

# Features of an Effective Future-Faculty Teaching-Development Program: A Case Study of 10 STEM Faculty

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*Many institutions are preparing graduate students and postdoctorals (future faculty) for effective teaching in undergraduate science, technology, engineering, and mathematics (STEM). Interestingly, little is known about beneficial features of teaching-development (TD) programs for future faculty after they transition into professoriate roles, and how these features are useful. We investigated the features of a TD program for STEM future faculty that were influential to their current teaching as faculty members, and in transitioning into faculty positions. Data were collected using in-depth interviews with 10 alumni (current faculty) from different STEM disciplines one to five years after participating in the TD program. Three themes emerged from this study: (1) exposure to multiple effective teaching approaches and pedagogy literature; (2) opportunities for experiential learning, active learning, a multi-disciplinary learning community, and diversity and inclusion; and (3) the impact of the TD program on participants' career choices. Findings imply the need to develop TD programs that expose participants to multiple evidence-based pedagogies, and that weave in opportunities for experiential learning, interactive-workshop activities, and a learning community.*

Pedagogical training of graduate students and postdoctorals (future faculty) on evidence-based teaching practices can minimize the use of lecturing in college STEM classrooms later as faculty members (Miller & Metz, 2014; Stains et al., 2018), and improve the professional identity of science professors as teachers and scientists (Brownell & Tanner, 2012). Studies have shown that lecturing is ineffective in promoting meaningful student learning (e.g., Freeman et al., 2014), and could be one major factor for attrition in undergraduate STEM education (Espinosa, 2011; Seymour, 2000); hence the need to adopt evidence-based teaching approaches (AAAS, 2015; PCAST, 2012). Many universities have implemented teaching-development (TD) programs to prepare STEM future faculty for evidence-based teaching (e.g., a network of 43 research-based universities that are part of the Center for Integrating Research, Teaching and Learning (CIRTL, 2017). However, little has been written about the features of future-faculty TD programs that participants report are essential after transitioning into faculty positions, and how these features are useful.

In this paper, we report findings from a case study of 10 faculty on features of a future-faculty TD program they perceived to be beneficial in their

current positions. We found that participants valued exposure to multiple evidence-based teaching pedagogies; engagement in the workshops through experiential learning, active-learning activities, and immersion into diversity and inclusion; and participation in a multi-disciplinary learning community. Additionally, participants reported that the TD had a positive impact on their careers and recruitment into faculty positions. Participants also reported that while some TD aspects did not seem to be valuable during the training, they became more meaningful when applying and interviewing for faculty positions, and later in their teaching positions. These findings indicate that being intentional about the design of future-faculty TD programs to include the aforementioned features could have a positive impact on participants.

## Literature review

In this paper, we report findings from a study assessing the impact of a CIRTL-related TD program on 10 doctoral students and postdoctoral alumni who are currently faculty members with some teaching responsibilities at the college level. Other universities have implemented TD programs to train STEM future faculty in scholarly teaching (e.g., Derting et al., 2016; Ebert-May et al., 2015), including graduate teaching-assistant programs (e.g., Dragis-

ich, Keller, & Zhao, 2016; Zehnder, 2016).

Past evaluation studies on future-faculty TD programs indicate that TD participants have positive experiences (e.g., Baiduc, Linsenmeier, & Ruggeri, 2015; Dragisich et al., 2016; Ebert-May et al., 2015; Vergara et al., 2014; Zehnder, 2016). Many studies have focused on immediate assessment of the TD-program impact on participants. Examples of immediate gains from TD programs include increased confidence in teaching (Dragisich et al., 2016; Vergara et al., 2014; Zehnder, 2016), more preparedness to teach (Dragisich et al., 2016), increased interest and comfort in teaching future courses (Zehnder, 2016), perceived knowledge, and use of best teaching practices (Ebert-May et al., 2015).

A few studies have reported on TD alumni after transitioning into faculty positions (Connolly, Savoy, Lee, & Hill, 2016; Derting et al., 2016). Connolly et al.'s (2016) study with doctoral-program alumni from three universities indicated that TD participants reported self-efficacy in their teaching practices and positive impact on their teaching practices compared to non-TD program counterparts. In Derting et al.'s (2016) study, biology postdoctorals who participated in a TD program and had transitioned into faculty positions reported more use of active-learning strategies and a higher level of self-efficacy in teaching than their nonTD counterparts who often used lecturing.

Few studies, if any, have investigated features of TD programs that are beneficial in enhancing future faculty's use of effective teaching practices and transition into a faculty teaching role. The current study contributes to addressing this gap. The research question guiding this study

was: What features, if any, of a TD program are perceived beneficial by participant alumni in their current faculty positions, and how are these features useful?

