to join the new cohort at meals for informal interactions. All FCSM faculty were invited to the August presentations to learn more about the newly developed CUREs and TU REP.
HHMI, Howard Hughes Medical Institute; IE, inclusive excellence; OIIE, Office of Inclusion and Institutional Equity.

also were provided for faculty to attend conferences and HHMI IE meetings.

PD Structure and Activities

Although consistently focused on CURE development and DEI training, PD evolved over the five years of the grant as project leadership learned how to better meet the needs of the faculty in each cohort, as more faculty completed the PD, and as the situational context changed, including teaching fully online during the COVID pandemic. Exit surveys and informal feedback informed these changes. The monthly meetings followed a pattern, although the exact topics within a session changed over time (Table 1). For example, given that most STEM faculty had not received formal pedagogical training, various topics were included for different cohorts. In the first two cohorts, TU experts developed PD sessions that reflected on the nature of science and general science pedagogy. Faculty input indicated that these topics were too general and redundant with their prior knowledge. However, a guest expert who ran a session on backward design and designing assessments to align with student learning outcomes was appreciated by cohorts 2 through 5, as faculty could see how these tools would assist them not only with CUREs but with all their classes.

All PD series included multiple opportunities to learn about CUREs, particularly from peers who had already

taught CUREs. The value of sharing experiences led to the development of faculty "spotlight" sessions, during which one faculty member who had already developed and taught a CURE gave a presentation of their course, including aspects they planned to change in the future and tips for handling challenges that arose throughout the semester. As the cohorts progressed, more faculty were available to discuss their courses, providing a broader array of subjects and issues. In addition, most PD sessions included discussion of readings about CUREs in general as well as examples of CUREs from specific disciplines (Table 1; e.g., Auchincloss et al. 2014, Clark, Ricciardo, and Weaver 2016; Kortz and van der Hoeven Kraft 2016; Shortlidge and Brownell 2016). Over time, themes emerged that the leadership team could ensure were discussed with each cohort, such as how much time to devote early in the semester to training students in techniques, assessment strategies and weights, and how much writing to require of students. At the end of the PD, faculty presented their CURE course plans to past and present cohort faculty, including how they were addressing the five CURE components identified by Auchincloss et al. (2014).

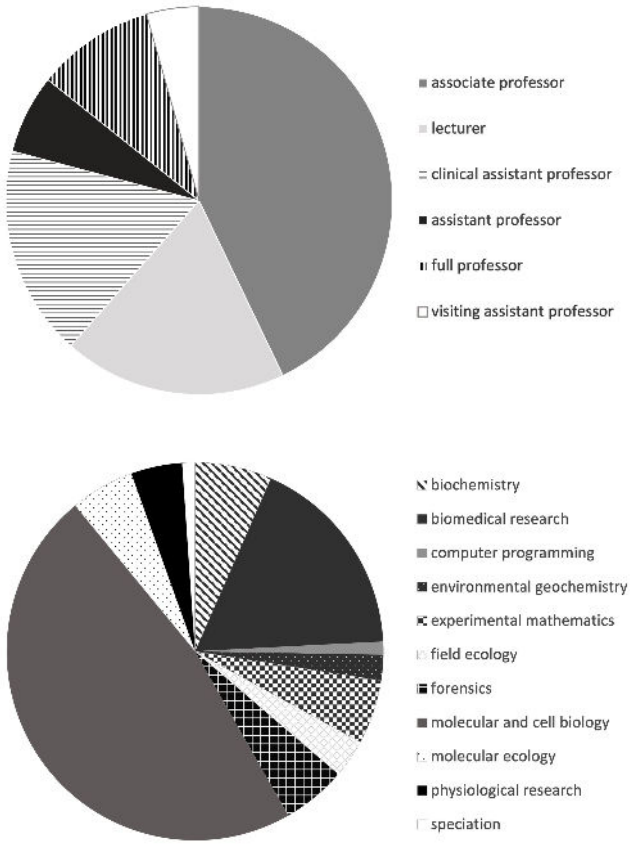
Along with CURE pedagogy, the PD sessions included DEI components. For cohort 1, an external speaker conducted one workshop regarding identity and bias. Beginning with cohort 2, when in-house expertise was available from OIIE, the first two PD sessions provided extensive DEI training in microaggressions, equity and equality, implicit bias, and inclusive teaching strategies. It was particularly important for faculty to reflect on their own privilege and identities, because Towson University faculty diversity does not match the diversity of the students. At the time there was no other comparable faculty training offered at TU, and TU REP provided an opportunity for OIIE staff to explore how to help faculty reflect on their own biases in the context of PD directed at developing pedagogy. In addition, these interactions created opportunities for faculty to promote DEI training, because TU REP faculty reached out to their department chairs to request additional department-specific training.

