

## **Theory to Practice: Faculty Professional Development to integrate Culturally Responsive Pedagogy and Practices in STEM Education to Improve Success of Underserved Students in STEM.**

**Cynthia Kay Pickering, Arizona State University**

Cynthia Pickering is a PhD Candidate and Researcher for the Center for Broadening Participation in STEM at Arizona State University. Cynthia has 35 years of experience working in industry with demonstrated technical leadership in software development, artificial intelligence, information technology architecture / engineering, and collaboration systems research. Cynthia is currently studying Human and Social Dimensions of Science and Technology in the School for the Future of Innovation in Society in ASU's College of Global Futures. She practices Socio-technical Integration Research as an embedded social scientist who collaboratively works with technologists (STEM students, STEM faculty, and Tech Companies) to increase reflexive learning during technology development and implementation to pro-actively consider the impact of technology decisions on local communities and society at large. This work creates spaces and processes to explore technology innovation and its consequences in an open, inclusive and timely way.

**Mara Lopez, Arizona State University**

Dr. Mara Lopez is a full-time Research Program Manager working at the Center for Broadening Participation in STEM at ASU. In her work at the Center, she works to develop culturally responsive practices and increase the intentionality with which institutions work with Latinx students in STEM. She has taught First-Year Success courses at ASU since 2019. She recently graduated with her Doctorate in Education from ASU's Mary Lou Fulton Teachers College with an emphasis in Leadership and Innovation. Her research is centered on curriculum redesign, career decision-making self-efficacy, equity in education, social justice in education, and culturally responsive pedagogy. Through her research she has developed a Curriculum Interrogation Checklist through a Culturally Responsive Lens, Culturally Responsive Recruitment and Retention Framework and a Culturally Responsive Curriculum Evaluation Framework. She has presented at several conferences, spoken on several podcasts and written several papers all related to these research topics. She has worked in research for over 14 years on NIH, NSF, DoD, and DoE grants. She earned her BA in Psychology from San Diego State University and an MA in Organizational Leadership from Point Loma Nazarene University. She hopes to continue to affect change within institutions of higher education, provide mentorship for students who have been historically marginalized in academia and use research to be an agent of change.

**Ms. Elaine L. Craft, Florence-Darlington Technical College**

Elaine L. Craft (Florence-Darlington Technical College, Florence, SC-retired) holds a baccalaureate degree in chemical engineering from the University of Mississippi and a MBA from the University of South Carolina with additional graduate studies in mathe

**Sarah Belknap, Westchester Community College**

**Caroline VanIngen-Dunn, Arizona State University**

Caroline VanIngen-Dunn is Director of the Center for Broadening Participation in STEM at Arizona State University where she is leading the Center's effort to create inclusive STEM environments for students who use the community college system and to provide access along their pathway to achieving their credentials, degrees, and jobs. She is Principal Investigator of a \$10M NSF INCLUDES Alliance to Accelerate Latinx Representation in STEM Education (ALRISE) with institutional intentionality and capacity building for experiential learning. She serves on the University of Iowa College of Engineering Advisory Board, and on several Workforce Development and Diversity, Equity and Inclusion (DEI) committees.

**Laurie S. Miller McNeill, Westchester Community College**

**Juan R. Rodriguez, Westchester Community College**

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## **Abstract**

The Hispanic Serving Institution Advanced Technological Education Hub 2 (HSI ATE Hub 2) is a three-year collaborative research project funded by the National Science Foundation (NSF) that builds upon the successful outcomes of two mentoring and professional development (PD) programs in a pilot that translates foundational theory related to culturally responsive pedagogy into practice using a 3-tier scaffolded faculty PD model. The goal of HSI ATE Hub 2 is to improve outcomes for Latinx students in technician education programs through design, development, pilot, optimization, and dissemination of this model at 2-year Hispanic Serving Institutions (HSIs).