### Description of the current future-faculty teaching-development program

A key component of the TD program in this study is a STEM Workshop Series, which comprises multiple, multi-disciplinary workshops on evidence-based teaching strategies for STEM. Other requirements include writing a teaching-philosophy statement and completing an introduction-to-the-scholarship-of-teaching-and-learning (SoTL) course. A summary of the program and workshop topics is available at <https://www.nsta.org/college/connections.aspx>. TD participants are from different STEM disciplines, with 50% in biology.

The objectives of the STEM Workshop Series include exposing future faculty from across STEM disciplines to (1) multiple evidence-based and inclusive teaching practices; (2) literature of research studies on teaching and learning drawn from discipline-based education research (DBER), cognitive and social psychology, and learning sciences, and having discussions on how to implement the findings to improve their own teaching (Fisher, Dufault, Repice, & Frey, 2013) and (3) repeated opportunities to engage in evidence-based teaching approaches through experiential learning. This multi-disciplinary STEM learning community gives opportunities to learn about, experience, and discuss evidence-based pedagogies that are adaptable across disciplines. Offering multiple workshops on evidence-based teaching is pivotal for pedagogical transformation (Henderson, 2008). The workshops are

developed and facilitated by faculty-development staff with expertise in STEM evidence-based teaching.

### Methods

The study was approved by the university's institutional review board. An exploratory case-study research design was employed (Yin, 2003). This approach can uncover contextual conditions (Yin, 2003) relevant for developing a robust TD program for future faculty. Additionally, it can provide clear boundaries between important features of a future-faculty TD program and the context within which these features are situated (Baxter & Jack, 2008; Yin, 2003). Understanding the beneficial features of a TD program for future-faculty participants is a phenomenon that can inform future designs of robust TD programs.

### Participants

Study participants were 10 TD program alumni (2 male and 8 female) who had completed either a doctoral or a postdoctoral program in STEM between 2011 and 2015 at a research-intensive university in the midwestern United States and had transitioned into faculty positions. Program alumni were identified from workshop attendance sheets and their contacts obtained from Linked In, Google, or a list of the alumni contacts from the university's Office of Alumni and Development. Out of 12 participants who showed interest to participate in the study, 10 volunteered to be interviewed. Of the ten interviewees, four held teaching positions at research-based universities (two nontenure-track full-time faculty, one tenure-track assistant professor, one adjunct faculty), and six were assistant professors at liberal-arts colleges. Participants were from

different STEM disciplines (biological sciences,  $n = 5$ ; psychology and brain sciences,  $n = 2$ ; physics,  $n = 1$ ; chemistry,  $n = 1$ ; and mathematics,  $n = 1$ ).

### Data collection and analysis

Data were collected through individual, in-depth interviews. During the interviews, participants were asked to describe beneficial features, if any, of the TD program they had participated in, and how these features were useful in their current positions (see <https://www.nsta.org/college/connections.aspx>). The interviews were transcribed and analyzed. The analysis was guided by the research question and the interview questions (Creswell, 2007). Two researchers together coded three of the ten interview transcripts (30%) to generate codes, with a 100% agreement reached on the coding (Creswell, 2007). The remaining seven transcripts were coded by JM and involved applying the previously identified codes to the relevant segments of the transcripts while allowing for new codes to emerge. Salient codes were combined to develop categories (see <https://www.nsta.org/college/connections.aspx>). DL verified the generated categories by examining all of the coded transcripts to ensure coherence between the categories and the interview data (Tashakkori & Teddlie, 1998). There were no noted conflicts between JM and DL. Similar categories were merged to develop themes and sub-themes.

The first two themes related to the structure of the TD program, whereas the third theme related to the overall impact of the TD on participants' careers. These themes included: (1) exposure to multiple effective teaching approaches and pedagogy literature on teaching and learning; (2) op-

portunities for experiential learning, active learning, a multi-disciplinary learning community, diversity, and inclusion; and (3) the impact of the TD program on participants' career choices. These themes and corresponding sub-themes, along with representative participants' responses supporting our findings (see <https://www.nsta.org/college/connections.aspx>), are discussed below.

