Teaching Computing in Indigenous Schools: An Early Experience Report

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ABSTRACT

To broaden indigenous students' participation in Computer Science (CS) education, we conducted a research practitioner partnership (RPP) project, where teachers were taught the CS principles lessons offered by Code.org and asked to integrate mobile application development within their current courses. Additionally, modules and guidance were provided on culturally responsive pedagogy (CRP), and an in-classroom implementation of a five-day lesson plan was co-created via a participatory approach. In this experience report, we describe the RPP organization and early findings from our collected teachers' pre/post survey, lesson plans, projects, and students' pre/post survey. The positive outcomes from our RPP project provided valuable teacher learning experiences and actionable, culturally responsive computing lesson plans for the indigenous community.

CCS CONCEPTS

• **Applied computing** → **Education**; • **Social and professional topics** → **K-12 education**; **Computer science education**; **Computational thinking**.

KEYWORDS

Indigenous, CS education, Culturally responsive computing, High school

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1 INTRODUCTION

57.5% of US high schools provide foundational computer science courses, but only 16% of the 174 schools on Native American reservations offer foundational CS[1]. 47% of White high school students enroll in CS courses, while only 0.7% of Native American students do [1]. Although there has been many efforts to broaden Native Americans' participation in K-12 Computer Science (CS) education, many barriers, such as low access to advanced CS courses and curricula, limited teacher preparation, and lack of culturally responsive ways to engage indigenous students in computing activities, still prevent Native American student participation in CS education[6]. With years of investigation, studies have indicated that providing more access to computer science courses and developing culturally responsive curricula can provide positive learning outcomes for underrepresented students' CS content knowledge[5, 7, 8]. There is an emerging need to promote high-quality access to CS education among indigenous public school systems and teacher education programs. Otherwise, there will continue to be an unequal power relationship between nation-states and tribes[5]. This experience report introduces how we implemented the research practitioner partnership (RPP) to broaden the indigenous community's participation in CS education.

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2 RESEARCH PRACTITIONER PARTNERSHIP ORGANIZATION

Our RPP project was designed to support high school teachers using a PRIMM (Predict, Run, Investigate, Modify, and Make) approach to teach CS in the indigenous community. This approach allowed teachers to experience the mobile application (APP) creation process, integrate Indigenous culture with the APP, and use it to teach CS in their classrooms. Teachers were recruited from the Native-serving schools that were signed up to partner with the project. Teachers who agreed to participate took a three-day Professional Development (PD) and implemented a five-day CS lesson in their classroom. More details of the PD and how the teachers implement the five-day lesson plan are listed below. Our Let's Talk Code project model may be helpful to others aiming to further broaden CS education participation among historically underrepresented groups and build closer and stronger connections between universities, community organizations, and native-serving schools.

2.1 Professional Development Lessons and Activities

Our PD consisted of three days: one day of introduction lessons on APP creation, one day of APP creation, and one day of lesson planning and product presentations. On the first day, mentors taught teachers how to design and program an APP through Code.org.

The content in CS instruction included an introduction to design, variables, conditional logic, and how to use block-based code to program the design elements. All materials for this content were delivered through Google Classroom. On the second day, mentors presented five phases of the app-making process: brainstorm, design, code, test, and fix if needed. In the brainstorming phase, teachers brainstormed and then chose content area and cultural topics that they would apply to their app design. Then, they drew out the app interface on scratch paper, which included design elements for their APP, such as screen, buttons, sound effects, etc. When teachers had the initial design draft, they added these elements to their Code.org project. Next, teachers were paired to write code for the design elements and make them interactive. This process was the third phase of the APP-making process. In the fourth phase, teachers tested if their code could let the app run without problems. In the final phase, they fixed the bugs existing in their code. When teachers were programming, mentors supported and facilitated them. After teachers finished their App, they were required to design a five-day lesson plan for their students on the third day. The template of the five-day lesson plan was provided to them. Then, these teachers presented and shared their APPs and lesson plans with the group.