The tiered PD model has been tested by two faculty cohorts at Westchester Community College (WCC), an HSI in the State University of New York (SUNY) system. In year one, Cohort A piloted the PD modules in Tier 1 which featured reflective exercises and small culturally responsive activities to try with their STEM students. In year two, Cohort A piloted the PD modules in Tier 2 and peer-mentored Cohort B as they piloted optimizations introduced to Tier 1 from Cohort A feedback. Three types of optimizations came from faculty feedback. The first considered feedback regarding delivery and/or nature of the content that influenced a subsequent module. The second involved making changes to a particular module before it was delivered to another faculty cohort. The third takes into account what worked and what didn't to decide which content to bring into virtual webinars for the broader advanced technician education community. Dissemination of the tiered PD model has been achieved in annual webinars with the broader ATE community and at conferences for advanced technician educators to achieve broader impacts in the ATE Community. Longer term, providing professional development in culturally responsive pedagogy and practices can help existing and future faculty learn to productively engage their students in more inclusive ways. As faculty mindsets shift to asset-based thinking and a climate of mutual respect is developed, the learning environment for all students in technician education programs will improve. When students learn in a supportive environment, their chances for success increase. The professional development provided in the HSI ATE Hub 2 project will lead to longer term improvements in four ways: 1) Retainment of Culturally responsive practices by those directly engaged after the project ends; 2) Inserting top activities from the PD into national webinars to extend the reach of the training; 3) Strengthening grant proposals as faculty integrate culturally responsive strategies, knowledge and experience within their ATE proposals to the NSF; and 4) Meeting industry demand for a diverse technician workforce.

This second paper in a three-part series describes ongoing progress and lessons learned in developing and piloting the 3-Tier PD model with two Cohorts of STEM faculty at a 2-year HSI.

## 1. Introduction

The Hispanic Serving Institution Advanced Technological Education Hub 2 (HSI ATE Hub 2) is a faculty professional development (PD) project providing practical guidance to implement culturally responsive practices and ultimately improve the diversity of the STEM technical workforce. Westchester Community College (WCC) and the Center for Broadening Participation in STEM at Arizona State University (CBP-STEM), with assistance from Florence Darlington Technical College (FDTC) and the National Science Foundation (NSF) Advanced Technological Education (ATE) funded Mentor Connect program, are collaborating to address the need for culturally responsive technician education to improve outcomes for Latinx and other underrepresented populations in the STEM technical workforce.

When compared to other ethnic groups, Hispanic/Latino students suffer low educational attainment at all levels, e.g. 18% of all Associates, 12% of all Bachelors, 9% of Masters and 7% of Doctorate degrees [1]. The authors describe multiple contributing factors such as first-generation students, the Hispanic cultural value for work ethic and contributing income to the family, distrust of the American education system, aversion to debt, and a focus on survival rather than success that is socialized in many working-class Latino children due to poverty issues and low-income levels. Twenty-five years of lower STEM degree completions despite growing enrollment, along with higher education costs, lack of preparedness [2], and not feeling welcome on campus [3] contribute to the equity gap. The problem propagates into the STEM workforce where Hispanic workers over the age of 25 occupy 8% of all STEM jobs as compared to 67% STEM workers who are White [4].

For the purpose of this project, the gender neutral term Latinx will be defined as students who identify as Latino, Latina, Hispanic, and/or of Latin American descent. The project team recognizes that no single term represents the varied historical origins and unique cultures of the community in which individuals may identify as Hispanic, Latino, Latina, Chicano, Chicana, or Mestizo to name a few. The intent in using Latinx is to be inclusive.

The HSI ATE Hub 2 project has three primary goals:

1. Novel professional development specifically aimed at improving Latinx student success in technician education programs is developed with educational research, foundational knowledge of Culturally Responsive Instruction, and the expertise of subject matter experts.
2. The ability of community college educators to apply research-based knowledge and implement successful asset-based, culturally responsive technician education is increased.
3. Peer-sharing motivates incorporation of Culturally Responsive Instruction in technician education programs within WCC, the ATE Community and 2-year HSIs nationally.

