Navigating Cultural Worlds: A Case Study of Teachers' Success, Challenges and Opportunities in Engaging Native American Students in Robotics Program at Tuba City High School

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Abstract: This study investigates the implementation of a robotics program at Tuba City High School, focusing on factors influencing its success, challenges encountered by teachers, and the role of culturally responsive teaching in student engagement. Using a qualitative case study design, data from self-rating checklist, questionnaire, and teacher interviews were analyzed across domains of instructional practice, cultural responsiveness, teacher confidence, and institutional support. Findings show that program success is driven by experiential, hands-on STEM learning, alignment with students' visual and kinesthetic learning preferences, and the development of confidence, resilience, and STEM identity. Cultural responsiveness significantly enhances engagement by integrating students' cultural identities and fostering inclusive learning environments. However, challenges such as limited awareness of robotics, logistical constraints, inconsistent implementation of culturally responsive practices, and resource limitations affect sustainability. Teachers addressed these challenges through inclusive strategies, scaffolded instruction, flexibility, and external partnerships. The study concludes that while the program is a high-impact, culturally responsive STEM initiative, its long-term effectiveness depends on strengthening instructional consistency and institutional support to ensure equitable and sustained student participation.

Keywords: *Culturally Responsive Teaching, Robotics Education, STEM Engagement, Indigenous Education, Experiential Learning.*

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I. INTRODUCTION

➢ *Background of the Study*

Robotics as an extracurricular activity was established in Tuba City High School by three visionary Filipino math and science teachers Fall of 2025 and with the goal to make Tuba City High School the nexus of robotics education and STEM-related activities in the Four Corners Region. Despite having neither formal training and experience in robotics, they made their vision a reality attending a robotics training offered and sponsored by a Navajo energy corporation. Their vision and goal is anchored on their strong belief in the abilities of their Native American students. They firmly believed that students in Tuba City High School hold so much talent and potential that need to be developed and tapped by providing them with the right training, materials, and motivation through an academic-based and STEM-related program that would showcase their talents. They hold the conviction in the potential of the students in Tuba City High School and that they deserve a STEM program that will develop and enhance their talent in the field of robotics.

The robotics club was officially recognized as a school club in October 2026. It started with ten members which are mostly senior students. The newly formed robotics club first competed last December 2025 and emerged champion in the regional tournament and brought home a special award. It again competed in the regional tournament in February 2026 and landed 10th place in a field of 16 and won a special award. On top of that, one of the team members was adjudged one of the two Dean's List awardee to represent the Four Corners Region in the national search to be held in Houston, Texas, in May 2026.

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Overall, the robotics club, despite being a neophyte regional team showed a great deal of potentials. And compared to other more established robotics team in the Four Corners who have the advantage in terms of training and experience, Tuba City High Schools Robotics Club emerged as one of the strongest teams today. The factors that contributed to the success of the robotics team deserves to be told, shared, and presented so that others will learn and draw insights that can be applied in their own unique context. It is also our expression of paying tribute to our students, the school, our school leaders, and community for their overwhelming support and guidance.

➢ *Problem Statement*

Despite the growing emphasis on STEM education, there remains limited understanding of the factors that contribute to the successful implementation of robotics programs in culturally diverse school settings such as Tuba City High School. In particular, little is known about how teachers, who may come from different cultural backgrounds than their Native American students, effectively support student engagement and achievement in such programs.

Teachers often face challenges related to cultural differences and varying levels of familiarity with students' cultural backgrounds, which may influence their coaching practices, communication styles, and relationships with students. However, there is insufficient research examining how these factors impact the success of robotics programs and how teachers navigate these challenges to create an inclusive and effective learning environments.

This gap in the literature highlights the need to investigate the role of teachers' cultural perspectives, experiences, and adaptive strategies in shaping the outcomes of robotics programs. Understanding these dynamics is essential for developing culturally responsive practices that can enhance student participation, learning, and success in STEM initiatives, particularly among Native American students.

➢ *Purpose of the Study*

This study examined and analyzed the key factors that contributed to the success of the robotics program at Tuba City High School. Specifically, it explored the role of teachers in fostering student success despite cultural differences between educators and their Native American students. The study investigated the challenges teachers encountered in implementing and sustaining the program, as well as the strategies they employed to effectively navigate these challenges.

Furthermore, this study examined how teachers' cultural perspectives and knowledge of their students' cultural backgrounds influence their coaching and training approaches. It also examined how these factors shape teacher-student relationships and contribute to student engagement and achievement within the robotics program. Ultimately, the findings of this study will provide insights into culturally responsive teaching practices that support the success of diverse learners in STEM education.

➢ *Research Questions*

Utilizing a case study design, this research study answers the following research questions:

- What are the factors that contributed to the success of the robotics program in Tuba City High School.
- What are the challenges did teachers encounter in establishing the robotics program and what strategies they effectively employed to navigate through these challenges?
- How do teachers' cultural perspectives and coaching practices influence student participation, engagement, and the overall success of the robotics program?

➢ *Theoretical Framework*

This study is grounded in multiple theoretical perspectives that explain how cultural awareness, social interaction, and teacher beliefs influence student engagement and success in STEM education, particularly in robotics programs within a culturally diverse setting.

First, this study is anchored in Culturally Responsive Teaching (CRT), which emphasizes the importance of integrating students' cultural backgrounds, experiences, and perspectives into instruction. According to Geneva Gay (2010), culturally responsive teaching enables educators to create more inclusive and effective learning environments by aligning teaching practices with students' cultural contexts. In this study, CRT provides a framework for understanding how teachers' familiarity with Native American culture and their ability to adapt their coaching strategies influence student participation and success in robotics programs.

Second, this study draws from Social Constructivism, particularly the work of Lev Vygotsky (1978), which posits that learning occurs through social interaction and collaboration. Robotics programs require teamwork, communication, and problem-solving, making this theory highly relevant. Through this lens, the study examines how teacher-student interactions, collaborative learning environments, and guided support contribute to students' engagement and skill development in robotics.

Third, the study is informed by the Funds of Knowledge Theory, introduced by Luis Moll *et al.* (1992). This theory suggests that students possess valuable cultural knowledge and lived experiences that can be utilized to enhance learning. In the context of this study, indigenous knowledge systems and cultural practices are viewed as essential assets that can enrich robotics education. Teachers who recognize and incorporate these funds of knowledge into their coaching practices are more likely to foster meaningful and relevant learning experiences.

➢ *Conceptual Framework*

Figure 1 below shows the relationship between independent, mediating and dependent variables. The theoretical framework posits that the success of the robotics program is shaped by the interaction of several key factors: teachers' cultural awareness, professional background, their ability to foster collaborative learning environments, and their

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use of students' cultural knowledge. These factors influence teachers' coaching styles, teacher-student relationships, and instructional practices, which ultimately affect student engagement, participation, and achievement in robotics.

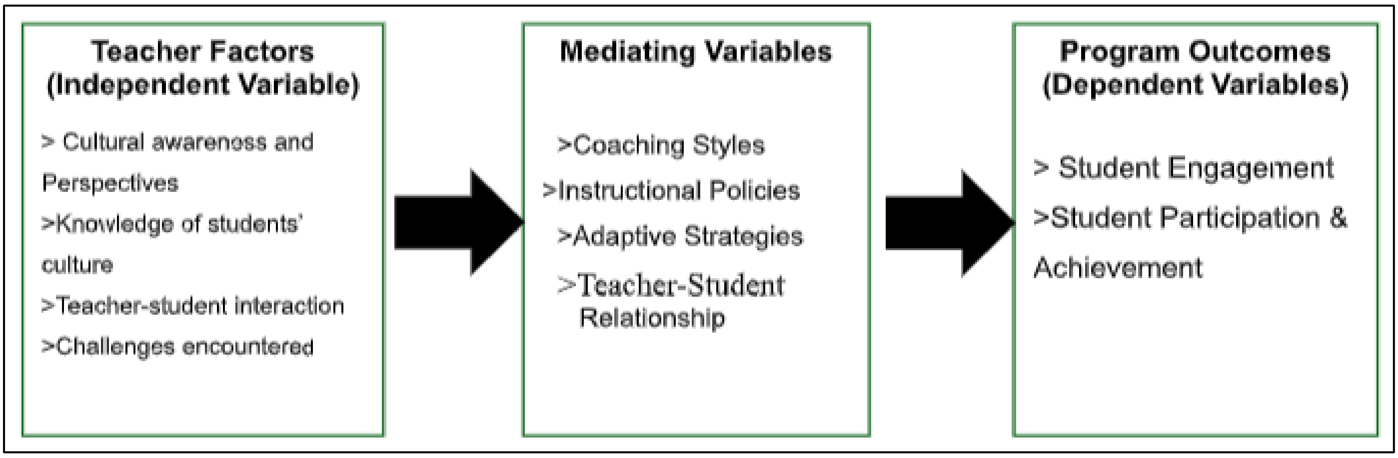

Fig 1 Conceptual Framework

➢ *Significance of the Study*

This study is significant as it contributes to the growing body of knowledge on STEM education by providing a deeper understanding of the factors that support the successful implementation of robotics programs in culturally diverse school settings. By focusing on Tuba City High School, a school serving predominantly Native American students, this research highlights the importance of culturally responsive practices in promoting student engagement and achievement in robotics and other STEM initiatives.

The findings of this study will benefit teachers and robotics coaches by offering insights into effective strategies for navigating cultural differences, addressing implicit biases, and building meaningful relationships with students. It will help educators better understand how their cultural awareness and adaptability can influence their coaching styles and ultimately improve student participation and success.

For school administrators and policymakers, this study provides valuable information that can inform the development of inclusive STEM programs and professional development initiatives. The results may guide the creation of support systems that equip teachers with the cultural competence necessary to work effectively in diverse educational environments.

This research is also significant for Native American students and communities, as it emphasizes the role of indigenous perspectives and cultural knowledge in shaping meaningful learning experiences. By identifying practices that enhance engagement, the study supports efforts to increase representation and success of Native American students in STEM fields.

Additionally, the study contributes to the academic community and future researchers by addressing a gap in the literature regarding the intersection of robotics education, teacher influence, and cultural responsiveness in Indigenous contexts. It may serve as a foundation for further studies exploring culturally sustaining pedagogies in STEM education.

Ultimately, this study aims to promote more equitable and culturally responsive robotics programs, ensuring that all students, regardless of cultural background, have the opportunity to succeed and thrive in STEM learning environment

➢ *Definition of Terms*

- Challenges - refer to the obstacles, difficulties, or barriers that teacher-coaches encounter while implementing, sustaining, and managing the robotics program in a culturally diverse environment. These may arise from cultural differences between teachers and Native American students, implicit biases, limited resources, school policies, or logistical constraints. Operationally, challenges will be identified through teachers' descriptions of difficulties in recruiting, engaging, or training students during interviews

- Opportunities - refer to the situations, resources, or strategies that teachers identify and utilize to enhance the success of the robotics program, transform challenges into learning experiences, and foster meaningful engagement with students. Operationally, opportunities will be examined through:

✓ Teachers' reflections on strategies that worked to overcome challenges
✓ Instances where Indigenous knowledge, cultural practices, or student perspectives were integrated to improve engagement
✓ Observed innovative teaching or coaching practices that promote participation, learning, or program sustainability

- Program Success -refers to the overall effectiveness and sustainability of the robotics program at Tuba City High School. Operationally, it includes:

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- ✓ Student achievement and performance in robotics competitions or projects
- ✓ Continuity and growth of student participation over time
- ✓ Implementation of effective teaching and coaching practices
- ✓ Positive teacher-student relationships and culturally responsive learning environments
- ✓ Recognition or support received from the school or broader community

- Student Engagement -refers to the level of students' active participation, motivation, interest, and commitment in the robotics program. Operationally, it will be measured through:
- Frequency and quality of students' involvement in robotics activities, participation in problem-solving, teamwork, and competition, overall enthusiasm and persistence during training sessions.
- Teacher's Cultural Views- refers to beliefs, perceptions, attitudes, and understanding that teacher-coaches hold regarding the cultural backgrounds, values, traditions, and ways of knowing of their Native American students. Measured through teacher interviews, observations, and reflections on coaching practices and culturally responsive strategies.

