**Supplementary Material**

**Table of Contents**

1. Supplementary Material 1: A STEM Future-Faculty Teaching Development Program and Workshop Topics with Selected References

2. Supplementary Material 2: Future-Faculty TD Alumni Interview

3. Supplementary Material 3

* Table S1: Generated Categories and Themes from the Interviews

4. Supplementary Material 4

* Table S2: Themes and Subthemes, and Samples of Participants’ Responses from the Interviews

**Supplementary Material 1: A STEM Future-Faculty Teaching Development Program**

**TRAINING IN EVIDENCE-BASED TEACHING IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS**

**FOUR LEVELS OF ENGAGEMENT**

**COMMUNITY MEMBER**

-Complete 4 STEM Pedagogies workshops

**ASSOCIATE**

Complete 6 advanced-level workshops:

-3 Foundational STEM Pedagogies

-2 Elective STEM Pedagogies

-1 Workshop on Writing a Teaching Philosophy Statement

- Write a teaching philosophy statement, with feedback from The Teaching Center

**PRACTITIONER**

- Complete Associate requirements

- Complete the Introduction to the Scholarship of Teaching and Learning (SoTL) course

- Document and reflect on one semester of teaching

**SCHOLAR**

- Complete all Practitioner requirements

- Design and implement a SoTL project (WU-STAR Internship)

- Participate in research-group meetings

- Present results of SoTL project

**1) STEM Pedagogy Workshops**

Participants experiences active-learning pedagogies with experienced facilitators and engage in discussions on how research data from the learning and cognitive sciences can be translated into effective teaching practices. Examples of topics include:

-Applying Cognitive Science to Improve Teaching\*

-Problem-Based Learning

-Designing an Introductory STEM Course

-Scholarly Teaching\*

-Inclusive Teaching in STEM\*

-Active Learning\*

-Process-Oriented Guided Inquiry Learning (POGIL)

\*Foundational (Core) workshops

**2) Reflective Teaching**

By writing a Teaching Philosophy Statement, participants articulate a specific teaching approach and arrive at new ideas to take into future teaching positions.

**3) Scholar Internship**

This program provides an opportunity for future faculty to design and implement a SoTL research project on pedagogical methods in STEM.

**4)** **Introduction to Scholarship of Teaching and Learning**

Students in this one-credit, semester-long course learn fundamentals of SoTL, including the practice of developing, reflecting on, and evaluating teaching methods to improve student learning.

This program creates a learning community of future faculty in STEM who practice scholarly teaching by:

-Learning about, and engaging in, evidence-based approaches that can improve learning for diverse undergraduates.

-Learning strategies for incorporating and evaluating these approaches in STEM courses.

-Developing methods for reflecting on and refining teaching.

-Developing knowledge of, implementing, and presenting Scholarship of Teaching and Learning (SoTL) research and methodologies (Practitioner and Scholar levels).

**CORE COMPONENTS OF TD PROGRAM**

**PROGRAM OBJECTIVES**

**Supplementary Material 1 (Continued): STEM Pedagogies Workshop Topics, with Selected Literature References**

* *Incorporating Active Learning into Lectures* (e.g., Vickrey et al., 2015; Freeman et al., 2014).
* *Inclusive Teaching Practices: Reducing Stereotype Threat and Fostering a Growth Mindset* (e.g., Rattan, Good, & Dweck, 2012; Spencer, Logel, & Davies, 2016).
* *Designing and Facilitating Inquiry-Based Laboratory Teaching* (e.g., Buck, Bretz, & Towns, 2008).
* *Designing Materials for Inquiry-Based Laboratories* (e.g., Beck, Butler, & Burke, 2014)
* *Mentoring Undergraduates in Research* (e.g., Dolan & Johnson, 2010; Handelsman, Pfund, Lauffer, & Pribbenow, 2005).
* *Teaching Students How to Critically Evaluate Scientific Literature* (e.g., Hoskins, Lopatto, & Stevens, 2011; Round & Campbell, 2013).
* *Introduction to the Scholarship of Teaching and Learning (SoTL)* (e.g., Bishop-Clark & Dietz-Uhler, 2012; Hutchings, Huber, & Ciccone, 2011).
* *Collaborative-Learning Groups: Philosophy and Implementation*
(e.g., Barkley, Cross, & Major, 2014).
* *Designing Collaborative-Learning Materials* (e.g., Anderson et al., 2001; Moog, 2014).
* *Structuring and Teaching an Introductory Course* (e.g., Nilson, 2010)
* *Peer-Led Team Learning (PLTL)* (e.g., Author et al., 2008; Wilson & Varma-Nelson, 2016).
* *Problem-Based Learning and Case-Based Studies* (e.g., Hung, 2009; Kulak & Newton, 2014).
* *Designing Problem-Based and Cased-Based Learning Materials*
(e.g., Hung, 2009; Kulak & Newton, 2014).
* *Process-Oriented Guided-Inquiry Learning (POGIL)* (e.g., Moog, 2014).
* *Applying Cognitive-Science Research to Improve Teaching* (e.g., Karpicke & Blunt, 2011; Karpicke, Butler, & Roediger, 2009).