Section 2 will discuss the updates to the professional development model based on feedback from the initial cohort in a pilot with a 2-year HSI as described in Sections 3 and 4. The activities and impacts surrounding Community Building will be discussed in Section 5. The paper finishes with overall Lessons Learned in Section 6, the Conclusion in Section 7, and Implications for Future Research in Section 8.

## 2. Updates to the 3-Tier PD Model for Culturally Responsive Technician Education

From Cohort A feedback, Tier 1 was reduced to two modules and delivery was synchronized with the beginning of Fall and Spring semesters. The feedback came from surveys and faculty workgroup discussions where participants raised questions, discussed what worked and where they encountered challenges in their courses while introducing culturally responsive activities and practices from the original four modules in Tier 1. Figure 1 shows the revised 3-tier Professional Development (PD) Model. The original Model was presented in last year's paper [5]. Table 1 shows the components of the original Model in comparison to the revised Model.

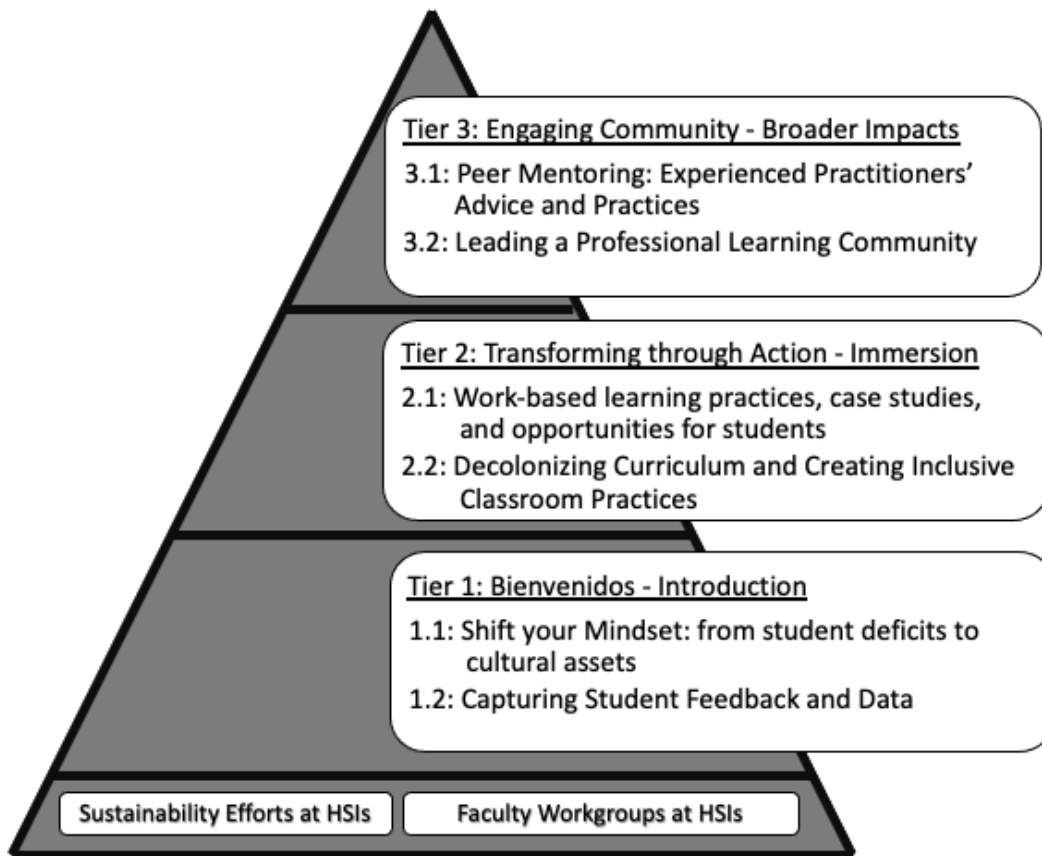


Figure 1: Revised 3-tier PD Model for Culturally Responsive Practices

Content from the four initial modules in Tier 1 was consolidated into two workshops, also by eliminating some material. Specific suggestions for what to keep and what to remove were provided by Cohort A and corroborated with the subject matter expert (SME) workgroup of six practitioners and researchers with expertise in culturally responsive practices who had collaborated to develop the four initial modules. The reworked Module 1.1 reused and streamlined original content and brought in some concepts from Cohort A's Module 1.2 such as collectivist and individualistic cultural frameworks and their differences. Resources in Module 1.4 that defined culturally responsive technician education and described the need were brought into the introductory section of Module 1.1. Examples of Cohort A faculty and student collages replaced original examples from other HSIs used in the flagship Module 1.1. Cohort A

recommended re-using the content, examples, and activities from Module 1.4 for Module 1.2 for year 2. A subset of content from Module 1.3 was moved to the new Tier 2 module 2.1 which also incorporated opportunities for students to develop employability skills. Modules 2.3 and 2.4 in the original Tier 2 model were eliminated as too large in scope and resource intensive. At Cohort A members' request to include activities and material for them to work on their pedagogical styles, a new Module 2.2 Decolonizing Curriculum and Creating Inclusive Classroom Practices is under development that uses liberating structures methodology and small doable activities to question current pedagogical practices, increase group engagement, and create opportunities to dismantle or "unlearn" existing practices. An important aspect will be for faculty to critically evaluate their positionality in the classroom.