II. REVIEW OF LITERATURE AND RELATED STUDIES

Native Americans are underrepresented in the field of STEM (DeDios, 2023**)**. The most often cited reasons for this under representation are poverty, lack of access to quality STEM education, lack of resources in school such as curricular offerings, and other systemic barriers including lack of qualified STEM teachers with sufficient experience and training (National Science Foundation, 2024). The role of having qualified STEM teachers is important not only to deliver the curriculum but more importantly to provide guidance, motivation and encouragement to Native American students with potentials in the field of STEM. The proponents of this study believed that their talents remain untapped because there are no teachers who will help them nurture their interest by providing them with the appropriate learning experience related to STEM.

➢ *Overview of STEM Education Disparities Among Native American High School Students*

Clark and Todd (2024) reported that very few Native Americans are taking STEM courses in college and or in the STEM-related professions because of systemic factors. However, from their own experiences, the researchers believed that it is the absence of qualified STEM teachers and absence of a STEM-oriented and STEM-driven curriculum are the most significant factors. Although all other factors are important, the main thesis of this study is that if there are STEM advocate-teachers in the school who will motivate and engage the students, students will be drawn to it. Also, it is their argument in this paper that a STEM-oriented and driven curriculum is likewise important for it will legitimize all STEM activities in the school and provide a roadmap to what activities and experiences that will be provided to the students.

The role of qualified STEM teacher and STEM-advocates are important to discover and nurture talents, provide guidance, motivation and encouragement to Native American students who have tremendous potentials in the field of STEM. Their role is not only to impart knowledge and skills and connect the curriculum and the students. More importantly, they plan and design activities and develop materials that aligned with the cultural backgrounds of their students.

Among Native Americans, teacher's knowledge of students' cultural background is important in the success of any STEM program such as robotics as experienced by teachers because students brought with them to school traditional values and ideas they grew up with at home or in their community and use them to construct knowledge and develop understanding of the scientific facts and concepts being taught in school. Students capitalized use their cultural values and traditions as filters and lens to understand, process, and evaluate scientific ideas and concepts mandated in curriculum to be learned and mastered that are mostly rooted from Western philosophy (Porterfield, 2023; Mazzocchi, 2006). Hence, it is important that instruction must be rooted on student's cultural background which often referred to as students "cultural fund" (Porterfield, 2023; National Academic, 2012).

The interaction of teachers' culture, implicit biases, and students cultural background played a pivotal role in learning and much more in robotics. Teachers and students bring with them set of cultural expectations during the training sessions and each party has to navigate and negotiate to achieve the goals. Teachers view the whole program and run the program and all related activities such as the training through the lens of an educator with their own unique culture similarly, students see things through their own cultural lens what they are doing and make sense of everything through a different cultural perspective.

➢ *Importance of Culturally Responsive STEM Programs*

Although culturally responsive pedagogy has gained traction in educational discourse, empirical studies focusing specifically on culturally responsive STEM programs remain limited, highlighting a critical gap in the literature, particularly in Indigenous and underrepresented contexts (Gay, 2018; Villegas & Lucas, 2002; Bang & Medin, 2010).

What is currently available are studies that are more related to culturally-responsive science education. According to the National Academies (2012), a culturally-responsive science education integrates the local culture of the learners in all aspects from the design and planning of the curriculum to its implementation including development of instructional materials (Activate Learning, n.d). A culturally-responsive science education is centered on the cultural background and upbringing of the learners from content to assessment and evaluation. It is based on active engagement between the school and the community, considers the learning styles of

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the in instruction, and the content incorporates indigenous knowledge (Porterfiedl, 2023). For instance, Native Americans learn best through nonverbal communication and are mostly visual learners (Pewardy, 2002). Oral discourse or student-led classroom discussion is not effective teaching strategies to teach science. When presenting a lesson, it is best to have plenty of visual materials because Native American learners are generally visual learners and they thrive through visualization.

Robotics program is one academic program that fits well with the cultural orientation and learning styles on Native Americans.

Research on robotics education shows that well-designed robotics programs can strengthen students' interest, confidence, collaboration, and problem-solving skills in STEM. Robotics provides students with hands-on opportunities to apply science, technology, engineering, and mathematics concepts in meaningful and practical ways. Through building, programming, testing, and redesigning robots, students engage in experiential learning that supports deeper understanding and persistence in STEM fields (Benitti, 2012; Eguchi, 2014). This aligns with constructivist learning theory, which emphasizes that students learn best when they actively construct knowledge through experience, reflection, and problem-solving (Piaget, 1970; Vygotsky, 1978).

In relation to the first research question, several factors contribute to the success of school-based robotics programs. One major factor is the use of hands-on, inquiry-based learning. Robotics activities encourage students to investigate problems, design solutions, test ideas, and revise their work, which promotes critical thinking and creativity (Barker & Ansorge, 2007; Sullivan, 2008). Robotics also supports collaboration because students often work in teams, share responsibilities, and solve engineering challenges together. These social learning experiences help students develop communication, leadership, and teamwork skills that are essential in STEM learning (Eguchi, 2014; Nugent et al., 2010).

Another factor that contributes to success is student motivation. Robotics competitions and project-based activities often create excitement, purpose, and a sense of achievement among students. Research suggests that robotics can increase students' engagement and interest in STEM careers, especially when students see the relevance of robotics to real-world problems and future opportunities (Nugent et al., 2010; Witherspoon et al., 2016). For Indigenous and underrepresented students, robotics programs may also become powerful spaces for developing STEM identity when students feel that their abilities, culture, and experiences are valued (Carlone & Johnson, 2007; McKinley & Stewart, 2012).

The literature also emphasizes the importance of teacher support in sustaining robotics programs. Teachers and coaches serve not only as technical instructors but also as mentors who guide students through problem-solving, competition preparation, and personal growth. Teacher confidence, or self-efficacy, plays a significant role in how effectively teachers implement STEM instruction. Teachers with higher self-efficacy are more likely to use innovative strategies, persist through challenges, and support student learning in complex tasks (Bandura, 1997; Tschannen-Moran & Hoy, 2001). Therefore, the success of a robotics program depends not only on student interest but also on teacher capacity, training, and commitment.

In relation to the second research question, studies show that teachers often encounter challenges when establishing robotics and STEM programs. Common barriers include limited funding, lack of materials, insufficient technical training, time constraints, and limited institutional support (Benitti, 2012; Kopcha et al., 2017). Robotics programs require equipment, tools, software, travel funds, and competition fees, which can place a heavy burden on schools, especially those serving rural or under-resourced communities. Teachers may also feel unprepared to teach robotics if they lack formal training in engineering, programming, or robotics design (Kopcha et al., 2017).

Despite these challenges, research highlights several strategies that help teachers sustain robotics programs. Professional development, collaboration among teachers, community partnerships, and mentorship from experienced coaches can improve teacher confidence and program quality (Bers, 2018; Yadav et al., 2016). Teachers also adapt by using scaffolded instruction, peer mentoring, trial-and-error learning, and student leadership structures. These strategies allow students to take ownership of learning while reducing the pressure on teachers to be the only source of technical knowledge (Eguchi, 2014; Sullivan, 2008). In this way, successful robotics programs often grow through shared responsibility among teachers, students, families, and community partners.

For schools serving Native American students, culturally responsive teaching is an especially important dimension of STEM success. Culturally responsive pedagogy emphasizes the use of students' cultural knowledge, lived experiences, values, and community contexts as meaningful foundations for learning (Gay, 2018; Ladson-Billings, 1995). In STEM education, this means connecting scientific and technological concepts to students' identities, local environments, traditional knowledge, and community needs. Research suggests that Indigenous students are more likely to engage in STEM when instruction respects their cultural backgrounds and when learning is connected to place, family, community, and responsibility (Aikenhead & Michell, 2011; Bang & Medin, 2010; McKinley & Stewart, 2012).

This literature directly supports the third research question, which examines how teachers' cultural perspectives and coaching practices influence student participation, engagement, and program success. Teachers' cultural perspectives shape how they build relationships with students, communicate expectations, interpret student behavior, and create inclusive learning environments. When teachers recognize and respect students' cultural identities,

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they are more likely to develop trust and belonging, both of which are essential for student engagement (Gay, 2018; Villegas & Lucas, 2002). In Indigenous educational contexts, relationality is especially important because learning is often connected to relationships, community responsibility, respect, and shared knowledge (Brayboy & Castagno, 2009; McCarty & Lee, 2014).

Coaching practices also influence student participation in robotics. A culturally responsive coach does more than teach technical skills; the coach creates a learning environment where students feel seen, respected, and capable. This includes encouraging students to take leadership roles, validating their cultural identity, and helping them see themselves as future engineers, scientists, programmers, and innovators. Research on STEM identity shows that students are more likely to persist in STEM when they are recognized by others as competent and when they begin to see STEM as part of who they are (Carlone & Johnson, 2007). For Native American students, this recognition can be especially powerful because it challenges deficit narratives and affirms that Indigenous communities have long traditions of engineering, problem-solving, environmental knowledge, and innovation (Bang & Medin, 2010; McKinley & Stewart, 2012).

Overall, the literature suggests that the success of the robotics program at Tuba City High School may be understood through three interconnected dimensions: strong experiential STEM learning, teacher persistence in overcoming structural and instructional challenges, and culturally responsive coaching that supports student identity and engagement. Robotics programs are most effective when they combine technical learning with meaningful relationships, cultural respect, student leadership, and community relevance. These ideas provide a strong foundation for examining how teachers' roles, challenges, strategies, and cultural perspectives contribute to the success of the robotics program.

III. RESEARCH METHODOLOGY

➢ *Research Design*

This study will employ a case study research design to examine and explore the success, challenges and opportunities teachers experience when engaging Native American students in a robotics program at Tuba City High School. Qualitative research is appropriate when the objective is to understand participants' perspectives, experiences, and meanings within a specific context (Creswell & Poth, 2018).

Case study research is particularly useful when a researcher seeks to investigate a contemporary phenomenon within its real-life setting (Yin, 2018). In educational research, case studies allow the researcher to examine complex interactions among teachers, students, institutional structures, and cultural influences (Merriam & Tisdell, 2016). According to Yin (2018), a case study approach is appropriate when the research focuses on how and why questions, the researcher has little control over events, and the study examines a phenomenon within its real-world context. The proposed study met all the criteria required by a case study design.

The bounded cases in this study include the robotics program at Tuba City High School and the lived experiences of three foreign teachers serving as coaches in a predominantly Navajo student population. By focusing on this specific program, the study provides an in-depth understanding of how robotics education operates within a culturally unique educational setting.

➢ *Research Setting*

The proposed study will be conducted at Tuba City High School, located in Tuba City within the region of the Navajo Nation, during the 2025–2026 school year.

The school serves a predominantly Native American population, primarily from the Navajo (Diné), Hopi, and Southern Paiute community. According to McCarty (2009), schools within indigenous communities often play a critical role in bridging traditional knowledge systems with modern educational opportunities. For instance, the robotics program provides students with opportunities to develop skills in robotics design, computer programming, engineering problem-solving, and collaborative teamwork. Programs such as robotics clubs have been shown to increase STEM participation among underrepresented groups (Honey, *et al*., 2014).

➢ *Participants*

The study participants will be the three teacher-sponsors responsible for the robotics program at Tuba City High School.

Participants will be selected through purposive sampling; a technique commonly used in qualitative research to identify individuals who possess relevant knowledge or experience regarding the phenomenon under investigation (Patton, 2015). They were selected because of their direct and active involvement in the robotics program. They have the experience in mentoring Native American students in robotics activities, and are willing to participate voluntarily. Since the study focuses on teacher perspectives, the unit of analysis is the robotics teacher-sponsor acting as coaches.

➢ *Data Collection Methods*

Multiple qualitative data collection methods were used to enhance the depth and credibility of the findings (Denzin & Lincoln, 2018). Data collection methods would include semi-structure interview, focus group discussion, and document analysis. Moreover, a self-rating checklist will be used as a data collection instrument to gather quantitative data on teacher-coaches' confidence, cultural knowledge, and awareness of implicit biases.

➢ *Semi-Structured Interviews*

Semi-structured interviews were conducted with the three teacher-sponsors. Semi-structured interviews allow researchers to explore participants' experiences while maintaining flexibility in probing deeper into relevant issues (Seidman, 2019). Each interview will last approximately 30–

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60 minutes and will be audio-recorded with participant consent.

➢ *Focus Group Discussion (FGD)*

FGD enables participants to discuss how they contributed to student success despite cultural differences. Through interaction, teachers can share effective coaching practices, compare strategies, and identify common factors that led to the success of the program.

It also encouraged participants to openly discuss challenges such as cultural barriers, communication issues, and resource constraints. It will allow participants to recall additional experiences that will lead to richer and more comprehensive data.