### Results

#### *Theme 1: Exposure to multiple effective teaching approaches and pedagogy literature exposure to multiple effective teaching approaches*

All participants reported that participating in the workshops exposed them to, and increased their knowledge of, effective teaching. Except for the two psychology alumni, participants had little or no knowledge of other teaching approaches beyond lecturing. Commonly mentioned areas of growth included: general scholarly teaching methods (six responses), developing clicker-format questions or implementing student-response systems (six responses), structuring in-class activities or small-group learning (three responses), inclusive mindset (three responses), and formative assessments (two responses). One participant said:

Alisa (biological sciences): I learned different teaching techniques and different ways to teach that is not lecturing, because when I was an undergraduate student, I remember being lectured. When I was a TA during graduate school, I remember that course was lecture-based, so that's all I knew till (I attended the workshops).

Overall, findings showed that participants perceived they gained knowledge of numerous evidence-based teaching approaches and best teaching practices.

**Exposure to pedagogy literature on teaching and learning.** Seven of the ten participants reported that they became aware of literature on effective teaching from the workshops and the SoTL course. Although these seven individuals had no prior knowledge about this literature base, they all reported being actively involved in consulting literature to improve their teaching:

Alisa (biological sciences): I never knew that there was literature about how to teach before taking the Teaching Center workshops. ... I had no idea that there was even a body of literature on best teaching practices. From attending those workshops, I have gone out myself and looked for best teaching practices and different ways of teaching genetics or cell biology. I even got to use...the NSF Case Studies...I hadn't heard that before taking the workshops; and that's just a fantastic repertoire for different case studies that I use for my biology classes. I have gotten all sorts of the information on Science Education that I didn't know it existed before taking the workshops.

Participants also highlighted the use of pedagogical or educational literature in discussing teaching, such as in journal-club meetings with faculty colleagues at their institutions:

Selina (biological sciences): As a medical scholar, I had never used search engines on teaching and

learning; I didn't know how to read research literature on teaching and learning, so just showing me not just what is in the paper but the kind of experiments to do, and even how to find the literature to start with. I found that helpful now because we have a faculty journal club here where we read papers from *CBE-Life Sciences* or other educational journals. These skills I would not have had if it were not for the SoTL class.

### *Theme 2: Opportunities for experiential learning, active learning, a multi-disciplinary learning community, and diversity and inclusion*

A slim majority (six responses) mentioned experiential learning as one beneficial feature of the TD program. Other mentioned features included "a multi-disciplinary learning community" (five responses), "interactive workshops crafted around active learning" (three responses), and "integrating diversity and inclusion into the workshops" (three responses).

**Experiential learning.** Alumni valued concrete experiences in learning and practicing specific pedagogies through workshop activities, and modeling of best practices by facilitators. The workshops provided opportunities for participants to experience the pedagogies in a student role, and many reported adopting these approaches in their current teaching. Specifically mentioned approaches learned through experiential learning included engaging in structured small-group learning with assigned group roles, use of iClickers, solving case-study issues, annotating figures from scientific literature, and engaging in reflection exercises

on how workshop participants can implement a given pedagogy in their teaching. One participant said:

Kellen (mathematics): Seeing concrete teaching materials was really useful... For POGIL (process-oriented guided-inquiry learning) workshop, there were worksheets that we went through as a group where we worked through parts of the assignments and that was effective and very powerful. The group structure (with roles) like leader, questioner, manager, and spokesperson, I have done these in various classes for my courses. So seeing how the worksheets were structured was very useful. I use digital sockets worksheets, so the idea came from that sort of seeing the POGIL worksheets. Also, sometimes during the workshops we had to brainstorm how we would develop something similar in our courses like brainstorming specific learning objectives for specific course and talking about them with people; I found that useful.

**Learning community.** Alumni appreciated sharing ideas with peers having similar career goals, and learning from those with more experience in using the approaches discussed. Participants said: "...hearing people say that they tried these things and made students more interested was part of the fun of the group discussion," and "sharing with peers who had experiences implementing some of the approaches we discussed was useful. That helped me translate into my situation on how to use it." Participants also valued hearing about practices peers in other disciplines employed. One alumnus

indicated that the community made him realize that he was not the only one struggling with "good" teaching; something that gave him assurance and passion to keep trying different pedagogical tools to become an effective teacher:

Johnston (psychology): One of the things that became clear to me was "early-career academics struggle" with teaching; that a lot of people were looking for guidance. So going to workshops and meeting these groups of smart people who say "this is hard" was kind of reassuring and there were times when I felt like a lot of these folks know stuff that I don't know, and there were other times that I felt like "oh I know this and nobody else does; cool I am doing well," but a lot of times it looked like everybody was trying to find some tools to be able to use, so it is nice to not be alone and I have a long way to be this effective teacher, so just being in that kind of community was useful.

