A Design Principles Framework for DEI Professional Development for Mathematics Graduate Teaching Assistants

Franklin Yu
Virginia Commonwealth University

Kelsey Quaisley
Oregon State University

Mary E. Pilgrim
San Diego State University

ELITE PD Research Group
EHR #2013590, 2013563, and 2013422

Diversity, Equity, and Inclusion (DEI) has become an increasingly important topic in mathematics education and in the professional development (PD) of Mathematics Graduate Teaching Assistants (MGTAs). Currently, little is known about the types of initiatives that are effective in supporting MGTAs' use of equitable and inclusive teaching practices. Based on data from 45 MGTAs enrolled in our DEI-focused PD program, we propose a preliminary framework to elucidate the characteristics of activities that support MGTAs' engagement in DEI issues. We illustrate the utility of the framework by highlighting examples of activities in alignment with the framework, as well as the memorable impact of these activities on the MGTAs who completed coursework in our PD program.

Keywords: DEI, Professional Development, Graduate Teaching Assistants

In recent years, scholars have made numerous calls for improving Diversity, Equity, and Inclusion (DEI) in mathematics education (AMS, 2019; MAA; 2019; Voigt et al., 2023). This involves addressing issues on all levels: societal, structural, departmental, and within the classroom. At the classroom level, enacting teaching practices that advance DEI efforts typically require appropriate training within a supportive system. With respect to Mathematics Graduate Teaching Assistants (MGTAs), the literature is clear that most MGTAs would benefit from more professional development (PD) that enables them to test and adopt new teaching practices (Deshler et al., 2015; Beisiegel, 2019; Speer et al., 2010). The professional development of MGTAs is one of many important areas to focus on in undergraduate mathematics education since MGTAs often lead multiple recitations for large lecture courses or teach lower level mathematical courses as the lead instructor (Selinski & Melbourne, 2015).

Although many institutions publicly state their support of DEI efforts, Cumming et al. (2023) discovered that only 21% of 83 universities that they polled met their DEI goals. This indicates that despite being actively engaged in DEI efforts, there is much to learn about what types of initiatives are effective in supporting DEI efforts, including the adoption of equitable and inclusive teaching practices. While studies on DEI training have increased over the years, the field is still investigating the efficacy of such training (Wang et al., 2024). We investigate one facet of DEI PD, namely design principles of effective DEI PD activities. The goal of this paper is to explicate a preliminary Design Principles Framework for individual activities that promote MGTAs' abilities to enact equitable and inclusive teaching practices, and to argue for the utility of the framework through a) examples of activities that employ the Design Principles Framework, and b) excerpts of MGTAs' experiences with and takeaways from those activities.

Background

At our respective universities, we employ the ELITE PD program which consists of a pre-fall term orientation, a sequence of three courses (each lasting one term, semester or quarter), and

a peer mentoring experience. This professional development program involves developing and advancing MGTAs' teaching practices that foster student engagement and active learning, equity, and inclusivity in the classroom. The authors are the instructors of these PD courses and have observed and reflected on how our MGTAs interacted with the curriculum.

The Design Principles Framework

Based on the literature on PD for teachers, our reflections on teaching, and our analysis of MGTA feedback from surveys and exit tickets, we provide four *Design Principles* when considering whether an activity will be productive in advancing MGTA's abilities to engage in DEI issues. It should be noted that not every activity will 100% adhere to these principles. Instead, we claim that these are useful guidelines that one should keep in mind when preparing an activity for MGTAs. Figure 1 summarizes the Design Principles Framework.