Moreover, FGDs aided the researchers in explore complex and sensitive topics such as cultural differences, beliefs and assumptions, and implicit biases. Through guided discussion, the participants can reflect on how their cultural perspectives and biases influenced their coaching strategies. The FGD will allows teachers to collectively examine how their approaches shaped relationship with their Native American students and how it influenced student engagement and participation in the training.

Since the study is grounded in culturally responsive teaching, the FGD provided insight into how teachers adapt instruction and coaching to students cultural contexts, how they build meaningful connection with their learners, and able to foster an inclusive and engaging STEM environments.

➢ *Self-Rating Checklist*

The self-rating checklist is a central instrument in this study because it provides a structured, quantifiable way to capture teachers' internal perspectives—specifically their confidence, cultural understanding, and awareness of bias—factors that are critical but not always directly observable. It functions as a primary quantitative tool that complements qualitative methods (e.g., focus group discussion). It allowed the teacher-coaches to systematically assess their own practices and perceptions while working with Native American students in the robotics program at Tuba City High School.

In conclusion, the self-rating checklist fits the study by offering a systematic and reflective measure of key teacher-related factors that influence student engagement and program success. By assessing teacher-coaches' confidence, cultural knowledge, and implicit biases, the instrument provides critical insights into how educators navigate cultural differences and create meaningful learning experiences in a robotics program serving Native American students.

➢ *Data Analysis*

Data were analyzed using thematic analysis, a widely used qualitative method for identifying patterns and themes within textual data (Braun & Clarke, 2006). Thematic analysis includes transcription of interviews, familiarization with data, coding, category development, theme generation, and finally interpretation of themes. Employing thematic analysis enabled the researchers to identify recurring patterns related to coaching strategies, cultural considerations, student engagement, program challenges, and program opportunities. According to Lincoln and Guba (1985) qualitative research requires strategies to ensure credibility and rigor such as triangulation of interviews and other data sources.

The data collected from the self-reporting rating scale were analyzed using descriptive and inferential statistical methods to examine teachers' perceptions of their experiences in engaging Native American students in the robotics program.

All responses were encoded numerically using the assigned Likert scale values:

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

Negatively worded (reverse-coded) items were recoded prior to analysis to ensure consistency in interpretation, where higher scores indicate more positive outcomes. Descriptive statistics was used to summarize the data, including mean and frequency. Composite (average) scores were calculated for each construct by aggregating the responses of the items under each category. This allows for comparison across different dimensions and identification of strengths and areas for improvement.

The mean scores were interpreted using the following scale:

Table 1 Table of Interpretation for Questionnaires

Mean Range	Interpretation
4.21 – 5.00	Very High
3.41 – 4.20	High
2.61 – 3.40	Moderate
1.81 – 2.60	Low
1.00 – 1.80	Very Low

Higher scores indicate greeted confidence in teaching robotics, stringer cultural competence, higher awareness of implicit bias, fewer perceived challenges, and greater perceived opportunities and success. The quantitative results from the rating scale were triangulated with data from the focus group discussion to validate findings, provide deeper explanation of patterns observed in the numerical data, and strengthen the overall interpretation of teacher's experiences.

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IV. RESULTS AND DISCUSSION

This chapter presents the findings and the corresponding analysis. The findings section is divided into three parts. Part 1 presents the data collected using a self-rating questionnaire on teacher's self-efficacy and Part 2 discussed the findings on teachers' knowledge of students' culture while Part 3 presents the findings of the semi-structured interview.

A. Part 1: Self-Rating on Self-Efficacy

➢ *Domain 1-Teacher-Coach Confidence in Training Students*

On a 5-point Likert scale, Teacher 1 demonstrates a high level of confidence across the measured domains, while Teacher 2 reflects a solid but slightly lower level, and Teacher 3 falls closer to the midpoint, indicating more tentative confidence. These differences are meaningful because teacher confidence, often conceptualized as self-efficacy, has been strongly linked to instructional effectiveness and student outcomes (Bandura, 1997).

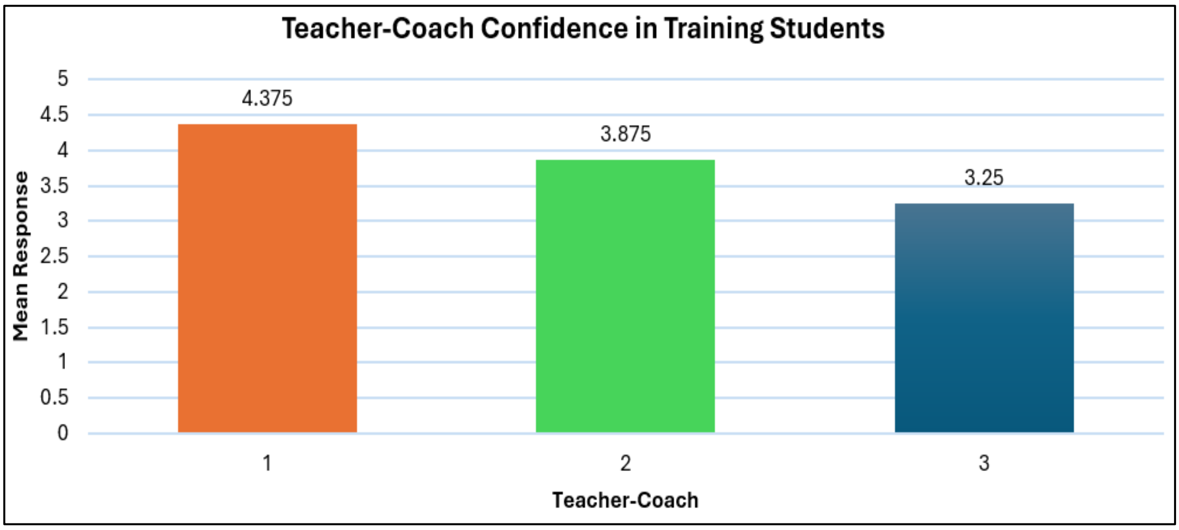

Fig 2 Mean Response on Teachers' Confidence

Teacher 1's high mean score (4.375) indicates strong confidence in both pedagogical and technical aspects of robotics instruction. This likely reflects a well-developed ability to teach core concepts, guide students through complex problem-solving, and adapt instruction to diverse learners. High confidence in mentoring during competitions and integrating new technologies suggests that Teacher 1 is not only comfortable with foundational teaching practices but also with dynamic, real-world applications of robotics. Research shows that teachers with high self-efficacy are more likely to implement innovative practices and persist through instructional challenges (Tschannen-Moran & Hoy, 2001), which aligns with this teacher's profile.

Teacher 2's mean (3.875) reflects a generally positive sense of confidence but with some areas that may require further development. This score suggests competence in guiding students and adapting instruction, but possibly less consistency in areas such as mentoring during competitions or integrating emerging technologies. The inclusion of statements such as providing effective feedback and managing diverse learners highlights important instructional dimensions where confidence may fluctuate. Teachers at this level often benefit from targeted professional development, particularly in hands-on and collaborative robotics environments, to strengthen both technical fluency and instructional adaptability (Darling-Hammond et al., 2017).

Teacher 3's mean score (3.375) indicates a more moderate level of confidence, suggesting uncertainty in several key areas of robotics instruction. This may include difficulty in troubleshooting technical problems, motivating students through challenges, or confidently integrating new tools and technologies. Lower confidence in managing diverse learners and providing effective feedback can also impact student engagement and learning outcomes. According to Bandura (1997), lower self-efficacy can lead to avoidance of challenging tasks and reduced persistence, which may limit opportunities for both teacher growth and student success in complex fields like robotics.

Overall, the results highlight a clear gradient of teacher confidence that has direct implications for instructional quality and student learning experiences. While all three teachers demonstrate at least moderate confidence, the variation suggests a need for differentiated support. Professional development programs focused on hands-on robotics training, collaborative coaching, and strategies for inclusive instruction could help elevate confidence levels, particularly for Teachers 2 and 3. Strengthening teacher confidence in providing feedback and managing diverse learners is especially critical, as these skills directly influence student persistence and achievement in STEM fields (Hattie, 2009).

➢ *Domain 2-Knowledge of Students' Cultural Background*

Figure 1 shows the mean response of the teachers for domain 2. The mean responses of the three robotics coaches—4.571 (Coach 1), 3.142 (Coach 2), and 4.571 (Coach 3)—reveal a notable contrast in their perceived knowledge of students' cultural backgrounds and their ability to integrate this understanding into robotics instruction. Coaches 1 and 3 demonstrate very high levels of cultural awareness and responsiveness, while Coach 2 reflects a moderate level of confidence that suggests gaps in culturally responsive teaching practices. These differences are important, as culturally grounded instruction has been shown to significantly enhance student engagement and learning, particularly in STEM contexts (Gay, 2018).

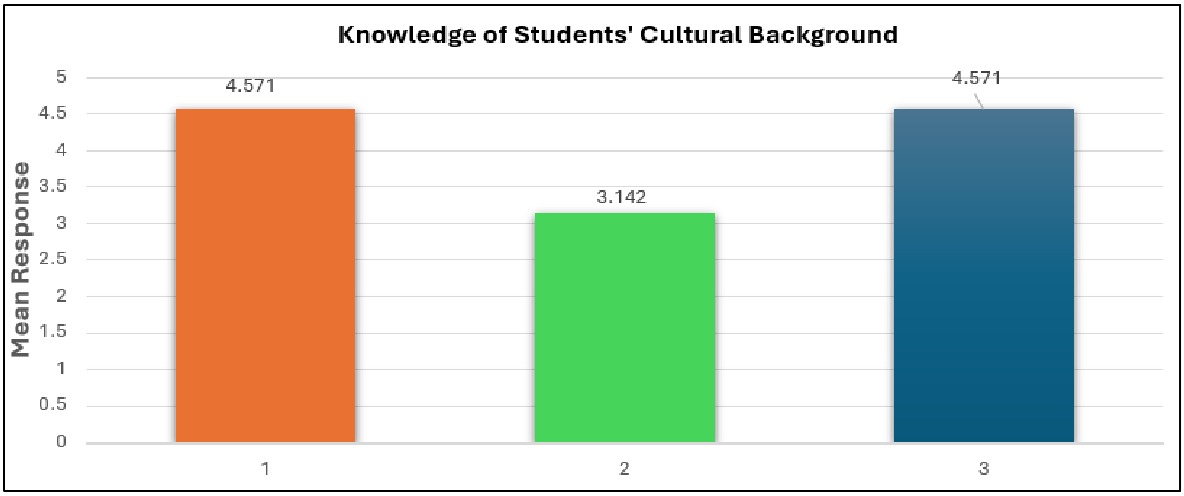

Fig 3 Mean Response on Knowledge of Students' Cultural Background

Coaches 1 and 3, with identical high mean scores of 4.571, indicate strong agreement across all statements, suggesting that they possess a deep understanding of their students' cultural backgrounds and actively incorporate this knowledge into their teaching. Their responses imply consistent efforts to align robotics activities with students' cultural values, traditions, and community influences. This includes adapting instruction to reflect students' lived experiences and designing learning environments that are culturally sensitive. Such practices align with the principles of culturally responsive teaching, which emphasize the importance of connecting academic content to students' cultural contexts to improve comprehension and motivation (Ladson-Billings, 1995).

In contrast, Coach 2's mean score of 3.142 suggests a more neutral to moderately positive stance, indicating inconsistency or uncertainty in applying culturally responsive practices. This coach may have some awareness of students' cultural backgrounds but may not consistently integrate this knowledge into instructional decisions or robotics activities. For example, while there may be some recognition of cultural traditions or family influences, the ability to actively seek cultural knowledge or adjust teaching strategies accordingly may be less developed. Research indicates that without intentional efforts to understand and incorporate students' cultural identities, instruction may fail to fully engage diverse learners (Villegas & Lucas, 2002).

The disparity between Coach 2 and the other two coaches highlights a potential need for targeted professional development in culturally responsive pedagogy. Building competence in this area involves not only awareness but also the ability to translate cultural knowledge into meaningful instructional practices, such as designing inclusive robotics challenges and fostering culturally affirming learning environments. Professional learning opportunities that emphasize community engagement, reflective practice, and culturally relevant curriculum design can help bridge this gap (Hammond, 2015).

Overall, the data suggest that while two of the three coaches are highly proficient in understanding and integrating students' cultural backgrounds, one coach would benefit from further support in this domain. Strengthening cultural competence across all coaches is essential, particularly in robotics education, where relevance and inclusivity can influence students' sense of belonging and persistence in STEM fields. Ensuring that all coaches actively consider cultural sensitivity, family influences, and community contexts can lead to more equitable and effective learning experiences for students (Gay, 2018).