Table 1: Original and Revised Modules of Culturally Responsive Technician Education Model

	Original Modules in 3-tier PD Model	Revised Modules in 3-tier PD Model
Tier 1 Bienvenidos	Module 1.1: Shift your Mindset from Student Deficits to Cultural Assets	Module 1.1: Shift your Mindset from Student Deficits to Cultural Assets
	Module 1.2: Teaching with Learning in Mind: Using Culturally Responsive Instruction to Align Course Activities with How the Brain Learns	<i>Bring in concepts from 1.2 and 1.4 Use Cohort A Example Collages</i>
	Module 1.3: Enlisting Industry Role Models and Partners	Module 1.2: Capturing Student Feedback and Data
	Module 1.4: Capturing Student Feedback and Data	
Tier 2 Transforming through Action	Module 2.1: Work-focused Experiential Learning Case Studies	Module 2.1: Work-based learning practices, case studies, and opportunities for students
	Module 2.2: Developing Students Employability Skills	<i>Bring in content from 1.3; combine original 2.1 and 2.2</i>
	Module 2.3: Culturally Responsive Instruction for Technicians "Mini-Project"	Module 2.2: Decolonizing Curriculum and Creating Inclusive Classroom Practices
	Module 2.4: Translate your learnings and data to ATE proposal writing	<i>Faculty work on their approaches and themselves; apply in small doable activities with students</i>

### 3. Professional Development Pilot

Currently there are two active cohorts piloting the professional development. The first, Cohort A, has completed Tier 1 and has progressed to Tier 2. The second, Cohort B, has begun Tier 1. Cohort A consisted of six faculty and two faculty mentors for a total cohort size of eight. Half of

Cohort A were full-time and the other half were adjunct faculty. Other Cohort A characteristics include six female faculty and two male; five Whites, two Hispanic/Latinx, and 1 multi-racial / Black. One male and one female participant from Cohort A decided not to continue to Tier 2. Cohort B consists of two full-time faculty and one adjunct. Two Cohort B members are female and one is male. One member is Hispanic/Latinx and two are White. A faculty mentor from Cohort A is assisting Cohort B.

Table 2 summarizes the results across all modules delivered to date. Last year’s paper [5] reported details for the delivery of Modules 1.1-1.3 to Cohort A. This year’s paper will discuss delivery of Module 1.4 and 2.1 to Cohort A, and delivery of the reworked Module 1.1 to Cohort B. Descriptions of activities for each module are provided after Table 2. Feedback and reporting on activities are explained in Section 4 Faculty Workgroups.