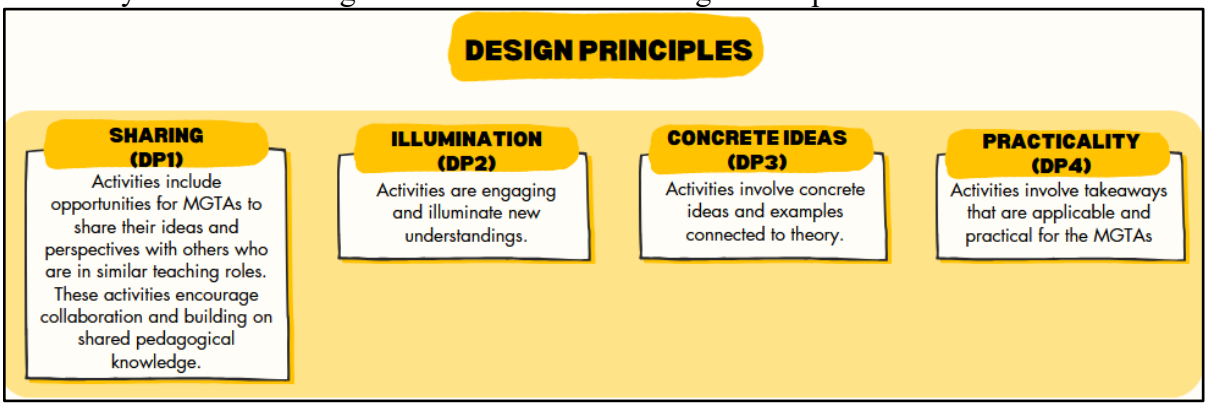


Figure 1. The Design Principles Framework

DP1 Community and Collaboration: Activities should include opportunities for MGTAs to share their ideas and perspectives with others who are in (or have been in) similar teaching roles. These activities should facilitate collaboration and building on shared pedagogical knowledge.

DP1 highlights the importance of the MGTAs as a cohort of educators and learners. Since the MGTAs have a unique composition of backgrounds and experiences, professional development activities should leverage those by providing spaces for MGTAs to share and discuss ideas as fellow educators (Quaisley, 2023; Oehrtman et al., 2009). We have consistently found that the MGTAs appreciate the opportunities to learn not only from us as the instructors, but also from their fellow MGTAs who are in similar positions. Practically speaking, this means that the kinds of discussions questions should be open-ended and in an environment that is safe for MGTAs to share. Additionally, since MGTAs usually have similar teaching assignments, providing the space to discuss their classrooms furthers their sense of community as a cohort of educators.

DP2 Awareness Leading to Enactment and Engagement: Activities should provoke engagement and illuminate new understandings. (How we intend MGTAs will experience and interact with these activities).

DP2 describes how activities should be oriented to productively engage MGTAs in reflecting on issues in DEI. We have observed that MGTAs have stronger recollections of DEI issues when the activities involve self-discovery, illumination of different perspectives, interaction, and/or a form of novelty. In essence, productive PD should not have MGTAs be passive learners, instead activities should have them take an active role (Soto & Marzocchi, 2021; Van Veen et al., 2012). For example, telling MGTAs to "do group work in their classes" and giving them a long list of methods has not been effective in shifting their pedagogy. Instead, we have MGTAs engage with

a few active learning techniques, thoroughly discuss how they can be employed, and create examples of implementation from the courses they teach. Additionally, we also provide hypothetical situations focused on specific equity issues, such as how to support women who are consistently underestimated by their male peers (Grunspan et al., 2016), when engaging in group work activities. These types of activities should support MGTAs in understanding the perspective and experiences of marginalized populations in mathematics.

DP3 Concrete Ideas and Examples Connected to Theory: Activities should not just be about theory, they should involve concrete ideas and examples connected to theory.

DP2 and DP3 are interconnected principles, where DP2 refers to how MGTAs should interact with the activity and DP3 refers to the substance that composes those activities. Specific examples help MGTAs process complex ideas from theory by providing a mental anchor they can associate with these theoretical topics (Darling-Hammond et al., 2017). For example, one activity we use involves MGTAs reading quotations from disabled students about their university experiences. These narratives allow students to learn from actual students about access and design issues that might have been previously imperceptible to them, which allows them to become more aware about the access needs of all students. In essence, effective activities in DEI PD should not be purely lecture and abstract. Instead, providing examples and sample narratives aids MGTAs in understanding the complexities of DEI issues.