➢ *Domain 3-Challenges in Engaging Students*

Figure 3 presents the result for domain 3. The mean responses of the three robotics coaches—4.50 (Coach 1), 4.75 (Coach 2), and 3.25 (Coach 3)—indicate generally high agreement with statements describing challenges in engaging Native American students in robotics, although the scale appears to contain a labeling inconsistency (both anchors listed as "strongly agree"). Interpreting the data as a typical 1–5 agreement scale, higher scores suggest stronger perceived challenges. Under this assumption, Coaches 1 and 2 report substantial difficulties, while Coach 3 indicates more moderate concerns. These perceptions are significant, as barriers related to engagement, communication, and resources can directly affect student participation and persistence in STEM fields (National Academies of Sciences, Engineering, and Medicine, 2016).

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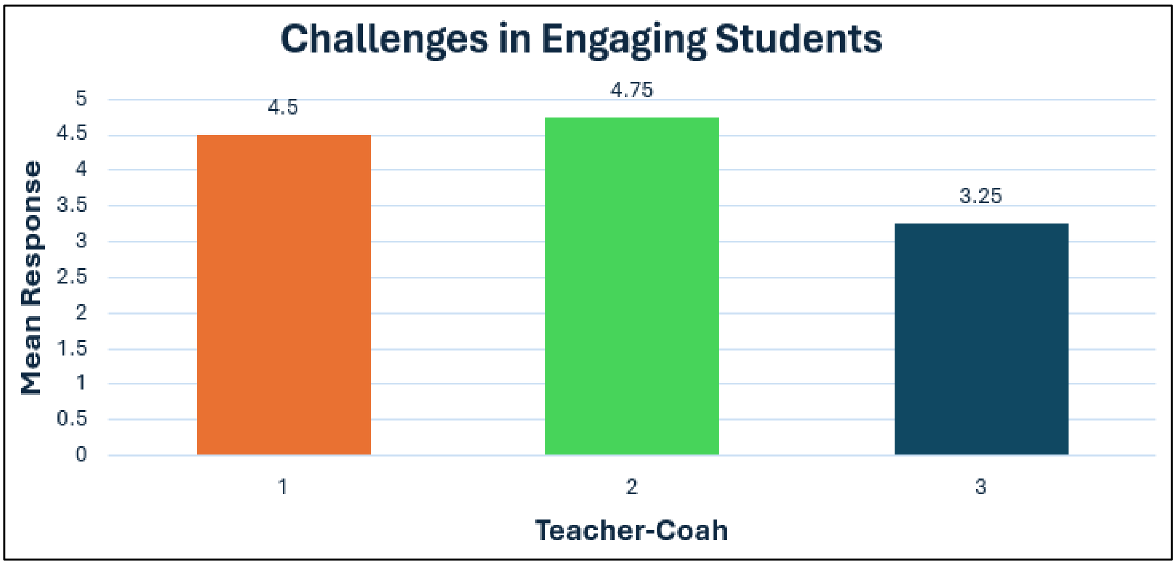

Fig 4 Results for Domain 3

Coach 2's mean score of 4.75 reflects the highest level of perceived challenges among the three. This suggests strong agreement that factors such as inconsistent student engagement, communication differences, limited resources, and cultural barriers significantly impact their robotics instruction. Such a high score may indicate structural and contextual constraints, including lack of access to materials or insufficient culturally aligned curriculum. Research highlights that under-resourced learning environments and cultural disconnects between instruction and students' lived experiences can reduce engagement and limit learning opportunities for Indigenous students (Brayboy et al., 2012).

Coach 1, with a mean score of 4.50, similarly reports high levels of challenge, though slightly less pronounced than Coach 2. This coach likely encounters consistent difficulties in maintaining student engagement and navigating cultural and communication differences. The inclusion of statements related to cultural barriers and language differences suggests that even experienced educators may struggle to fully align robotics instruction with students' cultural contexts. Studies in culturally responsive STEM education emphasize that when instruction does not reflect students' identities and community values, engagement can decline despite teacher effort (Castagno & Brayboy, 2008).

In contrast, Coach 3's mean score of 3.25 indicates a more moderate perception of these challenges. While this coach still acknowledges the presence of barriers, the lower score suggests either fewer experienced obstacles or more effective strategies for addressing them. This may reflect stronger cultural competence, better access to resources, or more successful adaptation of teaching practices to align with students' backgrounds. Educators who integrate culturally relevant pedagogy and community knowledge into STEM instruction often report improved student engagement and reduced perceived barriers (Bang & Medin, 2010).

Overall, the data reveal that challenges in engaging Native American students in robotics are prevalent but not uniformly experienced. The high scores from Coaches 1 and 2 point to systemic issues such as resource limitations and cultural misalignment, while Coach 3's lower score suggests that these challenges can be mitigated through effective practices. Addressing these concerns will likely require a combination of increased resource allocation, culturally responsive teaching strategies, and professional development focused on Indigenous education. Strengthening these areas can help create more inclusive robotics programs that better support the engagement and success of Native American students in STEM (National Academies of Sciences, Engineering, and Medicine, 2016).

➢ *Domain 4-Opportunities and Success in Engagement*

The mean responses of the three robotics coaches at Tuba City High School—4.25 (Coach 1), 4.78 (Coach 2), and 4.50 (Coach 3)—indicate a consistently high perception of opportunities and success in engaging students through robotics. All scores fall within the upper range of the scale, suggesting strong agreement that robotics serves as a meaningful and effective platform for student engagement, increased STEM interest, relationship-building, and culturally responsive teaching. This overall trend reflects a robust and positive program impact.

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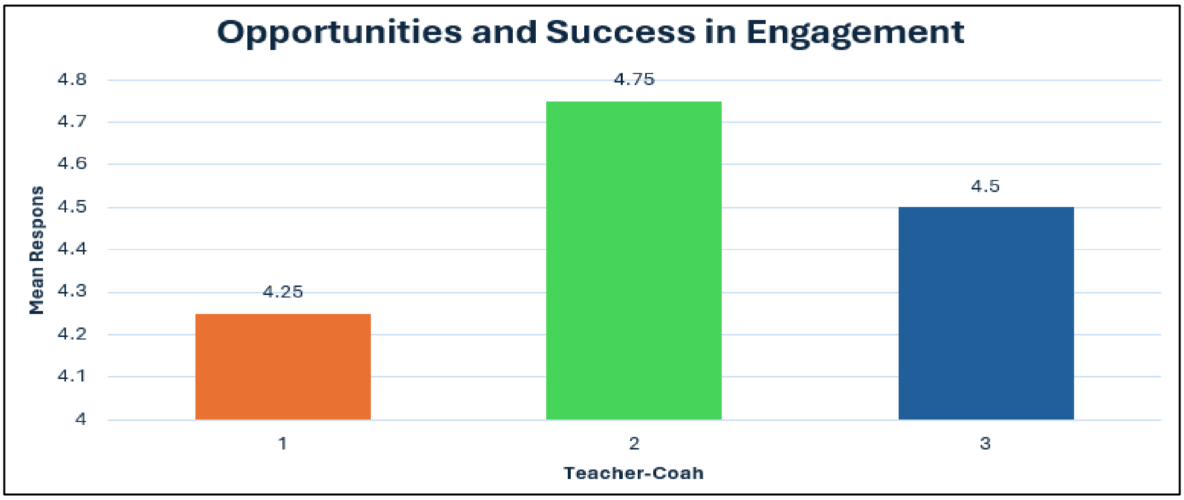

Fig 5 Mean Response for Domain 4

Coach 2's mean of 4.78 stands out as particularly high, indicating near-unanimous agreement across all statements. This suggests that the coach perceives robotics not only as highly engaging but also as transformative in fostering student interest in STEM and strengthening teacher-student relationships. Such outcomes align with research showing that hands-on, project-based STEM programs significantly enhance student motivation and identity in STEM fields (National Academies of Sciences, Engineering, and Medicine, 2016). Coach 3 (4.50) and Coach 1 (4.25) similarly reflect strong endorsement, though with slightly more variation, possibly indicating minor differences in implementation or student response.

Across all three coaches, the consistently high scores on statements related to culturally responsive teaching are particularly notable. This suggests that the robotics program is not only technically engaging but also culturally meaningful for students, allowing educators to connect learning with students' backgrounds and experiences. Culturally relevant pedagogy has been shown to improve both engagement and academic outcomes by making learning more authentic and inclusive (Ladson-Billings, 1995). The ability to build strong relationships through robotics further reinforces its role as a relational and community-centered learning space.

In sum, the data point to a highly successful robotics program at Tuba City High School, characterized by strong student engagement, growing interest in STEM, and meaningful cultural connections. While all coaches report positive outcomes, the slight differences in mean scores suggest opportunities for sharing best practices among coaches to further strengthen program consistency. Sustaining and expanding these strengths can help ensure continued student success and deeper participation in STEM pathways (Gay, 2018

➢ *Synthesis*

The synthesis of findings across the four domains reveals a nuanced but overall positive picture of the robotics program at Tuba City High School, characterized by strong opportunities for student engagement alongside identifiable areas for growth in instructional confidence and cultural responsiveness. Across domains, a consistent pattern emerges: while the program is highly effective in engaging students and fostering interest in STEM, variations in teacher-coach confidence, cultural knowledge, and perceived challenges influence the consistency and depth of implementation. These findings highlight the interconnected nature of teacher capacity, cultural competence, and student engagement in STEM education.

In Domain 1, teacher-coach confidence shows a clear gradient, with one teacher demonstrating high self-efficacy and the others reflecting moderate to developing confidence. This variation is significant because teacher self-efficacy directly impacts instructional quality, persistence, and the ability to implement innovative practices (Bandura, 1997; Tschannen-Moran & Hoy, 2001). Domains 2 and 3 further reinforce this pattern: coaches with stronger cultural knowledge (Domain 2) and lower perceived challenges (Domain 3) appear better positioned to create effective and engaging learning environments. Conversely, lower confidence and limited cultural integration correspond with higher perceived barriers, such as communication difficulties, inconsistent engagement, and resource constraints. This alignment supports research emphasizing that culturally responsive teaching and teacher preparedness are critical to reducing barriers and improving outcomes for diverse learners (Gay, 2018; Brayboy et al., 2012).

At the same time, Domain 4 highlights a major strength of the program—consistently high perceptions of opportunities and success in student engagement. All coaches strongly agree that robotics provides meaningful, culturally relevant, and relationship-centered learning experiences that increase student interest in STEM. This suggests that despite the challenges identified in Domain 3, the program is effective in creating impactful learning experiences. The strong ratings in this domain align with research findings that hands-on, project-based STEM programs can significantly enhance motivation, identity, and participation among underrepresented students (National Academies of Sciences, Engineering, and Medicine, 2016; Ladson-Billings, 1995).

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Taken together, the findings suggest that the robotics program at Tuba City High School is both promising and evolving. Its strengths lie in its ability to engage students meaningfully and connect learning to cultural contexts, while its challenges center on variability in teacher confidence and the consistent application of culturally responsive practices. Addressing these gaps through targeted professional development, collaborative coaching, and resource support could enhance program coherence and effectiveness. Strengthening teacher capacity in both technical instruction and cultural responsiveness will be key to sustaining and expanding the program's impact, ultimately supporting greater equity and success for students in STEM pathways (Hammond, 2015; Gay, 2018).

B. Part 2: Teachers' Knowledge of Students' Culture

➢ *Domain 1- Cultural Knowledge*

Figure 6 shows the mean responses of the three robotics coaches—4.2 (Coach 3), 4.0 (Coach 1), and 3.6 (Coach 2)—indicate generally positive levels of cultural awareness and understanding of Native American students, with variation that appears closely tied to years of experience. Using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree), all three coaches fall above the midpoint, suggesting that they perceive themselves as culturally aware; however, the differences in scores point to varying depth and consistency in that awareness. This pattern is consistent with research showing that cultural competence develops over time through sustained interaction and reflective practice in diverse settings (Gay, 2018).