Table 2: Pilot Results for Cohorts A and B during Tier 1 and 2 PD workshops and other activities

<b>Expectation first round of Pilot</b>	<b>Actual Results</b>
Cohort A, 4-6 faculty members at WCC complete Tier 1	Cohort A size was 8 WCC faculty. 4 WCC faculty completed all four modules 4 WCC faculty completed at least three modules; Opportunity to view recordings
WCC faculty implement at least one <b>activity</b> per module	Module 1.1 - 7 implemented the Culture Share Collage for the PD Workshop Module 1.2 - 3 tried one activity Module 1.3 - 1 invited industry speakers to Cybersecurity Club, 1 interested Module 1.4 - 5 tried 1 activity; 2 tried 2 activities
Participating WCC faculty Agreed or Highly Agreed that the PD was useful	Module 1.1 - 83% of participants Module 1.2 - 83% of participants Module 1.3 - 80% of participants Module 1.4 - 100% of participants
WCC faculty in PD cohort regularly <b>participate in Faculty Workgroup (FWG) Sessions</b>	Module 1.1 FWG - 7 attendees Module 1.2 FWG - 5 attendees Module 1.3 FWG - not held, summer break Module 1.4 FWG - 7 attendees
At least 2 Peer mentors per cohort	4 faculty agreed to peer mentor next cohort
<b>Expectation next round of Pilot</b>	<b>Actual Results</b>
At least 3-5 Cohort A members continue to Tier 2	5 members (62%) of Cohort A continued to Tier 2 5 attended Module 2.1 delivery or listened to recording 4 attended 3 Faculty Workgroups 3 tried at least 1 activity 2 faculty peer mentors including PI, co-PI 100% agreed or strongly agreed on clearness,

	usefulness, and understandability of work-based experiential learning content and examples, except for the advanced course example at 83%. Note that participating faculty teach introductory and intermediate courses only.
3-5 Cohort B members recruited and engage in Reworked Tier 1 Module 1.1	3 Cohort B members recruited, completed Module 1.1 pre-work, and attended the live workshop 3 attended 2 Faculty Workgroups 3 tried at least 1 activity 3 peer mentors from Cohort A including PI, co-PI 100% satisfied or highly satisfied with content and agreed that learning objectives were met.

Module 1.1: Shift your Mindset from Student Deficits to Cultural Assets included four activities for Cohort A faculty to try with their students. The cultural story collage activity was the primary activity where faculty were asked - prior to the workshop - to create a presentation slide with visuals that showed their cultural heritage, interests, their education and career journey, and other values. During the workshop they shared their collages and discussed using a similar activity with their students to create and share. Additional activities included a community of cultural wealth worksheet, with examples of cultural capital based on the work of Yosso [6], the bi-directional course pledge between the instructor and students [7], and mastery grading [8]. These activities carried over to Module 1.1 for Cohort B.

For Cohort A, Module 1.2 Teaching with Learning in Mind: Using Culturally Responsive Instruction to Align Course Activities with How the Brain Learns, included a reflective activity where faculty analyzed a personal learning experience from their own life for cultural engagement elements. Then after learning about concrete examples of how to put cultural engagement into their STEM teaching practice, faculty were asked to think of how they might make modifications to a learning experience in a course to create a more culturally engaging learning experience for their Latinx students. They were also asked to try something out and share it in a subsequent faculty workgroup.

Module 1.3, Enlisting Industry Role Models and Partners, involved three activities that the local industry offered Cohort A faculty to provide career development assistance and possibilities for their students. Activity 1 - Learn about STEM Career Opportunities at a Local Company - Bright Horizons; Activity 2 - Arrange a Site Visit to a Local Company - Learning Center Tour; and Activity 3 - Invite a local employee to your classroom or extracurricular to share their STEM Career Story and drive awareness of the Utility Industry. As discussed in last year's paper, Activity 3 was implemented with one faculty member [5].