Peer learning, mentoring, and reflection became more important over the course of the five years as more faculty were trained and could serve as mentors. This became acute when PD was online during the COVID-19 pandemic. Faculty in that cohort indicated to TU REP leadership that they felt they were not being prepared to teach their courses the following year. It was identified that the allotted Zoom time inadvertently limited opportunities for informal interactions related to PD. These peer interactions extended beyond the institution when the June PD each year consisted of a regional meeting with three other HHMI-funded IE projects. These meetings incorporated PD regarding DEI issues in STEM as well as progress reports and discussion of challenges. Discussions with faculty outside of TU helped faculty embrace an inclusive mindset.

Program Outcomes

Over the course of five years of funding, 25 CUREs were developed or modified by 35 faculty members across all five departments of FCSM (Figure 1). These CUREs spanned topics such as behavioral neuroscience, cancer prevention, experimental mathematics, next-generation sequencing in forensic science, protein engineering, bioinnovation, and species discovery. CURE development was shaped by both internal and external influences. For example, a substantial number of molecular biology CUREs have been offered at TU (Figure 1). This likely stems from the national dominance of molecular biology CUREs (Buchanan and Fisher 2022) and associated published resources (external), and the demand for molecular biology lab courses in TU's biology department (internal).

FIGURE 1. CURE Course Sections: Faculty and Content



Note: Percentage of CURE course sections (n = 91) taught by faculty of different ranks (upper panel) and specific content and skill sets (lower panel). Assistant, associate, and full professors have roughly even teaching and research loads at Towson University, whereas lecturers, clinical assistant professors, and visiting assistant professors have primarily teaching responsibilities.

CURE Faculty

CUREs were taught by tenure-track, tenured, and instructional faculty (Figure 1). The percentage of tenure-track or tenured faculty who participated in TU REP was highest in biology (~55 percent) and lowest in computer and information sciences (3 percent). As of spring 2023, 17 of 24 research-active tenure-track or tenured faculty in biology, 4 of 16 instructional faculty in biology, and 6 of 16 research-active chemistry faculty in their second year or higher were teaching CUREs. Many of the tenure-track and tenured faculty described student projects in CUREs that explored new research avenues and techniques, which they subsequently adopted in their own labs. In addition, as a result of teaching CUREs, faculty published pedagogical papers (e.g., Cheng 2022; Miranda et al. 2023; Oufiero 2019).

Instructional faculty, such as clinical assistant professors and lecturers at TU (Figure 1), generally do not have research expectations built into their workload and are not provided with start-up funds or research space. However, many instructional faculty hold PhDs and are interested in continuing to engage in the research process. CUREs provided an important opportunity for these faculty to mentor undergraduates, generate data, collaborate with research-active faculty toward publications, or publish their own pedagogical paper (e.g., Norman 2023).

