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BOARD # 381: Integrating Culturally Responsive Teaching (CRT) competencies and approaches across a Teacher Preparation Program through a NSF Noyce program

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Integrating Culturally Responsive Teaching (CRT) competencies and approaches across a Teacher Preparation Program through an NSF Noyce program

Abstract

The Teacher Preparation Program (TPP) at Worcester Polytechnic Institute (WPI) has been actively piloting components of Culturally Responsive Teaching (CRT) to better prepare our pre-service teachers to feel confident and excited to teach in urban, high need public school districts. With the awarding of an NSF Noyce Track 1 grant, we have intentionally created workshops that establish foundations for CRT while thoughtfully pairing pre-practicum experiences in our local community. Realizing the necessity to have more CRT theory, focused experiences, and reflections, as well as to develop and deepen CRT practices with feedback, we have mapped out different CRT competencies and approaches throughout the TPP curriculum. New pre-practicum courses and course assignments have been developed. This paper outlines our results in interspersing CRT throughout our TPP curriculum and sketches out the main learning objectives and topics organized by pre-practicum and (student teaching) practicum experiences and courses. The end goal is for our teacher candidates to be inclusive, culturally responsive, and effective educators such that all their students engage in STEM learning.

Background

At a private STEM-focused institution without a School of Education, our Teacher Preparation Program (TPP) students are earning their B.S. degree in a STEM field while also completing additional coursework and teaching experiences to be endorsed for an initial teaching licensure in the state of Massachusetts. Most of the TPP students complete their undergraduate degree and earn their teaching license within four years, and then have the option of entering the classroom to teach, attending graduate school, or working in industry. The NSF Noyce Track 1 grant offers $20k/year scholarships in the junior and senior year that could offset the need to work in industry to pay off school loans instead of entering the K-12 classroom. We have been continuously shifting the culture at our institution to highlight the challenging, yet rewarding and impactful, career in teaching. Over the past 4 years (i.e., the duration of our grant), the number of TPP students have been increasing, as well as the number who plan to teach math, science, technology/engineering, or digital literacy/computer science at the secondary level (i.e., middle and high school). Roughly 1/3 of our TPP students are also Noyce scholars.

The majority of our TPP students have different lived and K-12 school experiences than the learners that are in their practicum placement classrooms. Our local urban public school district (the 2nd largest in the state of Massachusetts) is considered "high need" and serves as appropriate preparation for our Noyce scholars to fulfill their Noyce scholarship obligation in teaching at a high need school district. Table 1 displays the race/ethnicity percentages of the Worcester Public School (WPS) District [1], the WPI undergraduate population [2], WPI Teacher Prep Program, and WPI Noyce scholars. The City of Worcester has a highly diverse population, while WPI and its TPP are majority white. While we attempt to increase the diversity of our TPP students and Noyce scholars, we are also working to strengthen our TPP with Culturally Responsive Teaching (CRT) pedagogy and equity mindsets for all of our pre-service teachers [3].

Table 1. Race/Ethnicity demographic percentages and total number of the local K-12 district, WPI, TPP, and Noyce Scholars

Race/Ethnicity	WPS (%)	WPI (%)	TPP (%)	Noyce (%)
Afr Am/Black	17.3	2.9	5.9	15.4
Asian	6.3	13.3	8.8	15.4
Hispanic	46	9.0	17.6	15.4
Native Am	0.2	0.1	0	0
Nat Hawaiian/PI	0.0	0.0	0	0
Multi-Race	4.1	3.8	0	0
White	26.1	67.4	67.6	53.8
unknown		3.6		
Total #	24,350	5205	34	13

Currently in the 4th year of our NSF Noyce Track 1 project entitled, "Cultivating University-School-Community Partnerships to Prepare STEM Undergraduates to Teach in Urban Environments" [4], we have embraced the engineering design process [5] of prototyping interventions, assessing and reflecting, and then continuously improving upon each iteration to reach our intended outcome that WPI TPP students develop an equity mindset and gain CRT competencies to be inclusive, culturally responsive, and effective educators such that all of their students engage in STEM learning.