2.2 Five-Day Lesson Plan Implementation Details

During the PD, we provided teachers with a five-day lesson outline (See Table 1) and a Culturally Responsive instructional lesson plan template for their implementation. Teachers utilized the APP they designed and created as an anchor for the lesson plan. They were expected to connect the App with their culture and let their students use, modify, and create a new App. The lesson plan template was also provided for teachers to fill out. To facilitate teachers' lesson plan design and implementation, our mentors set office hours biweekly to help them finish and polish the lesson plan. When these teachers were ready to implement the five-day lesson, mentors visited their classrooms to support the teachers and their students.

3 RECRUITING TEACHERS AND PD MENTORS

The PD team included four CS undergraduate students, two professors, one CS instructor, one practitioner, and one postdoc researcher. The instructor led the lecture, and the rest of the team facilitated the activities and helped solve teacher questions. The PD team had faculty and staff from Navajo Technical University, Northern Arizona University, and the Computer Science Alliance. Teachers in this report were recruited and selected from schools where: 1) the school has a high percentage of Native American students; 2) a high-needs population, such as students' families being in low economic status and students having low academic achievement. In this experience report, we describe experiences with teachers and students from one of these schools. Fifteen teachers were recruited from the school to participate in the project. Due to their availability, we provided two time slots for them to participate in Fall 2023. The first group had five teachers, and the second had ten teachers. Teachers had no prior experience with computing, coding, or computer science. Teachers were mostly Native and the subjects they taught ranged from languages, arts, science, math, and social sciences. They taught approximately 500 students. 96% students in this school are American Indian/Alaska Native. 43% of their families are in low economic status.

Day	Topic	Lessson Main Content
1	Introduction	Teachers introduce the project and lesson to their students; Students create a Code.Org Account and explore the App.
2	Brainstorm	Students brainstorm ideas, Explore the app-making process, and learn a bit about coding (make sure they take notes)
3	Design	This is going to take all day. Have students add screens, buttons, colors, and images to their app
4	Coding	The App should be done by the end of the day. This will take all day; Coding is hard - Mentors can Help!
5	Presentation	Students present their Apps to the class. This shows other students different ideas and the creativity they can have with coding!

Table 1: Lesson Plan Implementation Outline

4 POSITIONALITY STATEMENT

Positionality is unique and impacts the researchers' study process[4]. First, our group is a diverse team. We have mentors from different cultural backgrounds, including international scholars, Native American researchers, and undergraduates from the local community. Such diversity could develop a multicultural environment for teachers. Secondly, our mentors and researchers have different experiences in the K-12 setting. Some of them have years of experience in teaching K -12 courses, while some of them have experience in serving the local community. Thus, we were familiar with the school and curriculum setting. These experiences could let us share the same frame of reference with teachers. Finally, we have experience conducting this PD several times in different locations. The experiences enabled the local community to trust us and provide opportunities to come to the classroom to interact closely with students.

5 METHODOLOGY

This is an in-process project in which ten of fifteen teachers implemented a five-day lesson plan in Spring 2024. The data we collected included teachers' pre-/post surveys, teacher Apps and lesson plans, and students' pre/post surveys. Teachers' and students' demographic information is presented in section III.

5.1 Teachers' Data Collection and Analysis

Fifteen teachers filled out the pre-survey on the first day of the PD and the post-survey on the third. During the PD, teachers finished their code.org APPLab projects. The teachers' survey items were selected and modified based on the survey items used in NYC4CS4ALL

PD [3], which included teachers' confidence and self-identified CS skills. Since the sample size of the participating teachers was 15 and the responses to their survey did not meet a normal distribution, we conducted a Wilcoxon signed-rank test to determine whether PD affected teachers' confidence and their self-identified CS skills.

5.2 Students' Data Collection and Analysis

At the time of submission of this report, we had access to 38 student surveys from five teachers' classes Students filled out the pre-survey on the first day of the five-day lesson plan implementation and the post-survey on the end day of their project. To determine if there was a significant difference between pre and post-surveys, we used a paired-sample t-test to analyze the students' responses. We first checked the normality of the data through the Shapiro-Wilk normality test. Students' responses were normally distributed. Then, we compared the average of students' responses through a paired-sample t-test.