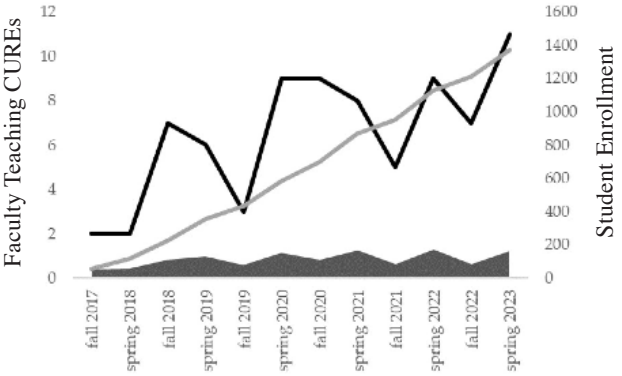
CURE Students

From fall 2017 until spring 2023, almost 1400 students participated in CUREs at TU, although enrollment varied substantially among departments (Figure 2). In biology, the department in which most CUREs were developed, three times as many students participated in research through CUREs as conducted IR in faculty labs during this period (Table 2, Figure 2). This represented a substantial increase in the number of students engaging in research. Incorporating CURE courses into the framework of the biology major also allowed for better participation of the student body as a whole in authentic research, when compared with students in more traditional IR faculty labs (Table 2).

Classroom Support

Funding to pay undergraduate learning assistants (ULAs) hourly for approximately six hours per week was offered to all interested faculty. Faculty instructors ideally found ULAs who had already taken their CURE or a CURE in a similar discipline, but also relied on referrals from other faculty classes or laboratories. ULAs supported faculty in a variety of ways both inside and outside of the classroom, with specific responsibilities varying based on the course and instructor. Some responsibilities included animal care, preparing reagents, cell culture maintenance, organizing and maintaining equipment, demonstrating experimental procedures, and developing computer code. In all cases, ULAs served as peer mentors to students currently taking the CURE and were present during lab and class time to answer student questions. In total, 21 faculty members (60 percent) taught at least one semester with a ULA.

FIGURE 2. CUREs by Semester: Faculty and Student Numbers



Note: Number of faculty teaching CUREs each semester (y-axis, black line), student enrollment in CUREs each semester (z-axis, filled dark grey), and cumulative student enrollment in CUREs (z-axis, light grey line) at Towson University between fall 2017 and spring 2023.

Anticipated Challenges

Govindan et al. (2020) published a list of anticipated challenges to faculty developing their own CUREs (also see Shortlidge et al. 2017). Within the TU REP funding period, external funds helped address several of these (Table 3). However, many of these challenges could be met without external funding, depending on partnerships available within the institution, including those at the department level, college level, FCSM level, and in other offices (e.g., student affairs, DEI office). Hopefully this paper will provide faculty and administrators who intend to develop CUREs guidance to overcoming some of these challenges.

Cost

Several of the challenges center on cost. Some CUREs cost much more than others to run (e.g., forensic chemistry, cell or molecular biology). At TU, laboratory classes have class fees, however these often do not cover the cost of CURE activities. One approach to reducing costs was to have equipment in the CURE labs that also was used for research, because other funds were available to purchase research equipment. Leveraging internal and external funding sources to ensure equipment is available for CURE students can bring costs down and may allow CURE students to use equipment "in the lab" rather than in a teaching lab, further enhancing their experience as novice researchers. At the departmental level, scheduling courses to balance expensive CUREs that may require funding support with less costly CUREs has been helpful. The most affordable CUREs are those that are in silico, in which the cost is usually limited to access to a particular data set. A field ecology CURE offered in biology is also relatively inexpensive,

TABLE 2. Independent Research vs. CUREs

Variable	Category	Independent research, *n* = 321 (%)	CUREs, *n* = 920 (%)
Gender	Male	30	28
	Female	70	72
Race/ethnicity	Black	24	33
	Asian	11	10
	Hispanic	6	10
	White	51	38
	>2 Races	5	6
Pell Grant recipient	Yes	46	52
	No	54	48
Entry status	First year	59	51
	Transfer	40	48

Note: Percentage of students participating in independent research with biology faculty compared with those enrolled in biology CUREs at Towson University from fall 2017 through fall 2022.

because most of the cost is for field trip expenses and some consumables each semester. Additional approaches to reducing costs include incorporating publicly available data sets (e.g., Avramovska and Rokop 2023) and developing collaborations and partnerships with external stakeholders (Table 3). Although grant funds were initially used to pay ULAs, these costs are now being met by the Office of Undergraduate Research and Creative Inquiry (OURCI), because the ULAs are supporting research efforts in the courses while gaining more research experience themselves. Similar funding may be available at other institutions. Alternatively, some undergraduate institutions allow ULAs to participate in the role for course credit, which comes at essentially no cost to the department.