DP4 Practicality and Actionable Takeaways: Activities should involve takeaways that are directly applicable and practical for the MGTAs.

While activities should be engaging and involve specific examples, there also needs to be tangible ways to shift their pedagogy. In other words, the activities should meet MGTAs where they are and provide something they can try out or consider in their classrooms (Sims & Fletcher-Wood, 2021). MGTAs need such opportunities to practice new techniques and get appropriate feedback. For example, in one of our classes, we assign MGTAs one active learning technique to learn about (they are given the resources to do so) and then report back on what the activity entails, what situations it is useful for, and a short sample of how they might implement it in their own class. Our MGTAs often reported back to us that they tried the techniques they learned about and mentioned that they were successful in making their classroom more interactive and engaging for the students.

Examples of Implementation

In this section, we provide samples of activities from the PD program that we have observed the MGTAs as finding memorable and impactful. We bolster our claims from data we collected from our 45 MGTAs by means of Exit Tickets from individual classes, End-of-Course Surveys, and Clinical Interviews with the MGTAs throughout the academic school year. To demonstrate the Design Principles in action, we provide two examples of activities that we have employed at our three universities. We provide a summary of the activity, sample discussion questions, and highlight how the Design Principles are employed.

Vignettes

The usage of vignettes, short descriptions of scenarios or teaching clips, has long been utilized in advancing teacher education (Angelides & Gibbs, 2006; Herman, 1998). Throughout the entire ELITE PD program, we employ vignettes to discuss specific topics in equity and issues pertinent to our local institutions. For example, we utilize Yong's (2018) vignette that focuses on an issue prevalent in STEM where women deal with the "chilly" climate by being undervalued and spoken over (Simon et al., 2017, p. 300) (Figure 2).

Rhea said that she found herself the only woman in a group with three men. The students were asked to answer questions on the back of a worksheet, which involved parsing some definitions on the front of the worksheet.

What do you think happened?

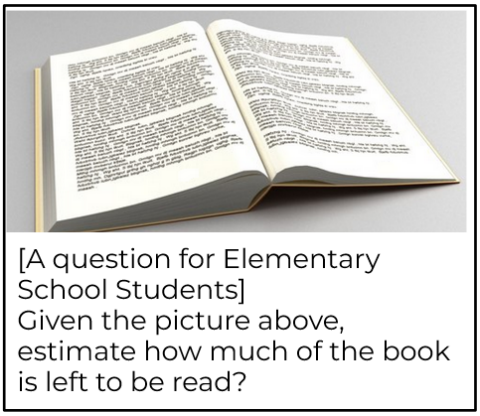
The three men chose to forge ahead on the questions without reading the definitions first, referring to them when they needed them. She wanted to read the definitions first and understand them before moving on. They left her behind and she basically worked on the assignment by herself.

How do you think student Rhea felt? How could the TA handle the situation?

Figure 2. Sample Vignette Targeting Equity Issues in STEM

With all the vignettes, our intent is to provide a realistic situation [DP3] that provides insight into a particular area or specific DEI issue [DP2]. Usually we leave open-ended questions such as "what do you think happened?", "how could the TA handle the situation?", and "what could the TA do next time to prevent this issue?" which allows for the MGTAs to share their unique perspective with their peers [DP1] as well as engage in thinking practically about what they would do as the instructor [DP4]. There is a wealth of sample teaching vignettes available online such as the works of Saul (2019) and Yong (2018), but we also advocate for drawing on the MGTAs' experiences in creating scenarios of issues pertinent to the local context.

Problematic Assessments



[A question for Elementary School Students]
Given the picture above, estimate how much of the book is left to be read?