Module 1.4, Capturing Student Feedback and Data, included four activities to collect qualitative and quantitative data from students to inform technician education practice:

1. Activity 1 - Fixed vs. Growth Mindset Student Survey [9] (beginning of Semester)
2. Activity 2 - Student Essay about prior learning experiences related to this course (beginning of Semester)

3. Activity 3- Fixed vs. Growth Mindset Student Survey [9] (end of Semester)
4. Activity 4 - Student Essay about learning experiences during this course (end of Semester)

The essay was assigned to students for extra credit points at the beginning and end of the semester. They were asked to write a 1-paragraph (or no more than 1-page) essay for the instructor's eyes only to describe why they are taking the course, what they think the course subject or skill is used for, a prior positive experience learning the course subject (include college experiences if possible), what made it a positive experience, and how they felt about the subject after the positive experience. Students were also asked to include a prior negative experience learning the subject (include college experiences if possible), what made it a negative experience, and how they felt about the subject after the negative experience. There was an option to also include anything else the student wanted the instructor to know about them.

The first module in Tier 2, Module 2.1, Work-based learning practices, case studies, and opportunities for students, introduced ways for Cohort A faculty to bring culturally responsive work-based learning into STEM courses at the introductory, intermediate and advanced levels. Activities were provided during the workshop for each of these three levels: Activity 1 - Introductory Course Example: Scientist Spotlight [10]; Activity 2 - Intermediate Course Example: Student Driven Learning and Resource Development [11]; and Activity 3 - Advanced Course Example: Simulated Workplace Assignment (Lab or IT) [12]. Resources for additional activities by course level were also provided.

#### **4. Faculty Workgroups**

Faculty Workgroups typically meet for one hour and are structured to discuss feedback about the most recent workshop, ongoing questions regarding guidelines, activities, and tools embedded in workshop modules, and report-outs from implementing workshop activities with their students. As faculty report challenges with particular activities, other faculty are quick to provide advice and examples of how they implemented the activity in ways that addressed the challenge. For example, instead of having all students share their culture collages in the same class, which takes time, do a few shares at the beginning of several classes to break the ice. Data in Table 2 about faculty workgroup attendees, and number of activities tried were compiled from faculty workgroup sessions. In the session after the delivery of Module 1.4, a faculty member shared the survey she had implemented in the learning management system (LMS) using the questions provided in the workshop. She offered to show other faculty how she set up the survey and helped with their survey setup. This was especially valuable as WCC had just rolled out a new LMS platform and faculty were learning how to use it while they were converting their courses to the new LMS. At the end of Tier 1, Cohort A dedicated a faculty workgroup session to provide feedback about Tier 1, which resulted in the changes described in Figure 1 and Table 1.

#### **5. Community Building**

Dissemination and community building with audiences external to the project took place at several different events in both virtual and in-person formats.



A two and a half minute video was prepared by WCC featuring lived experiences from the PI and co-PI about the challenges faced as first generation students in STEM, how they overcame those challenges, and are now helping the next generation of students as they navigate the STEM educational system and other barriers such as transportation needs. The video was featured on the May 2022 STEM-for-ALL video showcase, a national repository of 267 video “shorts” sponsored by the National Science Foundation. Thirty-four posts were made in the discussion area about the relevance and value of this video to broadening participation in STEM.

In Summer 2022, results from the grant were presented at two conferences: American Society of Engineering Education (ASEE) and the High Impact Technology Exchange (HI-TEC). The ASEE presentation shared results from Year 1 of the project, including three workshops and their delivery to Cohort A. The HI-TEC presentation included a subset of Culturally Responsive Instruction theory, practices and activities from the Year 1 workshops. A strong emphasis was placed on recognizing students’ assets and accommodating needs, while also maintaining high expectations. The HSI ATE Hub initiative, funded by two NSF ATE grants, was selected to receive the 2022 Innovative Program Award. The Innovative Program Award was presented to team representatives at HI-TEC during the conference Award Luncheon for all attendees.