Faculty Workload

A commonly reported challenge when developing CUREs (or any new pedagogical approach) is not having the time needed to develop (or teach) a new course (Brownell and Tanner 2012; Lopatto et al. 2014; Shortlidge et al. 2017). This may be particularly challenging if CUREs are new to a department or are not seen as contributing to the instructor's scholarship. Although the grant helped compensate faculty by funding a summer stipend or course buyout, a more affordable option of workload compensation may be course release or allocating more workload units to a CURE in recognition of the additional time required. In addition, CUREs can be included in faculty onload teaching, whereas IR may not be counted toward teaching load. Faculty workload can also be balanced by building CUREs from previously framed courses to replace a traditional cookbook lab approach. In addition, the use of ULAs in the classroom has proven to be a valuable resource for managing faculty workloads during CURE implementation because they help answer student questions both during and outside of class.

Institutional Resistance

Some faculty or departments may anticipate institutional resistance when developing CUREs. Given the increasing publicity around CUREs, there are now multiple resources available for faculty to share with administrators to explain how CUREs benefit students and faculty (e.g., Rowland et al. 2012; Shaffer et al. 2010; Shapiro et al. 2015). Networked CUREs might help open the door to developing CUREs by demonstrating the feasibility and effectiveness of this approach (e.g., Connors et al. 2021, Hanauer et al. 2022). Fortunately, there was no resistance from the university administration at TU; instead various offices supported these efforts. In fact, CUREs align well with university-wide DEI efforts and are supported because of this by several administrators. However, incorporating DEI into PD may not be permissible at public institutions in some states, so justification for a CURE PD program could be placed solely on the improvement in retention of STEM students associated with CUREs.

If a university strives to increase its research profile, CUREs can be seen as an important contribution to scholarship efforts; this has happened at TU—CUREs are now integrated with planning by OURCI. Two faculty in biology successfully earned grants from the NSF and the National Institutes of Health, with CUREs as an integral part of their proposed research and scholarship demonstrating additional benefits to the institution. Involving institutional stakeholders and outside departments in CURE activities, such as university-wide poster sessions, has allowed for more exposure of the TU REP program.

TABLE 3. Anticipated Challenges and Solutions

Anticipated challenge	Approaches and solutions
Cost	• *Grant funding* • Implementation of lab fees • Incorporation of publicly available data sets • Collaborations and partnerships • Strategic scheduling of high-expense course offerings
Workload	• *Summer stipend or course buyout option* • Utilizing ULA assistance • Building CUREs from previously framed courses • Workload credit for CUREs
Institutional resistance	• Connecting CURE benefits with university DEI efforts and research goals • Networking with institutional stakeholders and outside departments at CURE poster sessions • Development of PD applicable to interdisciplinary STEM programs
Student resistance	• Integrating CUREs into required lab coursework • Highlighting the value of authentic research • Disseminating positive experiences through undergraduate engagement opportunities
Faculty resistance	• *Summer stipend or course buyout option* • Providing "spotlight" days with experienced CURE instructors • Grounding the introduction of CUREs in relevant literature • Supporting faculty with Community of Practice opportunities • Seed funds to develop CUREs with clear link to scholarship output
Student learning and success measurements	• Highlighting student challenge topics in PD sessions (i.e., group work, peer assessment, IRB data collection) • Providing faculty an opportunity for feedback following PD and course development

Note: Addressing anticipated challenges associated with CURE development through TU REP and tailored PD programming. Italics represent external funds used during the grant period. Anticipated challenges are based on perceived barriers discussed by Govindan, Pickett, and Riggs and others (see reference column in Table 2 of Govindan, Pickett, and Riggs 2020).
PD, professional development; TU REP, Towson University Research Enhancement Program; ULA, undergraduate learning assistant.