Figure 3. The Book Approximation Problem

In this activity, we have our MGTAs discuss racially biased questions and reflect on what it is trying to assess and who it actually benefits. We start with a problem that we believe our MGTAs would find innocuous (Figure 3). From our experience, the MGTAs would answer in a normative way because of their accustomization in reading left to right, however some elementary school students with international backgrounds answered it incorrectly due to their cultural influence of reading right to left. When told this information, MGTAs start to realize their assumptions (one being the myth that mathematics is purely "objective"). We then move onto other racially biased questions, where we discuss what the question is trying to assess, what it actually assesses, who benefits, and what might an alternative assessment be.

In this activity, the MGTAs go in not knowing the conclusion, which enables them to be surprised by how the book question could be biased and provides an opportunity for them to reflect on their assumptions [DP2]. We have found that the book example as an introduction to problematic assessments has been memorable to our MGTAs in helping them realize different people's backgrounds [DP3]. Additionally, we guide the discussion to give them practical tools

to help them reflect on their usage of assessments. The questions we provide, "What does this question try to assess?" and "Who does this favor?" are easy questions for the MGTAs to ask themselves before deciding on a form of assessment [DP4].

MGTA Reception and Discussion

After implementing the ELITE PD program across several years with 45 MGTAs, we gathered feedback on the program and specific activities through surveys and interviews. Our preliminary data analysis indicates how the Design Principles had positive impacts on the MGTAs in relation to their pedagogy. These excerpts come from the MGTAs responses to questions such as "How has the ELITE PD program helped you thus far?" and "Are there things that really stand out as having a big impact?".

> *The things that had a big impact was I am able to kind of implement within the classroom. For instance, one group talked about series and how they could make that more interactive. So I found that something I could implement within my classroom. In another example, our group talked about the first day of class and how to make an inclusive environment like by asking open-ended questions and validating everyone's opinions that kind of break that math anxiety*. [DP1 & DP4]

> *One thing that really stood out to me was when something was that I hadn't thought about and I'm kind of aware of it. Things like that is like the way the ideas were presented was in a way that halfway through the activity I go "oh, this is important, I should think about that more".* [DP2]

> *We had so many kinds of good examples given, so with each of the lessons, I found that I would find a new aspect of it that I hadn't thought about before. And I think that really is the key of a program like this, it's not about checking things off. But the entire point is to make you think more introspectively, that we learned how to do these things and how to approach them and kind of opening your mind to new forms of pedagogy and examining the ways that we've approached it.* [DP2 & DP3]

Concluding Remarks

Overall, our preliminary data indicates the activities adhering to the Design Principles Framework was effective in making lasting impressions on MGTAs. The majority of the MGTAs stated that the specific examples [DP3] and opportunities to learn from each other were impactful in aiding them to reflect on DEI issues [DP1]. Additionally, the MGTAs valued the ways in which the activities demonstrated how issues of identity and power play out in the classroom [DP2] and that there were clear takeaways they could employ in their classrooms [DP4].

While the feedback from the MGTAs evidence the effectiveness of the Design Principles Framework in a DEI-focused PD, we are cognizant of the need of better assessments to track how MGTAs' teaching shifts in the long-term. However, we see our preliminary Design Principles Framework as contributing to the literature, by taking an initial step of illustrating the potential impact the framework could have on future MGTA PD development.

Questions for the Audience

1) What metrics might capture impactful changes in MGTAs' equitable teaching?
2) What seems important for productively engaging MGTAs in conversations about DEI?

Acknowledgments

This material is based on work supported by the National Science Foundation under NSF EHR #2013590, 2013563, and 2013422. Currently the ELITE PD Research group includes the authors listed above as well as Mary Beisiegel, Rebecca Segal, Pablo Duran Oliva, Mariah Moschettit, Hayley Milbourne, and Matthew Taylor. Past members also include David Fifty, Jhonny Guzman, V. Rani Satyam, Sloan Zak, and Stacy Zimmerman.

References

American Mathematical Society (AMS). (2019, April). Statement on equity, diversity, and inclusion. Retrieved from http://www.ams.org.