**References for the Workshop Topics**

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**Supplementary Material 2**

**Future-Faculty TD Alumni Interview**

**Interview Questions**

1. What is your current position?Please explain what you do in your current position.
2. Please explain how participation in the Teaching Center Programs influenced:
* Your ability to teach (please provide examples).
* Teaching skills and abilities (please provide examples).
* Career interests and goals (please provide examples).
* Knowledge of evidence-based teaching (please provide examples).
1. Reflecting on the Teaching Center training programs, what aspects or features of the programs were useful in your current teaching position?

**(Prompt): a)** Please explain how these aspects or features were useful.

**(Prompt):** b) How were the features of the TD influential, if at all, in your transition into a faculty position?

**Supplementary Material 3**

Table S1

Generated Categories and Themes from the Interviews

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Categories by DL & JM** | **Category Counts (DL & JM)** | **Category Counts by JM only** | **Major Categories** | **Themes** |
| **Beneficial aspects or features of the TTC program** |
| Exposure to various teaching approaches currently being implemented.Gained knowledge of:* Scholarly teaching methods
* Use of student response systems or clicker questions
* Inclusive mindset
* Formative assessments
 | 3322- | 73412 | Exposure to various teaching approaches currently being implemented. | Exposure to multiple effective teaching approaches and pedagogy literature on teaching and learning |
| TD improved participants’ teaching abilities and skills | 3 | 2 | TD improved teaching abilities and skills |  |
| Exposure to pedagogy literature or resources on teaching* Gained knowledge about scholarship of teaching and learning
 | 32 | 42 | Exposure to pedagogy literature on teaching and learning |  |
| Experiential learning was useful | 3 | 3 | opportunities for experiential learning | Opportunities for experiential learning, active learning, a multi-disciplinary learning community, and diversity and inclusion were useful |
| Interactive workshops | 3 | 2 | Active learning or interactive workshops |
| Learning community or collaborative learning | 3 | 2 | Learning community |
| Learning through diversity and inclusion | 2 | 1 | Integrating diversity and inclusion |

Table S1—Continued

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Categories by DL & JM** | **Category Counts (DL & JM)** | **Category Counts by JM only** | **Major Categories** | **Themes** |
| TC program strengthened or clarified career interests and goals in teaching | 3 | 3 | TD program increased participants’ interest in teaching. | The impact of the TD program on participants’ career choices |
| TC program preparing participant for or boosted chances for obtaining faculty position | 2 | 4 | TD program increased participants’ chances of obtaining faculty positions |

**Supplementary Material 4**

Table S2

Themes and Subthemes and Samples of Participants’ Responses from the Interviews

|  |  |  |
| --- | --- | --- |
| **Themes** | **Subthemes** | **Sample Participants’ Responses from the Interviews** |
| 1. Alumni Reported Exposure to Multiple Effective Teaching Approaches (10/10 Responses) and Pedagogy Literature (7/10 Participants) | Exposure to multiple effective teaching approaches (10/10 participants) | *-Njeri* (Psychology): There were things that I didn’t know prior to those workshops like knowing about the struggles that certain students have in learning, and knowing how certain interventions are helpful to those students; using clicker questions….the workshops reinforced my skills in knowing how beneficial clicker questions are. I am more likely to use clickers now because of additional information that I now know about them. Previously, I knew that asking questions was really good for attention and retention of information. I didn’t necessarily think that it will be something that will be beneficial to a certain group of individuals, but knowing that information makes it more likely for me to do it…. I use clicker questions because I know it is going to help students retain the information better.*-Adams* (Biological Sciences):It [teaching center programs] made me aware of the best teaching practices. The fact that there are other alternatives to lecturing, and what those alternatives are whether they are clicker questions, case studies, or different ways of engaging students with the material during the lecture. *-Jane* (Chemistry): [teaching center programs] exposed me to those ideas which I think is the front-edge ideas I think for education and pedagogical intervention. Also started me to think not just about presenting the material but more a deeper level like why I can use those interventions to improve my student learning.*-Keritu* (Biological Sciences): I gained a [pedagogical] toolkit which I refer to notes occasionally when developing a course.*-Miriam* (Physics): The most important things that I learned was the basic awareness of teaching methods. |