Faculty, staff, and administrators from other parts of the university have become more familiar with the program and participating students.

Student Resistance

Students may also be resistant to enrolling in CUREs, particularly if they require extensive time; in general, TU CUREs meet for six hours each week. As mentioned, student enrollment in biology was facilitated by requiring a CURE for major requirements or as elective credit. Student enrollment was lower in CUREs in departments where the classes did not fulfill graduation requirements. Student poster sessions have also proven to be an important recruitment event, as students not enrolled in CUREs stop by to see the posters, and instructors regularly advertise the courses to their students and advisees. If students are learning about research opportunities as they proceed through their major, a CURE may be most appealing to them because of the available course credit. Furthermore, students are attracted to the project-based grading and semester vs. standard weekly lab reports.

Faculty Resistance

Another key challenge to developing CUREs is faculty resistance, which can come from many directions. As mentioned, with the publicity that CUREs are gaining nationally, there are numerous resources available to help faculty consider a CURE and reduce any associated fears (e.g., Science Education Resource Center n.d.). Exposure to a networked CURE or hearing about a CURE at a conference may help faculty consider this option. Faculty workload concerns can be addressed as previously described.

For TU REP faculty, the grant provided funding and time for faculty to develop their courses and was an incentive for participating in PD. Although CUREs started with the cell and molecular biology faculty, others learned from their experiences to develop courses in other subjects (Figure 1); the challenges were often similar despite the subject matter being different. In some cases, however, challenges were quite different, such as establishing a field ecology course that required vehicles, field gear, and permits to conduct the research. As new faculty join FCSM since the grant has ended, they now ask about teaching CUREs because it has become so common in biology.

Shortlidge et al. (2017) surveyed faculty who had developed independent CUREs and identified the uncertainty of research as a theme that also contributed to faculty

resistance. The risk of spending an entire semester trying to effectively generate data and then failing to do so can affect faculty willingness to develop a CURE. In TU REP, having faculty already teaching the courses willingly share their own challenging experiences has helped new faculty understand the challenges but also emphasized the benefits, and may have helped overcome this concern. In fact, at a university like TU, where few departments have PhD and postdoctoral students, many faculty embraced the possibility of bringing their scholarship into the classroom. TU REP faculty have noted that students in their CUREs have helped generate new ideas or normalized the use of a new technique, moving their scholarship forward even when the data generated in the course were not publishable.

Implementation and Sustainability

Moving forward with curriculum changes after funding ended has forced the identification of ways to sustain much of the work that successfully supported faculty in developing CUREs. This section describes activities that leverage existing resources and partners at TU to help expand CURE offerings across FCSM and into new colleges of the institution. For a more detailed description and analysis of faculty perspectives, also see Gough et al. (forthcoming).

CURE Community of Practice

The importance of a faculty community of CURE developers and instructors emerged as one of the most critical aspects of PD. As discussed, during the COVID-19 pandemic, two key differences between online and in-person PD were noticeable: the lack of mealtime for informal interactions and the way in which Zoom made having one-on-one conversations following a group discussion difficult. The importance of these interactions is aligned with recent research on faculty experiences in networked CUREs (DeChenne-Peters and Scheuerman 2022) and participation in communities of practice (CoP) that emphasize the crucial role that personal interactions play in faculty engagement and continuing involvement in new practices when departments or undergraduate institutions are undergoing reform (e.g., Kezar et al. 2017; Gehrke and Kezar 2018). In fall 2022, a CURE CoP was developed with support from the Towson University Faculty Center of Excellence (FACET) to meet two goals: to continue to provide opportunities for peer interactions among TU REP faculty, and to create programming for faculty new to CUREs to learn more about them. Support from a university teaching and learning center for a CoP can include space outside of departments for meetings, invited speakers, technology support in the form of a Blackboard or Canvas site, peer-to-peer mentoring, and funding for food for meetings. TU REP faculty continue to participate in this CoP as speakers, panelists, and participants. In addition, several TU CURE instructors have contributed to the CURE community outside of the university by sharing their course details on CUREnet (Science Education Resource Center n.d.) and publishing their specific CURE development experiences in relevant journals (e.g., Cheng 2022; Norman 2023; Oufiero 2019). In addition, support from an office of undergraduate research embracing CUREs as an important research approach can provide resources and publicity.