Angelides, P., & Gibbs, P. (2006). Supporting the continued professional development of teachers through the use of vignettes. *Teacher Education Quarterly*, 33(4), 111-121.

Beisiegel, M. (2019, July). Teacher interrupted: How mathematics graduate teaching assistants (don't) learn about teaching. In *Proceedings of the 43rd Conference of the International Group for the Psychology of Mathematics Education* (Vol. 2).

Cumming, T., Miller, M. D., & Leshchinskaya, I. (2023). DEI institutionalization: Measuring diversity, equity, and inclusion in postsecondary education. Change: *The Magazine of Higher Learning*, 55(1), 31-38.

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). Effective teacher professional development. *Learning policy institute*.

Deshler, J. M., Hauk, S., & Speer, N. (2015). Professional development in teaching for mathematics graduate students. *Notices of the AMS*, 62(6), 638-643.

Grunspan, D. Z., Eddy, S. L., Brownell, S. E., Wiggins, B. L., Crowe, A. J., & Goodreau, S. M. (2016). Males under-estimate academic performance of their female peers in undergraduate biology classrooms. *PloS one*, 11(2), e0148405.

Herman, W. E. (1998). Promoting pedagogical reasoning as preservice teachers analyze case vignettes. *Journal of Teacher Education*, 49(5), 391-397.

Mathematical Association of America (MAA). (2018). Instructional Practices Guide. Retrieved from https://www.maa.org/sites/default/files/InstructPracGuide_web.pdf

Oehrtman, M., Carlson, M., & Vasquez, J. A. (2009). Attributes of content-focused professional learning communities that lead to meaningful reflection and collaboration among math and science teachers. *Professional learning communities for science teaching: Lessons from research and practice,* 89-106.

Quaisley, K. (2023). *Learning to teach prospective elementary teachers: A narrative inquiry of a newer mathematics content instructor* [Unpublished doctoral dissertation]. University of Nebraska-Lincoln.

Saul, M. (2019, June 3). Two Teaching Vignettes. *AMS Blogs*. https://blogs.ams.org/matheducation/2019/06/03/two-teaching-vignettes/

Selinski, N. E., & Milbourne, H. (2015). The institutional context. In D. Bressoud, V. Mesa, & C. Rasmussen (Eds.), *Insights and recommendations from the MAA national study of College Calculus* (pp. 31-44). Washington, DC: MAA Press.

Simon, R. M., Wagner, A., & Killion, B. (2017). Gender and choosing a STEM major in college: Femininity, masculinity, chilly climate, and occupational values. *Journal of Research in Science Teaching*, 54(3), 299-323.

Sims, S., & Fletcher-Wood, H. (2021). Identifying the characteristics of effective teacher professional development: a critical review. *School effectiveness and school improvement*, 32(1), 47-63.

Soto, R. C., & Marzocchi, A. S. (2021). Learning about active learning while actively learning: Insights from faculty professional development. *PRIMUS*, 31(3-5), 269-280.
Speer, N. M., Smith, J. P., & Horvath, A. (2010). College mathematics teaching: An unexamined practice. *The Journal of Mathematical Behavior*, 29, 99-114.
Wang, M. L., Gomes, A., Rosa, M., Copeland, P., & Santana, V. J. (2024). A systematic review of diversity, equity, and inclusion and antiracism training studies: Findings and future directions. *Translational behavioral medicine*, 14(3), 156-171.
Van Veen, K., Zwart, R., & Meirink, J. (2012). What makes Teacher professional development effective?: A Literature Review. *Teacher learning that matters*, 3-21.
Voigt, M., Hagman, J. E., Gehrtz, J., Ratliff, B., Alexander, N., & Levy, R. (2023). *Justice through the lens of calculus: Framing new possibilities for diversity, equity, and inclusion*. Mathematics Association of America.
Yong, D. (2018, March 28). The Ever-Present Challenges of Group Work. *Proteacher*. https://profteacher.com/2018/03/28/the-ever-present-challenges-of-group-work/