Table S2—Continued

|  |  |  |
| --- | --- | --- |
| **Themes** | **Subthemes** | **Sample Participants’ Responses from the Interviews**  |
|  | Exposure to pedagogy literature on teaching and learning (7/10 participants) | *-* *Keritu* (Biological Sciences): It helped me learn current topics in the literature. Most of the instructional faculty here at the X University are on top of that kind of literature, and I have a nice discussion with them about what worked and never worked in our classes.*-Selina* (Biological Sciences): I didn’t know how to find the literature [on teaching and learning] and I didn’t know how to read the literature.-*Miriam* (Physics): The most part that I got from it is just the idea of where to go look from the physics literature and apply in my teaching. The benefit from the workshops was the exposure to the ideas and helped me to understand key words that I could go and look up and understand effective strategies.-*Kellen* (Mathematics): …becoming aware there is active research being done in educational methods, and that certainly helped me be able to find articles about POGIL, problem-based learning, using clickers in classroom to actually see what is working and reasonable teaching methods to try do in the classrooms. *-Johnston (Psychology):* But also the Teaching Center workshops provided specific activities one could use that have been vetted through research, so that motivated me to make sure I use much evidence-based teaching as I can whether informal or formal these are things I know they will work because I have read or learned about them.- *Ashelina* (Biological Sciences): I really had no idea about this whole field of the SoTL research, so I learned about different resources as well. I also learned how I could learn more from resources on improving teaching and learning. |

Table S2—Continued

|  |  |  |
| --- | --- | --- |
| **Themes** | **Subthemes** | **Sample Participants’ Responses from the Interviews**  |
| 2. Opportunities for Experiential Learning, Active Learning, a Multi-Disciplinary Learning Community, and Diversity and Inclusion | Experiential Learning (6/10 participants) | *-* *Njeri* (Psychology): One thing that I liked about several of them [workshops] is that they [workshop facilitators] not only talked about clicker questions, but they actually used a lot of clicker questions in a lot of the workshops. So they would ask questions before they even started and then they would do the teaching instruction and then they would ask questions at the end. So they were actually implementing the strategies that they were teaching; they were teaching us by implementing the strategies….It was very nice to be a student in those, because a lot of time I read effective pedagogy but until you experience it you don’t really realize what it feels like from a student perspective.*-Adams* (Biological Sciences): The most valuable aspect was not necessarily what they [workshop facilitators] were talking about, you know, they were not lecturing to us about the workshop telling us these are strategies you can use, but they would let us break out and discuss how we think we might apply it. This gives you an opportunity to come up to almost a case study: what are some topics or strategies that we haven’t talked about that could be applied to, for example, solve an issue during the class/lesson?*-Alisa* (Biological Sciences): So just how the workshops were ran I got to see the techniques in action and then practice it from a student perspective.*-Jane* (Chemistry): Having the small-group discussions, I started to think how I could use those ideas in my teaching; or doing a reflection of those thoughts was a reinforcement of those ideas and it made the workshop itself more effective. Otherwise people would leave with very little knowledge; they would come in, listen and go, but instead they had to think.*-Selina* (Biological Sciences): I appreciated modeling of the approaches during the workshops.- *Ashelina* (Biological Sciences): The big thing [I learned] is using the student response systems. It is something that I became familiar with in the workshop seminars where we used them in the seminar and it was great because I had a good idea of the type of questions to ask for that. Then seeing the workshop facilitators use the clickers and just kind like how it can aide the flow of the discussion was a positive influence. |
|  | Learning Community (5/10 participants) | *-Jane* (Chemistry)*:*The programs created a community to the students and postdocs who are passionate and committed to teaching, because many people think research is much more important than teaching and they don’t evaluate teaching as important. With the [teaching center] programs, it is viewed that teaching is valuable and we do care. By attending the programs, you realize that you’re not the only who cares about teaching, but there are many peers interested in teaching, and who are interested in implementing many interesting interventions in their teaching. -*Ashelina* (Biological Sciences)*:* Discussions with other workshop attendees were useful. It was good be with other people and talk about different points of view, and learn other people’s experiences. |