**Active-learning or interactive workshops.** Alumni valued that workshop facilitators did not just lecture about active learning, but provided opportunities for them to engage with the material by being active participants. Active-learning approaches mentioned included: clicker activities, class discussions, small-group discussions, use of scenarios, and questioning technique. The interactivity was considered beneficial for enhancing understanding of the pedagogies and fostering critical thinking or retention:

Jane (chemistry): I really liked that the workshops are not hour-and-half-long presenta-

tions; it was usually 10-minute presentation, then interactions full of activities or group discussion. So it breaks down and really gets you to think during the workshop. If we were going to listen to a presentation for an hour, I would probably not remember anything by the end when I left the room.

### **Integrating diversity and inclusion.**

Aspects such as stereotype threat and impact on student learning, and valuing diverse voices in the classroom were reported as valuable by the alumni for current teaching positions, even if they did not perceive these topics to be important during the TD program. One alumna remarked: “The workshop on increasing and improving diversity in STEM has been very useful to me here. We are the second most diverse major research university in the United States, so having that was very useful in teaching my students.” Another alumna expressed that she did not see the practicality of these topics during the workshops, but she found them valuable after transitioning into her faculty position, where departments at her predominantly white institution are focusing on recruiting and pursuing mentoring programs for students from underrepresented groups:

Selina (biological sciences): Inclusive teaching, stereotype threat, getting minorities and underrepresented minorities in STEM; [during the workshops] I was like “just recruit them”; I didn’t understand why I needed to do anything special about that. I am at a school that is very white and wealthy, and that is something our departments are constantly pursuing with mentoring programs; departments are exploring ways of recruiting minorities, and that’s when I realized

it was very important learning these aspects, but I didn’t realize it at the time [of the workshops].

Overall, findings showed that providing opportunities for participants to “learn by doing” and modeling effective teaching practices during TD programs can catalyze participants’ adoption of evidence-based and inclusive teaching practices. Moreover, the learning community is an important platform for peer support and sharing of ideas and experiences.

### **Theme 3: The impact of the TD program on participants’ career choices**

Participants reported the TD program increased their interests in teaching careers while others reported a benefit in securing faculty positions.

**TD program increased participants’ interest in teaching.** Six of the ten alumni reported that although they had prior plans for teaching careers, participating in the TD program increased their interest in teaching, and one alumna expressed that the program was influential in solidifying her switch from researcher to teacher. Her interest for a teaching career was impacted by the STEM workshops, but also having concrete experiences in writing a teaching-philosophy statement. She noted: “...when I wrote my teaching philosophy, I realized my interest was in a teaching career. That’s where my passion was, and so I started to focus more on jobs in the teaching field.” Moreover, many alumni indicated that learning about unfamiliar evidence-based teaching methods motivated them to develop into effective teachers:

Keritu (biological sciences): I think my graduate training made

teaching feel like secondary to my career ...Sitting through the Teaching Center courses made me feel more confident, and made me excited and engaged that there are so many great studies and as a scientist it was like a quantification of best methods and I got super excited about that...knowing that I have this toolset made me an effective instructor.... In fact when I interviewed for jobs people were very impressed hearing the methods that I was going to apply, [like] low-stake assessments, you know, grade points that students can get throughout the semester instead of just having high-stakes assessment quizzes or midterm exams.... So the Chair of the department when he interviewed me was very interested in knowing some of these novel assessments.

**TD program increased participants’ chances of obtaining faculty positions.** Six alumni reported that this program increased their hiring opportunities for faculty positions, due to writing and receiving feedback on their teaching-philosophy statement in which they successfully articulated intending to use evidence-based teaching approaches in their future teaching, and being able to discuss these approaches during job interviews. Participants said: “Teaching Center programs really helped me talk about teaching in my teaching-philosophy statement and in the interviews... I don’t think I would have been competitive with my teaching if it were not for the Teaching Center workshops,” and “It helped me get this job because even when I was on the job market submitting my teaching statement, I had very specific ideas that I felt strongly about.”

In summary, participation in the TD

program not only increased participants' passion for teaching, but also positively affected their competitiveness for faculty positions and confidence in "talking about teaching." These benefits were partly influenced by exposure to multiple evidence-based approaches, experiential learning, and constant reflections on the learned pedagogies during the workshops.

## Discussion and conclusions

Findings revealed that the TD program exposed the alumni to multiple effective teaching approaches, which they reported to be currently employing from the TD workshops. As students, most alumni only had experience with lecturing, and now reported discomfort employing this method in their teaching. Findings revealed that while TD participants might not see value in some aspects during the program, they found that repeated exposure and practice through experiential learning and modeling of diverse teaching approaches reinforced reflection on and adoption of such practices later in their teaching positions.