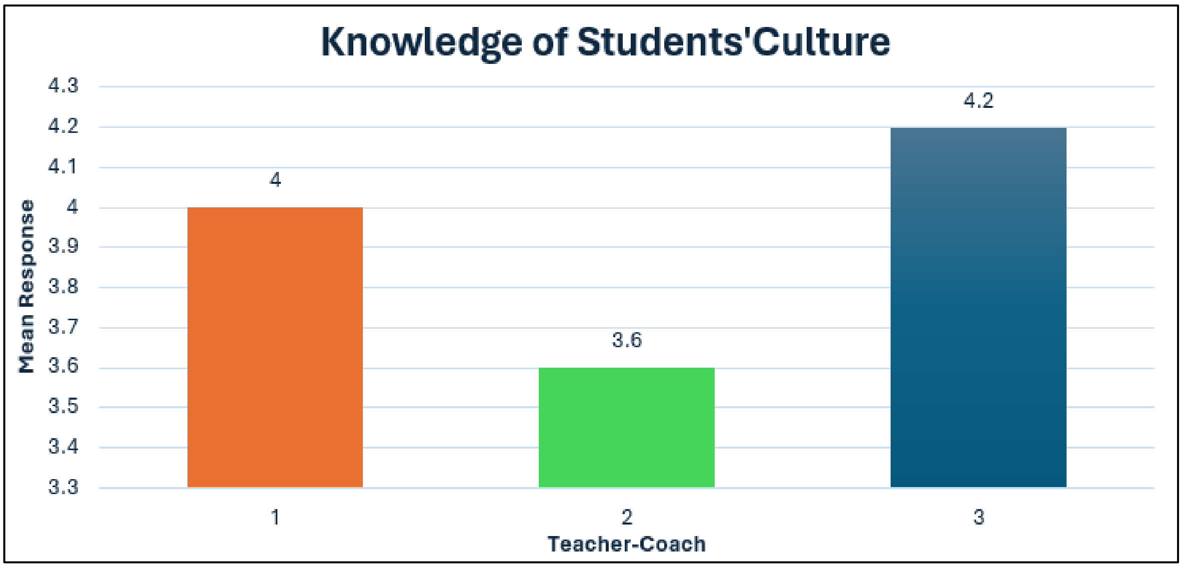

Fig 6 Mean Response for Domain 1

Coach 3, with the highest mean score (4.2) and 14 years of experience teaching Native American students, demonstrates the strongest level of cultural knowledge. This suggests a well-developed understanding of core cultural values, traditions, and the role of family and community, as well as sensitivity to communication styles such as respect and silence. Long-term immersion in a specific cultural context often leads to deeper relational understanding and more nuanced instructional practices. Studies indicate that educators with extended experience in culturally diverse environments are more likely to integrate culturally grounded perspectives into their teaching and demonstrate higher cultural competence (Villegas & Lucas, 2002).

Coach 1, with a mean score of 4.0 and six years of experience, also reflects a high level of cultural awareness, though slightly less developed than Coach 3. This suggests a solid understanding of students' cultural backgrounds, including awareness of historical influences and community dynamics, but potentially with less depth or consistency. Mid-career educators often demonstrate growing cultural proficiency as they continue to engage with students and communities, especially when supported by reflective practices and professional development (Hammond, 2015).

In contrast, Coach 2, with the lowest mean score (3.6) and the least experience (just over two years), shows a more moderate level of cultural understanding. While still above average, this score suggests some uncertainty or limited familiarity with key aspects such as local traditions, historical context, and culturally specific communication styles. Early-career educators frequently face challenges in fully understanding the cultural dimensions of their students' experiences, particularly in communities different from their own. Without intentional efforts to build this knowledge, instructional practices may not fully align with students' cultural perspectives (Ladson-Billings, 1995).

Overall, the data suggest a clear relationship between years of experience and level of cultural awareness among the coaches. While all three demonstrate a foundational understanding, deeper cultural competence appears to develop with sustained engagement in the community. This has important implications for practice, as culturally informed teaching is essential for building trust, improving

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communication, and enhancing student engagement—especially in Native American contexts where historical and cultural factors strongly influence educational experiences (Castagno & Brayboy, 2008).

➢ *Domain 2- Cultural Sensitivity and Respect*

The mean responses—4.4 (Coach 1), 4.8 (Coach 2), and 5.0 (Coach 3)—indicate very high levels of cultural sensitivity and respect among all three robotics coaches working with Native American students. On a 5-point Likert scale, these scores reflect strong agreement across all statements, suggesting that each coach consistently demonstrates respect for cultural beliefs, avoids stereotyping, and fosters inclusive classroom environments. This overall pattern is encouraging, as culturally respectful teaching is strongly linked to positive student engagement, trust, and participation, particularly in Indigenous educational contexts (Gay, 2018).

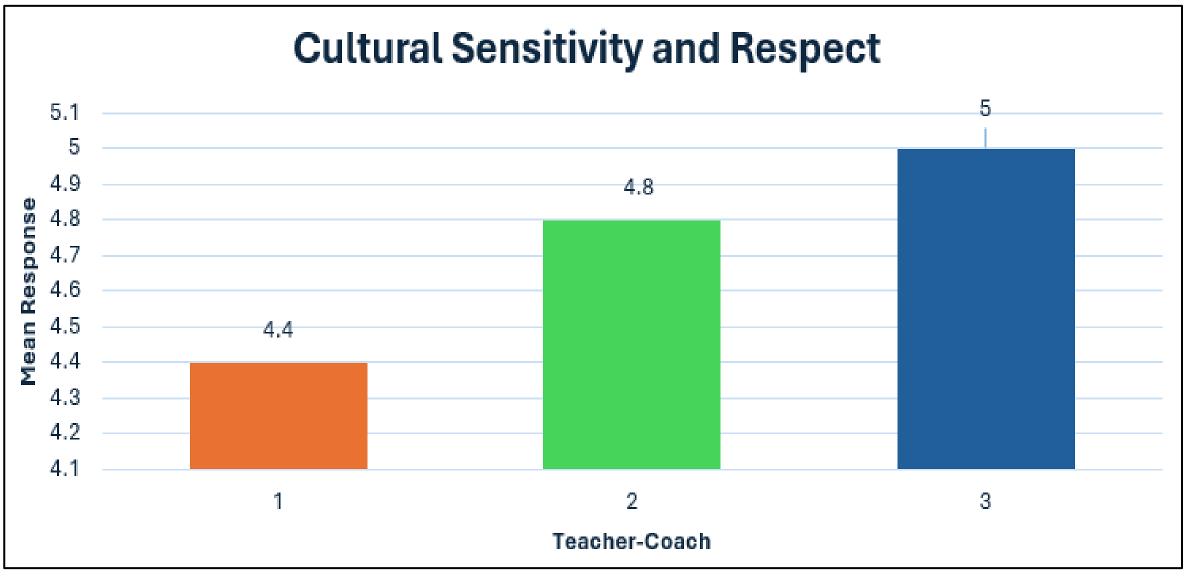

Fig 7 Mean Response for Domain 2

When examined in relation to years of experience, there is a partial but not definitive association. Coach 3, with 14 years of experience, achieved a perfect mean score of 5.0, which aligns with research indicating that sustained exposure to a cultural community can deepen understanding and refine culturally responsive practices (Villegas & Lucas, 2002). Similarly, Coach 1, with six years of experience, reports a slightly lower but still strong mean of 4.4, suggesting that cultural sensitivity develops progressively over time. However, Coach 2 presents an important counterpoint: despite having just over two years of experience, this coach reports a very high mean score of 4.8, nearly equivalent to Coach 3. This disrupts a simple linear relationship between years of experience and cultural sensitivity.

The case of Coach 2 suggests that factors beyond years of teaching experience significantly influence cultural sensitivity and respect. These may include prior cross-cultural experiences, personal beliefs and dispositions, professional training in culturally responsive pedagogy, or intentional efforts to learn about students' cultural backgrounds. Research supports this interpretation, noting that cultural competence is not solely a function of time but also of reflection, openness, and deliberate practice (Hammond, 2015). Educators who actively engage in self-reflection and seek to understand students' cultural identities can develop high levels of sensitivity even early in their careers (Ladson-Billings, 1995).

Additionally, the uniformly high scores across all coaches may indicate a shared school or program culture that prioritizes respect, inclusivity, and culturally responsive teaching. Institutional expectations, collaborative practices, and community engagement can all contribute to shaping teacher behaviors and attitudes. In such environments, even less experienced teachers may quickly adopt effective culturally responsive practices through mentorship and modeling (Castagno & Brayboy, 2008). This could help explain why Coach 2 demonstrates such a high level of sensitivity despite limited experience.

Overall, while years of experience appear to contribute to cultural sensitivity and respect—particularly in the case of Coach 3—it is not the sole determining factor. The data suggest that cultural sensitivity is influenced by a combination of experience, professional learning, personal commitment, and contextual support. This underscores the importance of ongoing professional development, reflective practice, and strong institutional culture in fostering culturally respectful teaching. Ensuring that all coaches, regardless of experience level, have access to these supports can sustain and further enhance culturally responsive robotics instruction for Native American students (Gay, 2018).

➢ *Domain 3-Application of Cultural Knowledge*

The mean responses—4.0 (Coach 1), 3.4 (Coach 2), and 3.4 (Coach 3)—suggest moderate but uneven application of cultural knowledge in robotics teaching, with no clear alignment to years of experience or gender. While all three

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coaches demonstrate at least some integration of students' cultural backgrounds into instruction, the scores indicate that translating cultural awareness into consistent classroom practice remains a challenge. This distinction is important, as applying cultural knowledge—through relevant examples, community-based learning, and adaptive strategies—is a key component of effective culturally responsive teaching (Gay, 2018).

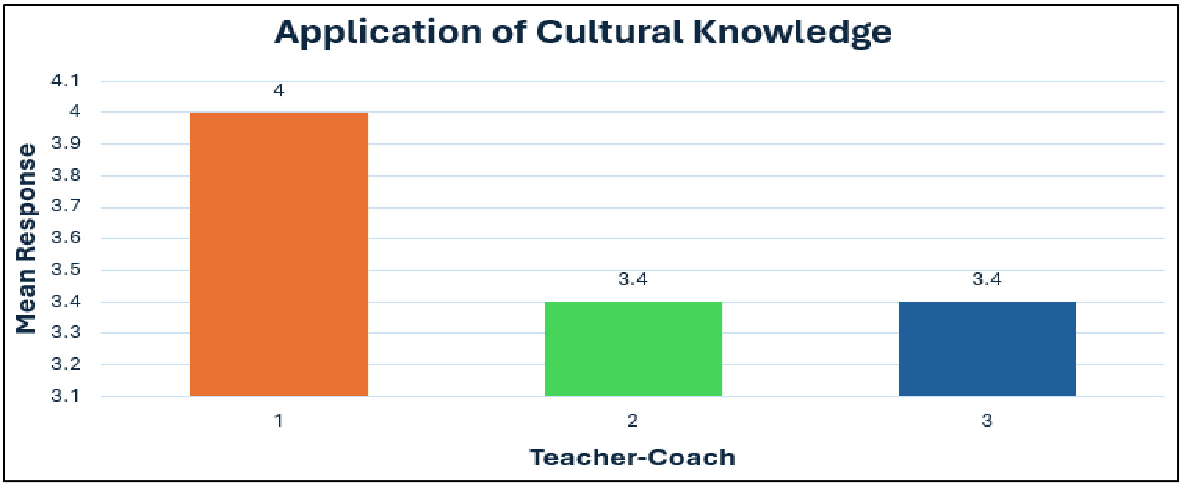

Fig 8 Mean Response for Domain 3

Coach 1's higher mean (4.0), despite having fewer years of experience than Coach 3, suggests more consistent implementation of culturally relevant practices, such as integrating students' lived experiences and encouraging cultural sharing. In contrast, both Coach 2 (3.4, ~2+ years) and Coach 3 (3.4, 14 years) report similar, more moderate levels of application. Notably, Coach 3's extensive experience does not translate into higher application, indicating that experience alone does not guarantee effective enactment of culturally responsive strategies. This aligns with research showing that awareness of culture does not automatically lead to pedagogical integration without intentional design and reflection (Paris & Alim, 2017).

The comparable scores of Coaches 2 and 3 suggest that other factors—such as training, instructional beliefs, or program structure—may play a stronger role than experience or gender in shaping practice. For instance, teachers may value cultural responsiveness but struggle to operationalize it in technical fields like robotics, where curriculum and competition demands can limit flexibility. Studies emphasize that culturally sustaining pedagogy requires deliberate planning to embed students' identities and community knowledge into academic tasks, rather than treating culture as an add-on (Ladson-Billings, 1995).

Overall, the data indicate that while cultural sensitivity may be high, its classroom application is less consistent across coaches. Strengthening this domain will likely require targeted professional development focused on concrete strategies—such as culturally relevant problem design and collaborative, community-centered projects—to bridge the gap between understanding and practice (Villegas & Lucas, 2002).