Culturally Responsive Teaching Competencies spiraled through the TPP curriculum

Eight (8) CRT competencies identified by New America (Figure 1) [6] are used as a guide and reflection tool for our TPP, and they are as follows:

- Reflect on One's Cultural Lens
- Recognize and Redress Bias in the System
- Draw on students' culture to share curriculum and instruction
- Bring Real-world Issues into the Classroom
- Model High Expectations for All Students
- Promote Respect for Students Differences
- Collaborate with Families and the Local Community
- Communicate in Linguistically and Culturally Responsive Ways
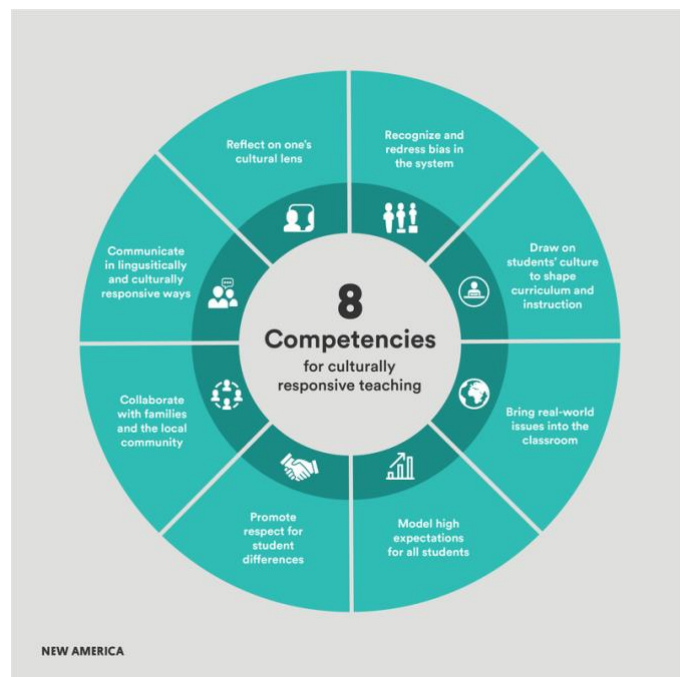
Figure 1. The eight CRT competencies identified by New America [6] and threaded throughout the TPP.

Establishing the Foundation for CRT through Pre-Practicum Courses and Experiences

At the start of our Noyce project (2021), we instituted required CRT workshops (on a couple of Saturdays) and pre-practicum experiences of volunteering at least 10 hours in some sort of K-12 teaching experience in the community. The volunteer hours were conducted when and where the TPP students could fit it into their schedules (e.g., during the summer in their hometown). The flexible requirement had little oversight, and thus the pre-practicum experiences varied widely and the couple of workshops could only introduce broad, surface-level concepts on equity and inclusion, achievement vs. opportunity gaps, identity and race/ethnicity, and institutional racism. While requiring additional coursework might be a barrier to students participating in the TPP, we felt it was necessary. Establishing a foundation and disposition for CRT [7] was essential in preparing confident, capable, and effective teachers. In Spring 2024, we piloted new courses that paired class sessions with arranged pre-practicum experiences in the local community.

Because most of the WPI TPP students are not from the local area, the course was designed to have the pre-service teachers immersed in the local community and learning about the history and assets of city [8]. The course goal was "to develop *teacher-student* relationships that enable reciprocal learning of each other's assets and lived experiences through regular, ongoing engagement with Worcester community-based organizations (CBOs) that support local PreK-12 students (and their families)." Four of the CRT competencies [6] were selected for this stage of the TPP: Reflect on One's Cultural Lens, Recognize and Redress Bias in the System, Collaborate with Families and the Local Community, and Communicate in Linguistically and Culturally Responsive Ways. Additional learning objectives included:
- Examine and define the meaning of "community" and "community engagement"
- Practice **cultural humility** when engaging with community members
- Investigate one's **identities** and **positionality** in the local community
- Examine **implicit bias** (with the Harvard Implicit Associations Test) and discuss how it affects teaching and family engagement
- Demonstrate a growth and **asset-based mindset** when interacting with learners
- Practice student-centered tutoring/teaching skills that foster independence and deep learning, and instill a **growth mindset** in learners)
- Identify components of **community cultural wealth** [9] of students and families
- Adopt a **culturally responsive lens** to working with the community and towards teaching