Most alumni appreciated exposure to teaching-and-learning literature, which is rare in their training specialties. Other studies have reported similar findings (e.g., Connolly et al., 2016). Participants experienced multiple pedagogies adopted from teaching-and-learning research by discussing interpretations of research findings, and then reflecting on how these findings will inform their use of these pedagogies in future teaching. This component provided participants with insights on the effectiveness of the pedagogy, how to implement the proven pedagogies, and skills for consulting pedagogy literature. According to the alumni, this component encouraged them to stay abreast with this literature in their current teaching.

Findings also revealed that TD par-

ticipants valued the opportunities to experience "learn by doing" interactive activities such as group work; clicker activities; and peer-to-peer discussions of scenarios, role-plays, and demonstrations, and to observe best teaching practices during the workshops. Participants experienced these evidence-based approaches from the dual perspective of student and instructor-in-training, thus allowing them to better understand potential challenges and successes associated with implementation. These concrete experiences allowed participants to meaningfully learn the pedagogies, and assisted in the transfer of these learned practices to their classrooms.

Participants also appreciated engaging in a multidisciplinary learning community with peers, in which participants engaged in workshop activities by working in small multi-disciplinary learning groups and sharing ideas with the whole group. This finding is consistent with Connolly et al.'s study (2016) in which participants reported a sense of a learning community by engaging in TD programs, in which there were avenues to interact, network, and learn with and from each other.

Immersing TD participants in frequent conversations about diversity and inclusion was reported valuable. Discussions about being intentional in promoting diversity and inclusion by mitigating stereotype threat, valuing diverse voices, and fostering growth mindsets among students were incorporated in each workshop. Interleaving these phenomena in all workshops gave participants repetitive exposure to and continual reflection on such practices. Understanding these phenomena is crucial for increasing student persistence and performance in STEM, especially for students from marginalized groups (e.g., Aronson et al., 1999; Rattan, Good, & Dweck, 2012; Fink, Cahill, McDaniel, Hoffman, & Frey, 2018).

Alumni found that being acclimated to diversity-and-inclusion ideas better prepared them for transition into faculty positions, especially at institutions focusing on diversity-and-inclusion efforts.

Results further showed that participating in TD increased participants' interests in teaching careers and opportunities for hiring in faculty positions. This exposure provided participants with a pedagogical toolkit, which nearly all found beneficial in developing their teaching-philosophy statements and discussing their teaching skills during job interviews. Connolly et al. (2016) also showed that high engagement in TD programs during doctoral training increased participants' chances for securing tenure-track faculty positions. Our findings indicated the focus on evidence-based teaching approaches in our program was key to this success.

In summary, this study reveals that embedding aspects such as experiential learning, modeling active learning, a multidisciplinary learning community, and integrating diversity and inclusion into future-faculty TD programs can catalyze the adoption of evidence-based and inclusive teaching practices, and increase chances for obtaining faculty positions. Ultimately, these aspects could encourage participation of future faculty in future TD programs.

## Implications

Based on our findings, we suggest that higher-education institutions, especially those that offer few teaching experiences and formal training on pedagogy, could modify their future-faculty training programs to include focused opportunities to learn about and experience multiple evidence-based teaching practices. Socializing future faculty to these teaching practices early in their training can enhance their pedagogical knowledge

and perhaps minimize nonuse of evidence-based teaching later as faculty (Henderson, Dancy, & Niewiadomska-Bugaj, 2012; Wieman, Deslauriers, & Gilley, 2013). Additionally, TD programs should be intentionally structured to provide modeling of best teaching practices through active learning, and for immersing participants in pedagogy literature and experiential-learning opportunities. Last, considering a multidisciplinary learning community over a discipline-based learning community can help participants to exchange ideas and to visualize different pedagogies they might adopt from other disciplines to improve learning in their own discipline. ■

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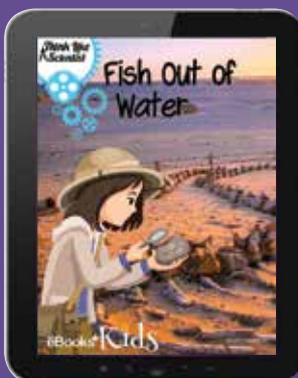
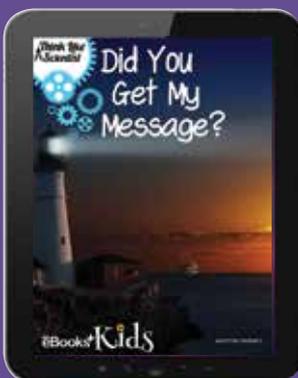
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