Table S2—Continued

|  |  |  |
| --- | --- | --- |
| **Themes** | **Subthemes** | **Sample Participants’ Responses from the Interviews**  |
|  | Active learning or interactive workshops (3/10 participants) | *-* *Keritu* (Biological Sciences)*:* The workshops were very interactive…it kept me engaged. Instead of just sitting there and trying to absorb information, I was actively involved in thinking about it.*-* *Miriam* (Physics): [Beneficial features were] the discussions that happened in the workshops where we could bring out ideas and share about a particular problem or teaching approaches with others. So having times where we could get questions about a particular method or about a particular problem related to teaching … The discussion was useful because I could learn from other people asking questions, and then how to apply the techniques learned in our courses was quite useful.  |
| Integrating diversity and inclusion (3/10 participants) | *- Miriam* (Physics): There was definitely a benefit learning about the pedagogies, but there was also workshops that talked about how you manage who’s speaking in class, and creating an inclusive learning.*-Ashelina* (Biological Sciences): In the past, I may not have paid attention to gender differences especially how the stereotype could influence student performance. So by attending the workshops and reading the books, all those concepts started to influence my teaching like when preparing for my teaching and when assigning students to groups; I need to keep those things in mind. They also influenced my teaching like improving my own teaching, and I also think it makes my students happier and comfortable in the classroom. |
| 3. The Impact of the TD Program on Participants’ Career Choices | TD program increased participants’ interest in teaching (6/10 participants) | - *Alisa* (Biological Sciences): I think I already had the [teaching] interest prior to the workshops. I felt vindicated that I really like this after the workshops, so it really affirmed what I wanted to do.- *Adams* (Biological Sciences): I got help on how I could shift my focus more into teaching (80%) with less research (20%). The programs were good for me to clarify what I wanted to be; what type of academic career I thought I was suited for. …[It] helped me make better decisions, and it turns out that it I love this position and I like predominantly teaching.- *Miriam* (Physics)*:* Before attending the TC workshops, I knew I wanted to teach, but the teaching center reinforced the idea that this can be a line of research in the same way I do scholarship in physics. And that certainly influenced how I approach my teaching in that. -*Kellen* (Mathematics):I went to a liberal Arts college as an undergraduate so I wanted to teach at a similar institution, so it didn’t necessarily change my career goals; it made me more likely to sort of get the kind of a job that I wanted.] |

Table S2—Continued

|  |  |  |
| --- | --- | --- |
| **Themes** | **Subthemes** | **Sample Participants’ Responses from the Interviews**  |
|  |  | - *Ashelina* (Biological Sciences): The Teaching Center programs introduced these ideas of scholarship to teaching and learning and effective teaching methods. So that gave me a little more enthusiasm even to a career in teaching, or to be involved largely in teaching. So when I saw the posting for the position that I am in right now for Cell Biology, I felt more confident in applying for it than I would have been prior to this experience. I interviewed for the adjunct position with Dr. X, and I was more confident to share my ideas and my experiences from the workshops and the SoTL class, and I got the job.  |
|  | TD program increased participants’ chances of obtaining faculty positions (6/10 participants) | -*Keritu* (Biological Sciences): I found that extremely helpful when I was crafting my teaching statement in applying for jobs because having not taught it was intimidating to figure out how exactly I will be a teacher and what tools to employ to help my students in performance. So just having those few hours of workshops to learn about teaching at University X was extremely helpful, and in developing that document. In fact when I interviewed for jobs people were very impressed hearing the methods that I was going to apply.- *Njeri* (Psychology): I do think the teaching center workshops helped me to get a position where teaching is valued by being able to say I participated in these workshops to improve teaching.*-Kellen* (Mathematics): I think one of the reasons I got the job is because during the interview I was able to talk about teaching with technology. So I had to talk very intelligently about teaching Discrete Math using blog post in solving the problems. So the Teaching Center programs really helped me talk about teaching in my teaching philosophy statement and in the interviews. I think that is very essential given the state of the market today; it is very hard to get a tenure-track job. I don’t think I would have been competitive with my teaching if it were not for the Teaching Center workshops. *-Jane* (Chemistry)*:* When I started to look for jobs in teaching positions, I realized that many of those pedagogical concepts that I learned from attending the Teaching Center workshops are very front-edge. For many of the schools when I mentioned those concepts to them during the interview, they had never heard of those terminologies. … it was a great advantage to me when I was looking for jobs at those moments. I think it was a great opportunity that I appreciated. |