Strong presence at the Fall 2022 ATE Principal Investigator’s (ATE PI) conference included a “Birds of a Feather” panel discussion, a workshop and a virtual synergy session. The panel featured two male computer science instructors of Puerto-Rican and Cuban heritage who led a lively discussion about how community colleges can help shorten the talent gap in the CyberSecurity field and equip students with the necessary skills to fit the demands of today's rapidly changing and demanding workforce; how underrepresented minorities can become part of the mix of the new talent; and, how Community Colleges can help create a more diverse workforce. By meeting the students where they are and developing an understanding of their background and communities, we can better assist them so they not only enroll in our programs but persist all the way to completion, internships, apprenticeship, and career. Over 30 attendees were present at the panel and raised excellent questions during the final Q&A period.

A high impact practices (HIP) workshop, “Using Qualitative Data to Grow Cultural Wealth and Sense of Belonging,” was also featured at the 2022 ATE PI Conference. Adapted from a project module about capturing student feedback and data, the workshop brought in two faculty members from other 2-year HSIs to share their culturally responsive practices. The purpose of the workshop was to develop awareness and capacity among educators at community colleges for culturally responsive practices to engage and retain underserved students in STEM in order to:

1. Gain students’ trust;
2. Focus on assets of students instead of deficits;
3. Create a sense of belonging for students in STEM; and,
4. Develop student agency and voice.

The presenters collaborated to convert four virtual activities to in-person activities. Groups of multiple attendees at five tables participated in the workshop, tried the four activities, and engaged in discussion with the presenters and each other throughout. The first activity, which is also an activity for students that had been previously tried early in the semester at WCC, involved writing a paragraph about a recent learning experience (related to the course topic if done with students) describing: 1. What you were trying to learn and why; 2. How you planned to use your learning; 3. A positive experience during your learning; and, 4. A negative experience during

your learning. After that, in a second activity, pairs of participants: 1. Reviewed each others' paragraphs; 2. Captured empathy and encouragement points; and, 3. Verbally summarized what they learned about each other. For students in their classroom, this activity would be replaced by the instructor performing items 1 and 2 where, instead of pair discussions, the instructor would provide to each student written empathy and encouragement points and a summary of what they learned about the student. The third activity involved a table discussion about how this activity might play out with students in their classes. In the fourth activity, the table shared highlights from their discussion. Some of the participants indicated plans to try the paragraph activity with their students and use what they learned to provide empathy and encouragement throughout the entire semester.

The synergy session, "Increasing Career and Technical Education (CTE) Student Retention by Implementing Inclusive STEM Practices" was featured during the virtual track of the 2022 ATE PI Conference. The session goal was to increase the retention and participation of people from historically marginalized groups in STEM. This commitment is part of increasing critical recognition that the systems that have sustained programs like CTE and STEM have also marginalized these groups. CTE and STEM communities are calling for an inclusive ecosystem to prepare today's learners for the STEM workforce. The synergy session contributed to the conversation, generation of new ideas, and understanding of how best to implement inclusive STEM practices for advanced technological education students. Five minutes of lively discussion at the end of the session resulted in shared guidance for frank and honest dialog with resistant faculty about the importance of an asset-based mindset and creating a welcoming learning environment for all students. An emerging research focus on culturally responsive transfer pathways was acknowledged based on a question using the online chat feature.

Additionally, in Spring 2023, internal dissemination took place at WCC to build community beyond Cohorts A and B. The PI and co-PI at WCC engaged in internal dissemination efforts by creating a one hour training session, "Culturally Responsive Education in the STEM Classroom" for the campus community via WCC's in-house center for professional development, the Center for Teaching and Learning. The training was advertised across campus and delivered on the second day of the spring 2023 semester. Topics included a basic introduction to Culturally Relevant Instruction, and two classroom activities from the PD workshops for faculty use in the new semester. There were 20-30 attendees from across campus.