Intentional DEI Efforts

The development and implementation of CUREs within TU REP have contributed to both increased faculty participation in DEI PD and increased participation of students from diverse backgrounds in authentic research. TU REP faculty have commented that their involvement in the program caused them to consider inclusive approaches in all their courses and laboratories. For example, several TU REP faculty began incorporating research by scientists from traditionally underrepresented groups in their CUREs and other classes as a result of discussion of this approach during PD. The integration of DEI issues into PD as a high-impact practice was relatively straightforward, ensuring that DEI issues were central to program activities.

Partnership with OIIE and focus on DEI during PD led to additional IE activities by TU REP faculty that would likely not have occurred otherwise. For example, TU REP faculty helped lead a DEI task force at FCSM to assess the status of DEI issues and compile a list of recommendations for an incoming dean. One TU REP faculty member has been working to make undergraduate research grants within FCSM more accessible to students with lower GPAs, and similar efforts have been underway in several different arenas to ensure that transfer students have the same opportunities as first-year full-time students. These unplanned TU REP outcomes have occurred as faculty becomes more aware of DEI issues and begins to engage in these topics on committees, in department meetings, and at university activities in ways that will benefit the entire university community.

Logistical and Financial Support

With the end of HHMI funding, collaboration with institutional partners is allowing for new CURE development, although at a slower pace than during the grant period. This strategy may help institutions new to CUREs as well, depending on their mission. For example, once the OURCI director began discussing CUREs across campus as a form of undergraduate research, funds were able to be directed toward ULAs and course supplies for current and future CUREs. FACET provides support for the CURE CoP and also is funding a CURE FACET fellow who is offering one-on-one consultation to faculty designing CUREs, connecting the CURE faculty with OURCI support, and helping lead the CoP. As of December 2023, a new CURE development program is being created with four faculty from colleges outside of FCSM based on support from OURCI, FACET, and TU REP faculty. Similar

collaborative efforts may be possible at other institutions internally. Institutions also may take advantage of collaborators nationally (such as CUREnet).

Conclusions

CUREs are established high-impact practices that can benefit students in many ways, including by providing opportunities for research for more students, and particularly students from underrepresented groups. CUREs also can be incredibly rewarding for faculty. TU REP faculty comment that they enjoy being able to facilitate research projects within the structure of a formal class, they are gratified to lead 16 to 20 students through research during a semester, and they are excited to implement more inclusive strategies in their classes. Faculty research programs benefit when students ask new questions or generate intriguing data, on which faculty can follow up in their own laboratories. In addition, CUREs provide an opportunity for instructional faculty to engage in the research enterprise if they are interested in doing so. Research papers coauthored by CURE students demonstrate how CUREs can concretely contribute to faculty scholarship (e.g., VanOrsdel et al. 2018).

Although it can be challenging to develop and implement CUREs, CURE-focused PD and development of a CoP can help overcome these barriers and sustain changes in both CURE and DEI pedagogical approaches. As CUREs continue to gain popularity, more examples can be brought forward as potential ways to engage faculty and students in research in the classroom. Creating a system for peer support, engaging with potential partners within an institution, educating faculty about inclusive approaches, and allowing for some flexibility in workload have helped transform the curriculum. Many of these practices are eased with additional funding, but many of them also can be implemented with cooperation from university administration.

Data Availability

The data, critical questions used in scripts, and instruments underlying this study are available within the text.

COI Statement

There are no conflicts of interest to declare.

Institutional or Ethical Review Board

Approval not required because the research did not involve human or animal subjects or samples.

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