➢ *Domain 4- Teacher-Student Connection*

Figure 9 summarizes the results for Domain 4. The results indicate generally positive teacher–student connections across all three teacher-coaches, with mean scores above the midpoint of the 5-point Likert scale. Teacher 1 (M = 4.2) demonstrates a stronger perceived ability to build culturally responsive relationships compared to Teachers 2 and 3 (both M = 3.8), suggesting a higher level of confidence and consistency in culturally grounded practices.

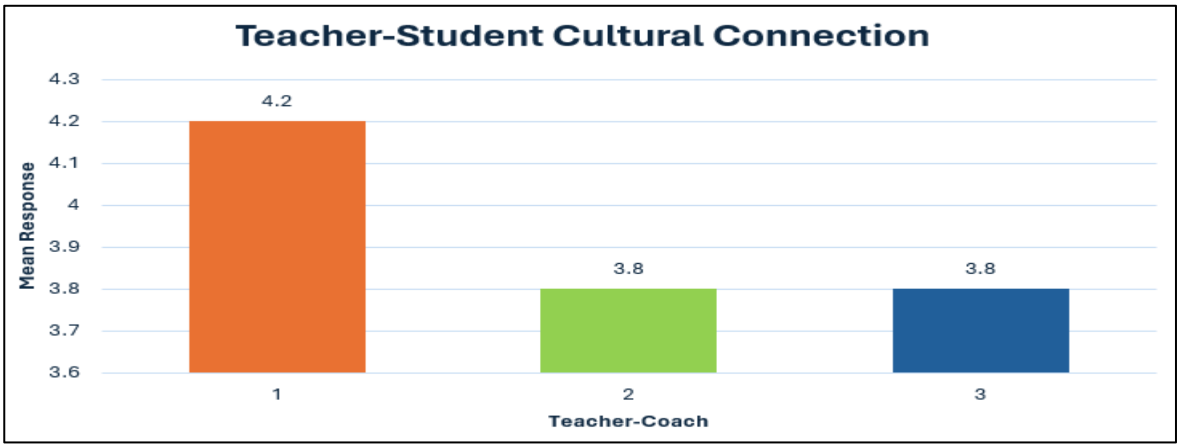

Fig 9 Mean Response for Domain 4

Teacher 1's higher mean may be influenced by his longer experience (6+ years) working with Native American students, supporting the idea that sustained cultural immersion enhances relational teaching practices (Gay, 2018; Ladson-Billings, 2021). In contrast, Teacher 2's relatively shorter experience (2+ years) may explain the slightly lower mean, as culturally responsive teaching competence typically develops over time. Interestingly, Teacher 3, despite having the longest experience (14 years), reports the same mean as Teacher 2, which may suggest that years of service alone do not automatically translate to stronger perceived cultural connection, but rather depend on ongoing reflective practice and adaptation (Villegas & Lucas, 2007).

Overall, all three teachers show moderate to high agreement with statements related to cultural understanding, communication, and respect, indicating a solid foundation in culturally responsive teacher–student relationships—an essential factor in student engagement and success in diverse classrooms (Hammond, 2015).

➢ *Domain 5- Cultural Responsiveness in Practice*

The mean responses for cultural responsiveness in practice—Coach 1 (3.2), Coach 2 (4.2), and Coach 3 (3.6) is presented in Figure 10. It indicates a mixed level of enacted culturally responsive teaching among the three robotics coaches. While Coach 2 demonstrates relatively strong application of culturally responsive practices, Coaches 1 and 3 show more moderate engagement, suggesting that translating cultural awareness into consistent instructional action remains uneven. This domain is particularly important because culturally responsive practice involves ongoing reflection, adaptation, and collaboration rather than static knowledge (Gay, 2018).

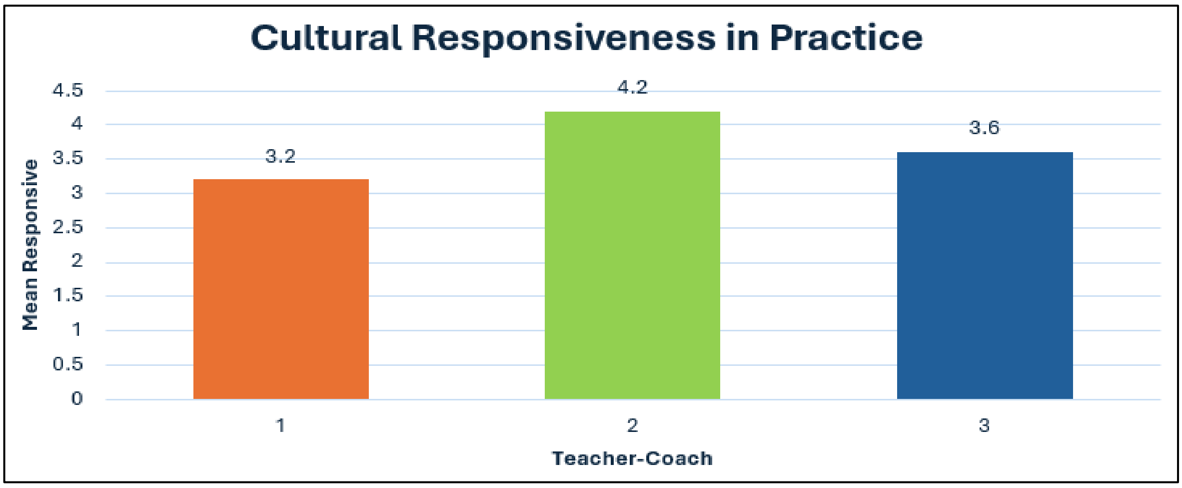

Fig 10 Mean Response for Domain 5

Coach 2's higher mean (4.2), despite having the least experience, suggests that active responsiveness—such as seeking student feedback, adjusting instruction, and reflecting on biases—may be more strongly influenced by intentional practice or professional orientation than by years of teaching Native American students. This aligns with research emphasizing that culturally responsive teaching is a skill set developed through reflective practice and not simply accumulated experience (Hammond, 2015). In contrast, Coach 3 (3.6), despite 14 years of experience and strong cultural knowledge in earlier domains, shows only moderate application, indicating a gap between understanding culture and consistently enacting responsive strategies.

Coach 1's lowest mean (3.2) suggests limited or inconsistent engagement in reflective and adaptive practices such as collaborating with families or seeking student feedback. This is notable given that Coach 1 previously showed relatively strong scores in confidence and cultural connection domains, indicating that confidence does not necessarily translate into culturally responsive action. This pattern is consistent with findings that self-efficacy alone does not guarantee instructional adaptation without explicit training in culturally sustaining pedagogy (Paris & Alim, 2017).

When compared with earlier domains, a broader pattern emerges: cultural knowledge (Domain 2) and teacher-student connection (Domain 5) do not consistently align with actual classroom responsiveness (this domain). Coach 3, for example, ranked highest in cultural knowledge but not in practice, while Coach 2 shows the opposite pattern. This suggests that the critical gap lies between knowing and doing—between cultural awareness and instructional enactment. Research on culturally responsive education emphasizes that effective practice requires continuous reflection, community engagement, and adaptive teaching strategies rather than reliance on experience alone (Villegas & Lucas, 2002).

Overall, the synthesis across domains reveals a consistent theme: cultural competence among the coaches is present but unevenly operationalized. While awareness and respect are generally high, the implementation of culturally responsive teaching practices varies significantly, suggesting that systemic professional development focused on reflective practice, community collaboration, and applied strategies is necessary to strengthen consistency across the program (Castagno & Brayboy, 2008; Gay, 2018).

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➢ *Domain 6- Perceived Impact on Students*

Figure 12 presents the mean response for Domain 6. indicate consistently high agreement among all three Asian robotics coaches working with Native American students. This suggests a shared belief that culturally responsive teaching enhances student engagement, participation, motivation, and success in robotics. The uniformly high scores reflect strong perceived effectiveness of culturally informed coaching practices, consistent with research showing that culturally responsive instruction improves student engagement and academic outcomes in STEM contexts (Gay, 2018).

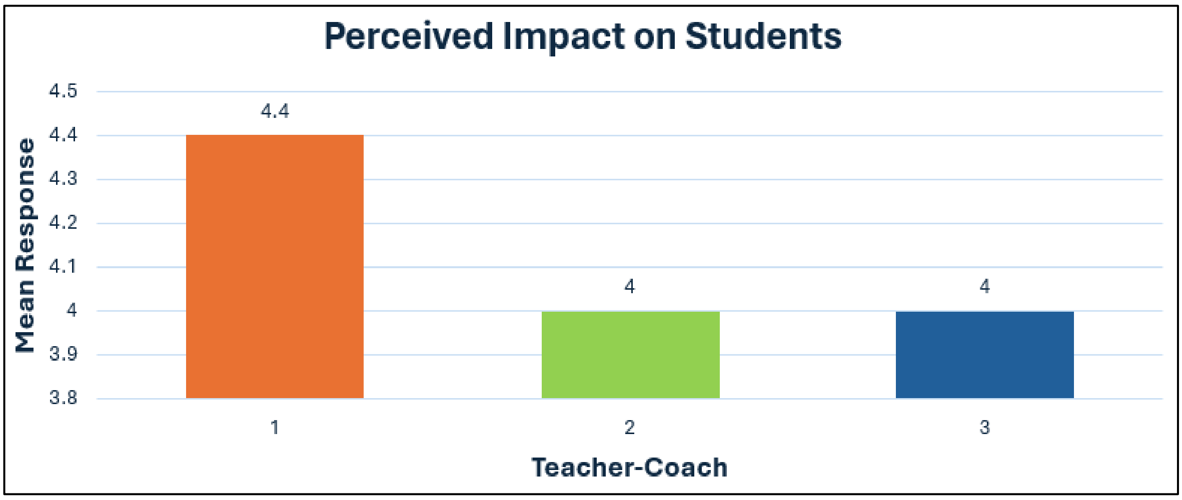

Fig 11 Mean Response for Domain 6

When connected to earlier domains, a clearer pattern emerges. In Domain 2 (cultural knowledge), Coach 3 previously demonstrated the highest cultural understanding due to extensive experience, while Coach 2 showed moderate understanding. However, in this domain, Coach 1 reports the highest application of cultural responsiveness (4.4), despite having fewer years of experience than Coach 3. This suggests that cultural knowledge and years of experience do not always directly translate into stronger perceived instructional impact. Instead, intentional integration of culture into teaching appears to be a more immediate driver of perceived effectiveness, aligning with findings that culturally responsive pedagogy depends on practice rather than tenure alone (Hammond, 2015).

Comparing across domains also reveals consistency in a broader theme: while all coaches generally report strong cultural respect and awareness (Domains 2 and 5), their ability to operationalize culture into teaching outcomes (this domain) is uniformly high but slightly differentiated by confidence in application. The pattern suggests that cultural responsiveness in this setting is more evenly distributed than other domains, indicating that robotics as a hands-on, collaborative subject may naturally facilitate culturally embedded engagement. Research supports this, noting that project-based STEM learning environments can reduce gaps between cultural understanding and instructional practice by emphasizing collaboration and real-world relevance (National Academies of Sciences, Engineering, and Medicine, 2016).

Regarding ethnicity, the data do not suggest that being Asian is a determining factor in the outcomes. Instead, the consistently high scores across all three coaches indicate that cultural responsiveness is more strongly influenced by pedagogical orientation, reflective practice, and experience with Native American students rather than ethnic background alone. This aligns with scholarship emphasizing that culturally responsive teaching is a learned and evolving practice, not an inherent trait tied to teacher identity (Villegas & Lucas, 2002). What appears more influential is sustained engagement with the community and deliberate integration of cultural context into instruction.

Overall, the synthesis across domains reveals a central theme: the robotics program demonstrates strong cultural intent and perceived effectiveness, but variations across domains suggest that experience, reflection, and instructional strategies—not ethnicity—shape how cultural responsiveness is enacted. Strengthening consistency may require continued emphasis on translating cultural knowledge into structured teaching practices that consistently support student engagement and success (Castagno & Brayboy, 2008; Gay, 2018).

➢ *Synthesis of Findings Across All Domains*

The combined synthesis across all six domains presents a comprehensive and coherent picture of the robotics program at Tuba City High School as a culturally responsive, high-impact STEM initiative that is both promising and still developing in key areas of instructional consistency. Overall, the data reveal a strong and consistent pattern: the program is highly effective in fostering student engagement, cultural respect, and perceived academic and motivational benefits, yet it shows variability in how cultural knowledge is translated into instructional practice and sustained across teachers. This underscores the interconnected nature of teacher capacity, cultural competence, and student outcomes in Indigenous STEM education.