The course included several readings, class discussions, guests to the class, and many reflections. We also utilized the book, *The Student Companion to Community-Engaged Learning* [10] to frame the course and teaching profession as being with learners/community to lessen possible saviorism attitudes. The class meetings allowed the TPP students to share their observations and experiences at the CBOs in context of what we are learning in the course. As an example, institutional racism and the legacy of redlining was made real when a history professor visited the class. TPP students brought up the buildings and landscape they saw as they traveled to the CBOs. We examined a 1936 historical city map from the Federal Home Owners' Loan Corporation (HOLC) [11]. The map was used by real estate professionals and policymakers that established "redlining" (i.e., denying fair access to credit based largely on the race of the residents of a neighborhood). Notably, WPI is situated in a green area, while our CBO partners are generally in or border the red and yellow zones. The HOLC's classifications led to the

underinvestment in certain neighborhoods, and the consequences continue to be felt today in terms of property value and environmental (in)justice zones [12].

After getting to know K-12 students and community members, TPP students then facilitate hands-on STEM learning activities at the CBOs. The pre-service teachers begin to practice some culturally and linguistically responsive pedagogical approaches. Additional CRT competencies [6] are brought in at an awareness level: Draw on students' culture to share curriculum and instruction, Bring Real-world Issues into the Classroom, Model High Expectations for All Students, and Promote Respect for Students Differences. These competencies are deepened with later coursework (i.e., Sheltered English Immersion, Teaching Methods) and are especially highlighted during the student teaching practicum.

Assessment of the pilot course (and impact on the TPP students) were conducted by the Noyce grant evaluator, and details can be found in another publication [13]. The course instructors felt that the pre-service teachers who took the courses are much more engaged with the community and eager to continue with classroom teaching. The next iteration of the pre-practicum courses will include community walks [8], and family engagement competencies from the National Association for Family, School and Community Engagement (NAFSCE) [14].

Connecting CRT Theory and Practice during the Student Teaching Practicum

A Teacher Prep course is taken alongside the beginning of the student teaching practicum when pre-service teachers are slowing taking over the teaching duties under the supervision of a mentor teacher in WPS. As the TPP students begin to develop and adapt lesson plans, we revisit the CRT competencies and explore the evolution and leaders of Culturally Responsive Teaching (e.g., Ladson-Billings, Gay, Hammond, Tatum). During the TPP class, we also discuss concepts such as how STEM is not neutral, Harro's Cycle of Socialization, Oppression, and Liberation, and social justice in STEM. The TPP students also explore different online teacher resources pertaining to culturally responsive teaching, research evidence-backed approaches to advance equity and justice through STEM teaching [15], and review CRT classroom look-fors. We hope to incorporate CRT observations tools [16] in the future.

A key deliverable for the course is for the pre-service teachers to design and teach a lesson with an equity and culturally relevant lens with the following criteria:
- Draws on the learners' knowledge, experiences, and cultural practices ("funds of knowledge") when identifying lesson goals and learning outcomes
- Creates opportunities for students to suggest how they can apply the lesson learning objectives, STEM content and skills in ways that are *relevant* in their lives
- Prioritizes learning outcomes that foster diverse STEM identities, definitions, interests, and civic engagement
- Provides multiple ways for students to show their learning

The TPP students share the development of their lesson plan with classmates to get feedback from their peers, and later share how the implementation of the CRT lesson went.