A second annual webinar for the general ATE community, "Impacts of Culturally Responsive Practices in Technician Education: Student and Faculty Perspectives," was hosted for the HSI ATE Hub-2 project by Mentor-Connect on April 26, 2023. The webinar featured two WCC instructors who serve as PI and Co-PI on the HSI ATE Hub-2 project. These instructors described how they include culturally responsive activities in their classes, the resulting benefits, and some challenges they encountered. The webinar also included two short videos, each featuring a student commenting on their experiences in classes where the instructor introduced culturally responsive activities. Thirty-seven people attended the annual webinar and their responses to the survey were favorable overall in their understanding of the culturally responsive strategies shared, and their confidence in implementing the activities shared by the WCC instructors. Attendee comments included:

“The faculty clearly care about their students and helping students from diverse backgrounds feel at home in their classes and subject areas. Loved the student videos!”

“An outstanding way to really engage students on a personal level which most likely leads to persistence and retention.”

“I can’t wait to share these ideas with our Culture and Talent Team.”

“I think this would be beneficial for EVERYONE at our institution!”

## **6. Lessons Learned**

Cohort A is comprised primarily of faculty who teach general education STEM disciplines, e.g. mathematics, chemistry, and astronomy. These faculty consider transfer students as their primary student base. However, in Cohort A, there was one cybersecurity faculty, teaching courses for technicians pursuing 2-year degrees and/or professional certifications. Cohort B is made up entirely of faculty who teach technician education courses, e.g. cybersecurity, information technology, and digital graphics. Based on Cohort A feedback about modules 1.3 Enlisting Industry Role Models and Partners, and 2.1 Work-focused Experiential Learning Case Studies, Cohort A faculty from general education disciplines neither prioritize career or work-related topics and employer interactions during their courses, nor do they have connections with WCC Career Services and associated career development resources. The exception in Cohort A is the cybersecurity faculty, who found Module 1.3 and 2.1 useful and implemented the activity from Module 1.3, to bring in local employers to speak with their students about careers at their company. Looking forward to recruitment of Cohort C, the team believes that a more even mix of both types of faculty will be helpful in learning from each other, as faculty teaching general education STEM disciplines also have students pursuing technician careers in their classes, and faculty who teach advanced technological education courses could provide practical advice to contextualize general education topics in ways that resonate with future technicians to help them understand the ways that mathematics or physics, for example, will be critical to their future careers. In the meantime, Cohorts A and B will begin meeting together in at least two Faculty Workgroups this year to share experiences from implementing workshop activities and to learn from each other.

## **7. Conclusion**

The workshops provided practical value to faculty in the form of professional development to learn, discuss, reflect, and try out culturally responsive activities to use in their courses. Because the learning was grounded in theory and empirical research, it increased faculty confidence in the recommended activities - that they would lead to positive impacts with underserved students. Faculty mentors from their institution also contributed to relevance and contextualization of the guidance provided in the workshops. The examples showed faculty how to apply theory in their daily practice. This approach was more efficient than having faculty read several academic research papers, synthesize the findings, and decide what to do.

## 8. Implications for Future Research

The combined HSI ATE Hub-2 team, with WCC as lead, has proposed to expand current efforts and knowledge gained to create the New York HSI Hub, with a focus on impacting STEM workforce development and systemic improvements at fourteen diverse and highly enrolled 2-year HSIs and emerging HSIs in the New York City area. The proposed five-year Hub intervention will build on previously-funded NSF projects to provide: 1) mentored professional development; 2) grantsmanship mentoring; 3) participatory action research; 4) webinars featuring culturally relevant practices and grantsmanship topics of interest; 5) annual regional peer-sharing forums; and 6) proactive information sharing and communication among an engaged advisory council of participant college leaders.

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