Across Domains 1, 2, and 5 (teacher confidence, cultural knowledge, and cultural responsiveness in practice), a clear

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developmental gradient emerges. Teachers and coaches demonstrate generally high cultural awareness and respect, with stronger scores often associated with greater experience in Native American contexts. This aligns with research suggesting that cultural competence deepens through sustained engagement and reflective practice over time (Gay, 2018; Villegas & Lucas, 2002). However, the findings also show that experience alone does not guarantee consistent instructional application. In several cases, less experienced coaches demonstrate comparable or even higher levels of culturally responsive practice, suggesting that intentionality, reflective practice, and professional orientation are equally—if not more—important than tenure. This disconnect between knowing and doing reflects a recurring theme in culturally responsive education literature (Paris & Alim, 2017).

Domains 3 and 4 (challenges in engagement and teacher–student connection) further contextualize this pattern by showing that while coaches generally perceive strong relational bonds and high student engagement, they also experience systemic and instructional barriers. These include variability in confidence, resource constraints, and difficulties in consistently integrating cultural knowledge into robotics instruction. Importantly, stronger teacher self-efficacy is associated with stronger relational outcomes, reinforcing the role of confidence in shaping instructional quality and student connection (Bandura, 1997; Castagno & Brayboy, 2008). At the same time, the presence of challenges does not negate program effectiveness but rather highlights areas where support structures could enhance consistency and impact.

Domain 6 (perceived impact on students) serves as a culminating indicator of program effectiveness, with all coaches reporting strong agreement that culturally responsive robotics instruction enhances student engagement, participation, and motivation. This convergence suggests a shared belief in the transformative potential of the program, consistent with research showing that hands-on, culturally relevant STEM learning environments significantly improve student identity formation and persistence in STEM pathways (National Academies of Sciences, Engineering, and Medicine, 2016; Ladson-Billings, 1995). Notably, this perceived impact remains high even when other domains show variability, indicating that the program's core design is effective in engaging students despite implementation differences.

Across all six domains, a central and unifying theme emerges: cultural responsiveness in this robotics program is strongly valued and widely present in belief, but uneven in consistent instructional enactment. While teachers and coaches demonstrate high levels of respect, awareness, and perceived impact, the translation of cultural knowledge into sustained pedagogical practice varies. This gap is not strongly explained by ethnicity or experience alone; rather, it reflects a combination of factors including teacher confidence, reflective practice, institutional support, and instructional context. The findings therefore support the view that culturally responsive teaching is a learned, dynamic, and context-dependent practice rather than a fixed attribute tied to identity or tenure (Hammond, 2015; Gay, 2018).

In conclusion, the robotics program at Tuba City High School is both a strength and a developing system: it successfully engages Native American students through meaningful, culturally relevant STEM experiences, while simultaneously revealing the need for more structured support to ensure consistency in culturally responsive practice across educators. Strengthening this program will require sustained professional development, collaborative coaching, and intentional integration of culturally sustaining pedagogy to bridge the gap between awareness and action. Doing so will further enhance equity, deepen student engagement, and solidify the program's role as a model for culturally responsive STEM education in Indigenous contexts (Gay, 2018; Castagno & Brayboy, 2008).

C. Part 3: Results of the Semi-Structure Interview

➢ *Overview of Findings*

The analysis of three robotics teacher-sponsor interviews (P1, P2, and P3) revealed several interconnected themes that describe both the opportunities and challenges associated with engaging Native American students in robotics education. Across the interviews, participants shared experiences related to program development, student engagement, cultural responsiveness, instructional strategies, and institutional support. Although each participant entered the robotics program with varying levels of experience, all described robotics as a transformative learning environment that promotes student confidence, teamwork, and interest in STEM fields.

Seven major themes emerged from the data: (1) Hands-On STEM Engagement as a Primary Motivator, (2) Recruitment and Awareness Challenges, (3) Cultural Responsiveness Enhances Engagement, (4) Hands-On and Visual Learning Preferences, (5) Robotics Builds Confidence and Resilience, (6) Logistical and Structural Barriers Affect Participation, and (7) Institutional Support and Sustainability Needs. These themes reflect existing research that emphasizes the importance of experiential learning, culturally responsive pedagogy, and institutional support in STEM education (Gay, 2018; Ladson-Billings, 2014; Kolb, 2015).

Table 2 Theme 1: Hands-On STEM Engagement as a Primary Motivator

Theme	Participant	Supporting Quotation
Hands-On STEM Engagement	P1	"To provide students with authentic hands-on STEM experiences."
Hands-On STEM Engagement	P1	"To connect physics lessons to real-world applications through robotics problem-solving."
Hands-On STEM Engagement	P2	"I want to engage our students in STEM-related activities to develop their full potentials."

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Hands-On STEM Engagement	P2	"To provide our high school students an avenue to express or develop their talent in robotics and STEM."
Hands-On STEM Engagement	P3	"I saw that many students had untapped potential and curiosity about technology but lacked access to hands-on experiences."
Hands-On STEM Engagement	P3	"Starting a robotics initiative… is not just about building robots; it's about building confidence, interest, and a culture of curiosity."

Across all three participants, robotics was consistently described as an effective tool for delivering hands-on STEM experiences that extend beyond traditional classroom learning. Participants emphasized that robotics allows students to actively engage with complex concepts through building, testing, and problem-solving tasks. These findings align with experiential learning theory, which emphasizes learning through direct experience and reflection as a foundation for meaningful understanding (Kolb, 2015).

Participants described robotics as a platform for applying classroom knowledge in real-world contexts. Research in STEM education suggests that hands-on learning environments enhance student engagement and improve conceptual understanding by allowing learners to construct knowledge through active participation (Hmelo-Silver, Duncan, & Chinn, 2007). Robotics programs, therefore, provide authentic opportunities for students to explore engineering design principles and technological problem-solving.

Additionally, robotics programs were described as expanding educational opportunities within schools where academic extracurricular programs may be limited. This finding supports research suggesting that STEM enrichment activities can broaden access to learning opportunities and increase participation among underrepresented students (National Research Council, 2011). Robotics programs function not only as learning environments but also as mechanisms for increasing equity in access to STEM education.

Table 3 Theme 2: Recruitment and Awareness Challenges

Theme	**Participant**	**Supporting Quotation**
Recruitment Challenges	P1	"Many students were unfamiliar with robotics."
Recruitment Challenges	P1	"Initially, some students show limited interest because they believe robotics is only for highly academic students."
Recruitment Challenges	P2	"Students think robotics is only for very smart students."
Recruitment Challenges	P2	"Robotics is a new club and did not get much attention."
Recruitment Challenges	P3	"Many of them are starting from zero… I have to introduce even the most basic ideas."
Recruitment Challenges	P3	"The absence of an existing robotics program created an initial barrier."

Recruitment difficulties emerged as a recurring challenge across all participants. Many students initially lacked familiarity with robotics, leading to hesitation and misconceptions about participation. These findings are consistent with research indicating that limited early exposure to STEM activities often contributes to reduced participation among minority and rural student populations (National Science Foundation, 2019).

Participants noted that misconceptions about robotics being only for academically advanced students created barriers to recruitment. This observation aligns with stereotype threat theory, which suggests that perceived academic expectations may discourage students from engaging in challenging academic fields (Steele, 2010). By creating supportive learning environments, teachers were able to reduce these misconceptions and encourage participation.

Over time, recruitment improved as students observed successful outcomes in competitions. Visible achievements increased motivation and encouraged peer participation. This pattern reflects social learning theory, which emphasizes the importance of observational learning and modeling in shaping behavior and motivation (Bandura, 1977). Students who observed peers succeeding in robotics were more likely to believe in their own ability to participate successfully.

Overall, recruitment barriers appear to stem primarily from limited awareness rather than lack of interest. These findings suggest the importance of early exposure programs that introduce robotics concepts at younger grade levels to increase familiarity and confidence in STEM participation.

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Table 4 Theme 3: Cultural Responsiveness Enhances Engagement

Theme	Participant	Supporting Quotation
Cultural Responsiveness	P1	"The robotics club logo and robot name were inspired by Navajo art and language."
Cultural Responsiveness	P1	"We respect students' cultural responsibilities by encouraging them to attend ceremonies."
Cultural Responsiveness	P2	"We asked them to create a name for our robot that represents Navajos, Hopis, and Paiutes."
Cultural Responsiveness	P2	"If training days fall during ceremonies, we encourage them to prioritize cultural activities."
Cultural Responsiveness	P3	"Cultural values… encourage teamwork, collaboration, and shared goals."
Cultural Responsiveness	P3	"Understanding and respecting these commitments is important when planning practices."

Cultural responsiveness emerged as a central theme influencing student participation and program sustainability. All participants emphasized the importance of respecting students' cultural identities and traditions when designing robotics activities. This finding aligns with culturally responsive teaching theory, which emphasizes the integration of students' cultural experiences into instructional practices to improve engagement and achievement (Gay, 2018).

Participants described incorporating cultural symbols, respecting ceremonial responsibilities, and encouraging family involvement. These practices reflect the principles of culturally relevant pedagogy, which emphasizes academic success, cultural competence, and critical consciousness as key components of effective instruction (Ladson-Billings, 2014). When students see their cultural identities represented in educational activities, they are more likely to feel valued and motivated to participate.

Furthermore, the recognition of cultural responsibilities demonstrates an understanding of community-centered learning traditions common in many Indigenous cultures. Research on Indigenous education highlights the importance of relational learning environments that respect cultural knowledge systems and community values (Brayboy & Castagno, 2009).

Overall, cultural responsiveness appears to strengthen relationships between educators, students, and families while enhancing the relevance of STEM education within Indigenous communities.

Table 5 Theme 4: Hands-On and Visual Learning Preferences

Theme	Participant	Supporting Quotation
Hands-On Learning	P1	"Many students respond well to hands-on learning and visual demonstrations."
Hands-On Learning	P1	"Providing opportunities to physically build robots helps support their learning."
Hands-On Learning	P2	"Navajo, Hopi, and other Native American students are visual and kinesthetic learners."
Hands-On Learning	P2	"Making models to illustrate complex science concepts is very effective."
Hands-On Learning	P3	"Many Navajo students tend to learn best through hands-on, experiential activities."
Hands-On Learning	P3	"Providing visual guides and step-by-step modeling helped bridge understanding."

All participants identified hands-on and visual learning approaches as highly effective strategies for engaging Native American students in robotics education. These findings align with constructivist learning theory, which emphasizes that learners build knowledge through active engagement with materials and experiences (Piaget, 1972; Vygotsky, 1978).

Participants observed that students demonstrated improved understanding when instruction included demonstrations, visual guides, and step-by-step modeling. Research indicates that visual and kinesthetic learning strategies enhance comprehension by allowing students to connect abstract ideas with concrete experiences (Mayer, 2009). Robotics naturally supports these strategies because it integrates physical construction with visual problem-solving.

Additionally, experiential learning methods have been shown to support culturally diverse learners by aligning with community-based learning traditions that emphasize observation, demonstration, and practice (Kolb, 2015). Robotics programs therefore provide an instructional approach that accommodates diverse learning preferences and encourages sustained engagement.

Overall, the alignment between instructional strategies and student learning preferences contributed to increased comprehension and participation across all participants.

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Table 6 Theme 5: Robotics Builds Confidence and Resilience

Theme	Participant	Supporting Quotation
Confidence and Resilience	P1	"Students quickly repaired the robot when its wheels detached."
Confidence and Resilience	P1	"This experience demonstrated resilience and adaptability."
Confidence and Resilience	P2	"One student shared that he wanted to challenge misconceptions about Native Americans."
Confidence and Resilience	P2	"He wanted to demonstrate that Native Americans are capable of excelling as engineers."
Confidence and Resilience	P3	"Students voluntarily came together during lunchtime to improve and refine the robot."
Confidence and Resilience	P3	"Despite the setback, students reflected on what went wrong instead of giving up."

Robotics participation was consistently associated with the development of confidence, resilience, and leadership skills. Participants described situations in which students encountered technical failures but demonstrated persistence in resolving problems. These experiences align with growth mindset theory, which emphasizes the belief that abilities can be developed through effort and persistence (Dweck, 2006).