By the end of the course, the pre-service teachers also write a positionality statement in addition to their teaching philosophy. Through course assignments, the Culturally Responsive Teaching

Preparedness Survey (CRTPS) [17], and Noyce scholar interviews by our project evaluator, we hope to gain insight into how our TPP students develop to be equitable and inclusive STEM classroom teachers.

Acknowledgements

References

1. "School and District Profiles," *profiles.doe.mass.edu*. https://profiles.doe.mass.edu

2. "Facts & Figures," *WPI*. https://www.wpi.edu/about/facts

3. E. R. Hollins, "Teacher Preparation For Quality Teaching," *Journal of Teacher Education*, vol. 62, no. 4, pp. 395–407, Sep. 2011, doi: https://doi.org/10.1177/0022487111409415.

4. https://www.nsf.gov/awardsearch/showAward?AWD_ID=2050461

5. K. C. Chen, S. Weaver, and G. Fougere, "Utilizing an Engineering Design-Based Research Approach to Study and Strengthen a Teacher Preparation Program in STEM at the Secondary Level (Work in Progress)," 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference, 2021, July. ASEE Conferences, 2021.

6. J. Muñiz, "Culturally Responsive Teaching: A Reflection Guide," *New America*, Sep. 23, 2020. https://www.newamerica.org/education-policy/policy-papers/culturally-responsive-teaching-competencies/

7. T. Meidl and B. Baumann, "Extreme Make Over: Disposition Development of Pre-Service Teachers," *Journal of Community Engagement and Scholarship*, vol. 8, no. 1, 2015, doi: https://doi.org/10.54656/oqxw7982.

8. C. Wilcoxen, A. Steiner, and J. Bell, "Strengthening Preservice Teachers' Understanding of Culturally Responsive Classrooms Through Exposure, Immersion, and Dialogue," *Journal of Community Engagement and Scholarship*, vol. 14, no. 1, 2021, doi: https://doi.org/10.54656/flxy2991.

9. T. J. Yosso, "Whose culture has capital? A Critical Race Theory Discussion of Community Cultural Wealth," *Race Ethnicity and Education*, vol. 8, no. 1, pp. 69–91, Aug. 2005, doi: https://doi.org/10.1080/1361332052000341006.

10. D. M. Donahue and S. Plaxton-Moore, *The Student Companion to Community-Engaged Learning*. Taylor & Francis, 2023.

11. *Arcgis.com*, 2025. https://www.arcgis.com/home/item.html?id=48173f9ea9344b628f61a6a8cfc670c1 (accessed Jan. 06, 2025).

12. "Environmental (In)Justice - Worcester Regional Research Bureau," *Worcester Regional Research Bureau*, Nov. 21, 2023. https://www.wrrb.org/reports/2023/11/environmental-injustice/ (accessed Jan. 06, 2025).

13. "Partnering with Community-Based Organizations to Support Pre-Service Teachers in Developing Competencies in Culturally Responsive Teaching (Work in Progress)," submitted to *2025 ASEE Annual Conference*

14. "Core Competencies - NAFSCE," *nafsce.org*. https://nafsce.org/page/CoreCompetencies

15. "How can you advance equity and justice through science teaching?" StemTeachingTools (en-US), *stemteachingtools.org*. https://stemteachingtools.org/brief/71

16. C. M. Hernandez, A. R. Morales, and M. G. Shroyer, "The development of a model of culturally responsive science and mathematics teaching," *Cultural Studies of Science Education*, vol. 8, no. 4, pp. 803–820, Oct. 2013, doi: https://doi.org/10.1007/s11422-013-9544-1.

17. Y.J. Hsiao, "The Culturally Responsive Teacher Preparedness Scale: An Exploratory Study," *Contemporary Issues in Education Research (CIER)*, vol. 8, no. 4, p. 541, Oct. 2015, doi: https://doi.org/10.19030/cier.v8i4.9432.