Students learned to view mistakes as opportunities for improvement rather than failures. This finding reflects research on engineering education, which emphasizes iterative design processes that require testing, reflection, and revision (National Academy of Engineering, 2009). Robotics competitions provide structured environments where students practice problem-solving under pressure, strengthening both technical and emotional resilience.

Additionally, collaborative problem-solving experiences contributed to leadership development and teamwork skills. Research suggests that cooperative learning environments enhance communication, responsibility, and peer support among students (Johnson & Johnson, 2009). These collaborative experiences encouraged students to take ownership of their learning and develop confidence in their abilities.

Overall, robotics programs function as environments where students develop both technical competence and emotional resilience, preparing them for future academic and professional challenges.

Table 7 Theme 6: Logistical Barriers Affect Participation

Theme	Participant	Supporting Quotation
Logistical Barriers	P1	"Transportation challenges limit students' ability to attend practices."
Logistical Barriers	P1	"Many students are involved in multiple extracurricular activities."
Logistical Barriers	P2	"Most students depend on the bus to get to school."
Logistical Barriers	P2	"Getting a ride to weekend practice is one of the barriers."
Logistical Barriers	P3	"Time constraints are a major issue because students are involved in other activities."
Logistical Barriers	P3	"Academic pressure prevents some students from fully committing."

Logistical challenges were consistently identified as barriers affecting participation across all participants. These challenges included time constraints, transportation limitations, and competing academic responsibilities. Similar barriers have been documented in rural education research, where geographic distance and limited transportation reduce student access to extracurricular programs (Azano & Stewart, 2015).

Participants also described administrative responsibilities associated with establishing new robotics programs. These responsibilities required additional time for documentation, funding requests, and scheduling. Research on program implementation indicates that insufficient administrative support can create barriers to sustainability and limit program effectiveness (Fullan, 2007).

These findings suggest that logistical barriers extend beyond student participation and also influence teacher workload and program continuity. Addressing these challenges requires systemic planning and coordinated support from educational institutions.

Overall, reducing logistical barriers through structured systems and resource allocation may improve participation rates and program sustainability.

Table 8 Theme 7: Strong Institutional and Community Support Enables Success

Theme	Participant	Supporting Quotation
Institutional Support	P1	"The principal actively supports the robotics program."
Institutional Support	P1	"The district provides transportation and meal allowances."
Institutional Support	P2	"Our school district funded our trips, hotel, and transportation."

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Institutional Support	P2	"We need mentors like university professors to improve our capabilities."
Institutional Support	P3	"We took the initiative to attend training at our own expense."
Institutional Support	P3	"A designated robotics budget would help sustain the program."

Institutional support was identified as both a strength and an ongoing need across all participants. Participants reported receiving varying levels of financial and administrative assistance but emphasized the importance of consistent support to maintain robotics programs. This finding aligns with research indicating that institutional leadership plays a critical role in sustaining educational innovation (Fullan, 2007).

Participants emphasized the importance of professional development and mentorship partnerships. Research suggests that teacher training and access to expert mentors significantly improve program quality and student outcomes in STEM education (Darling-Hammond et al., 2017). Access to advanced equipment and funding resources further enhances program sustainability.

Additionally, collaboration with external partners such as universities and industry professionals was identified as beneficial. Partnerships of this nature provide access to technical knowledge, resources, and scholarship opportunities that extend learning beyond the classroom (National Research Council, 2011).

Overall, long-term sustainability depends on continuous institutional commitment and investment in robotics education.

Table 9 Overall Synthesis of Findings

Major Theme	**Subthemes**	**P1**	**P2**	**P3**	**Frequency**
Hands-On STEM Engagement	Real-world STEM application	✓	✓	✓	3
	Opportunity creation for students	✓	✓	✓	3
Recruitment Challenges	Lack of robotics awareness	✓	✓	✓	3
	Misconceptions about robotics difficulty	✓	✓	✓	3
Cultural Responsiveness	Respect for cultural traditions	✓	✓	✓	3
	Cultural integration into robotics	✓	✓	—	2
Learning Preferences	Visual learning	✓	✓	✓	3
	Hands-on learning	✓	✓	✓	3
Confidence and Resilience	Problem-solving development	✓	✓	✓	3
	Leadership and teamwork	✓	✓	✓	3
Logistical Barriers	Transportation issues	✓	✓	—	2
	Time and scheduling conflicts	✓	✓	✓	3
Institutional Support	Financial support	✓	✓	✓	3
	Need for professional training	✓	✓	✓	3

The Theme Frequency Table (Table 9) shows that all seven major themes were consistently identified across all three participants, indicating strong thematic convergence in the data. The presence of each theme across all participants (3 out of 3) demonstrates that these experiences are not isolated but represent shared realities among robotics teacher-sponsors working with Native American students. This level of consistency strengthens the credibility and trustworthiness of the findings.

Subtheme analysis further revealed that hands-on learning, cultural responsiveness, and logistical barriers were among the most frequently reported instructional and operational factors influencing robotics participation. Recruitment challenges and misconceptions about robotics were also universally reported, suggesting the need for increased awareness and early exposure to STEM programs within Native American communities.

Overall, the frequency patterns support the conclusion that robotics programs serve as valuable educational opportunities while simultaneously presenting structural and cultural considerations that must be addressed to ensure long-term sustainability.

V. SUMMARY

This chapter presents the summary of findings, conclusion, and recommendations

➢ *Research Question 1 What Factors Contributed to the Success of the Robotics Program in Tuba City High School?*

The findings indicate that the success of the robotics program is driven by a convergence of instructional, cultural, and institutional factors:

- *Experiential, Hands-on STEM Learning as a Central Driver*

Robotics serves as an effective platform for active, experiential learning, enabling students to apply theoretical knowledge through real-world problem-solving. This hands-on approach significantly enhances engagement, comprehension, and sustained interest in STEM.

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- *Alignment with Students' Learning Preferences*

Instruction that incorporates visual, kinesthetic, and scaffolded learning strategies improves accessibility and understanding. The natural alignment between robotics activities and these learning preferences contributes to higher participation and success.

- *Development of Student Confidence, Resilience, and Identity*

Participation in robotics fosters problem-solving skills, perseverance, and leadership, while also strengthening students' self-efficacy. Students begin to view themselves as capable contributors in STEM, challenging existing stereotypes.

- *Cultural Responsiveness as a Foundation for Engagement*

The integration of students' cultural identities—through respect for traditions, incorporation of indigenous elements, and flexibility around cultural responsibilities—enhances relevance, belonging, and motivation.

- *Strong Teacher–Student Relationships and Coaching Practices*

Positive relational dynamics, supported by teacher confidence and culturally aware practices, contribute to trust, collaboration, and sustained engagement.

- *Institutional and Community Support Systems*

Administrative backing, funding, transportation, and access to competitions and training are critical in enabling participation and sustaining program operations.

- *Expanded Access to STEM Opportunities*

The program addresses gaps in access by providing equitable opportunities for students in a rural and underrepresented context, thereby increasing participation in STEM pathways.

➢ *Research Question 2: What Challenges did Teachers Encounter, and what Strategies did they Employ to Navigate them?*

- *Recruitment and Awareness Barriers*

Students' limited exposure to robotics and misconceptions that it is only for academically advanced individuals hindered initial participation.

- *Logistical and Structural Constraints*

Transportation issues, scheduling conflicts, academic demands, and competing extracurricular activities limited consistent student involvement.

- *Variability in Instructional Implementation*

While teachers demonstrated cultural awareness, there was inconsistency in translating this knowledge into instructional practice.

- *Limited Resources and Sustainability Concerns*

Challenges included insufficient funding, lack of dedicated budgets, limited access to mentors, and additional teacher workload in program development.

To address the challenges, teachers employed the following strategies:

- *Increasing Awareness and Accessibility*

Teachers introduced robotics at foundational levels, actively worked to demystify the subject, and used student success stories to encourage participation.

- *Creating Inclusive and Supportive Learning Environments*

They emphasized that robotics is accessible to all students, fostering collaboration, peer learning, and a non-intimidating atmosphere.

- *Utilizing Hands-on and Scaffolded Instruction*

Step-by-step modeling, demonstrations, and guided practice helped students gradually build skills and confidence.

- *Practicing Flexibility and Responsiveness*

Teachers adapted schedules and expectations to accommodate transportation limitations and students' multiple responsibilities.

- *Seeking and Leveraging External Support*

They pursued partnerships, training opportunities, and institutional support, sometimes through personal initiative, to strengthen program capacity.

➢ *Research Question 3: How do Teachers' Cultural Perspectives and Coaching Practices Influence Student Participation, Engagement, and Overall Program Success?*

The findings reveal that teachers' cultural perspectives and practices play a critical mediating role in program effectiveness:

- *Cultural Respect Fosters Trust and Participation*

Teachers' recognition of students' cultural obligations (e.g., ceremonies, community roles) reduces barriers to participation and strengthens student commitment.

- *Cultural Integration Enhances Relevance and Motivation*

Embedding Indigenous identity into robotics activities (e.g., naming, symbolism, collaborative values) increases student ownership and engagement.

- *Coaching Practices Reflect Relational and Community-Centered Values*

Emphasis on teamwork, shared responsibility, and collective success aligns with Indigenous cultural values, creating a more inclusive and supportive learning environment.

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- *Teacher Confidence Influences Relational and Instructional Effectiveness*

Higher teacher self-efficacy is associated with stronger teacher–student connections and more effective implementation of culturally responsive practices.

- *Cultural Responsiveness is Uneven in Practice*

While teachers demonstrate strong cultural awareness and positive beliefs, the consistency of implementation varies, indicating a gap between knowledge and practice.

- *Cultural Responsiveness as a Learned, Dynamic Practice*

The findings show that effective culturally responsive teaching is not determined by experience or identity alone but is shaped by intentional practice, reflection, and institutional support.

VI. CONCLUSION

The robotics program at Tuba City High School is a culturally responsive and high-impact STEM initiative that effectively promotes student engagement, confidence, and participation, but its long-term success depends on strengthening the consistency of culturally responsive instructional practices, addressing structural barriers, and enhancing institutional and professional support systems.

The evidence suggests that program effectiveness is strongest where experiential learning, cultural relevance, and teacher capacity intersect, while challenges arise when these elements are not consistently aligned in practice.

RECOMMENDATIONS

Based on the findings of this study, several key recommendations are proposed to strengthen the robotics program at Tuba City High School and enhance its impact on Native American student engagement and learning in STEM.

➢ *Strengthen Culturally Responsive Instructional Practice (RQ1 & RQ3)*

While teachers demonstrate strong cultural awareness and respect, there is a need to improve the consistent integration of cultural knowledge into robotics instruction. It is recommended that the school implement sustained, practice-oriented professional development focused on culturally responsive and culturally sustaining pedagogy. Training should move beyond awareness and emphasize concrete strategies for embedding local cultural knowledge, community practices, and Indigenous ways of knowing into robotics activities and problem-solving tasks.

➢ *Provide Structured Professional Support and Collaborative Coaching (RQ2 & RQ3)*

To address variability in instructional practice and teacher confidence, the program should establish ongoing coaching and mentorship structures. This may include peer observation, co-teaching opportunities, and professional learning communities where teachers can share best practices, reflect on challenges, and collaboratively design culturally responsive lessons. Such structures will help bridge the gap between knowledge and implementation.

➢ *Enhance Teacher Self-Efficacy Through Targeted Capacity-Building (RQ1 & RQ2)*

Given the strong link between teacher confidence and student engagement, targeted support should be provided to build teachers' confidence in both robotics instruction and culturally responsive teaching. This can include technical training in robotics, access to instructional resources, and opportunities for teachers to experience success through guided practice and feedback.

➢ *Improve Resource Allocation and Program Support (RQ2)*

To mitigate challenges related to materials, time, and instructional demands, the school and district should ensure adequate funding, access to updated robotics equipment, and dedicated time for planning and collaboration. Institutional support is essential for sustaining program quality and reducing teacher burden.

➢ *Integrate Community and Cultural Partnerships (RQ1 & RQ3)*

To deepen cultural relevance, the program should actively involve community members, cultural experts, and local knowledge holders in the design and implementation of robotics activities. This can strengthen authenticity, reinforce cultural identity, and provide students with meaningful connections between STEM and their lived experiences.

➢ *Establish Systems for Reflective Practice and Continuous Improvement (RQ2 & RQ3)*

Teachers should be supported in engaging in ongoing reflection on their instructional practices and student outcomes. The use of reflective journals, student feedback, and program evaluation tools can help identify areas for improvement and promote more intentional, consistent application of culturally responsive teaching.

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