6 RESULTS

In the sections below, we present the results of the current data analysis.

6.1 Teacher Survey Results

These five scales of survey items could answer our questions: 1) do the teachers' confidence change over PD, and 2) do the teachers' self-identified CS skills change over PD? Figure 1 showed the average

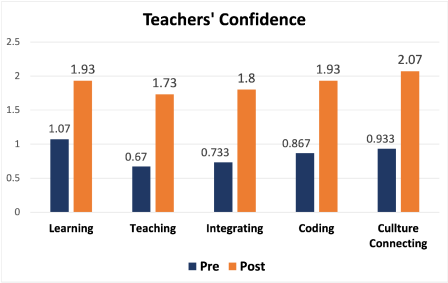

Figure 1: Pre-/post Survey Results for Teachers' Confidence

responses from five items related to teachers' confidence before and after PD. These five items asked about teachers' confidence in learning, teaching, integrating CS and learning content, coding, and connecting culture with CS instructions. Figure2 showed the average responses from six items related to teachers' identified CS skills before and after participating in the PD. The six self-identified CS skills included developing an app, writing code using a textual language, writing code using a drag-and-drop tool, relating written code to algorithms, troubleshooting and fixing errors related to code, and finding help while writing codes. As indicated in the two figures, the average responses of teachers' confidence and self-identified CS skills increased after participating in PD. In addition, we compared if there was a significant difference between teachers' pre- and post-survey responses. Based on the Wilcoxon signed-rank test and using a statistical threshold of $p < 0.05$, we concluded PD significantly affects teachers' confidence and their self-identified

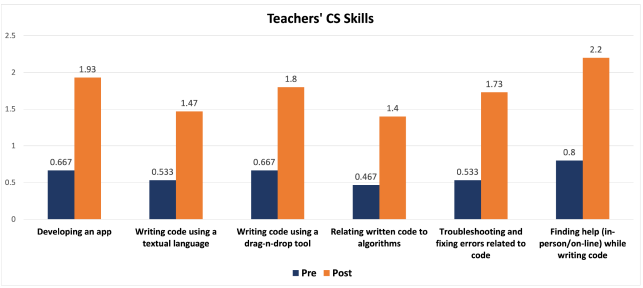

Figure 2: Pre-/post survey results for Teachers' CS Skills

CS skills. The median of teachers' confidence in each item and each self-identified CS skill became higher after participating in the PD. Table 2 shows the results for each item in the teachers' survey.

	Survey Items	Pre	Post	P value	V
Confidence	Learning	1	2	< 0.01	45
	Teaching	1	2	< 0.01	66
	Integrating	1	2	< 0.01	55
	Coding	1	2	< 0.01	74
	Culture Connecting	1	2	< 0.01	55
CS Skills	Developing an App	0	2	< 0.01	78
	Writing code using a textual language	0	1	< 0.01	66
	Writing code using a drag-n-drop tool	1	2	< 0.01	78
	Relating written code to algorithms	0	1	< 0.01	55
	Troubleshooting and fixing errors related to code	0	2	< 0.01	78
	Finding help (in-person/online) while writing code	1	2	< 0.01	78

Table 2: Wilcoxon Signed-rank Test Results of Teachers' Survey

6.2 Teacher Projects

The teachers who participated in the PD created an App as an example for their students. As we presented the whole project outline to teachers, they were engaged in the designing and developing process. They designed their apps as examples for their culturally responsive five-day lesson plans. These projects incorporated Hopi/Navajo culture. For example, one teacher created an app to help students learn about sacred Navajo mountains. She put four mountains' information and knowledge check questions at the end of the APP. In her lesson plan, students needed to remix the APP she created and apply other Navajo cultural topics within the APP. Table 3 shows four examples of the teachers' Apps and how these teachers used these apps for their lessons.

Project Name	Lesson Plan Objectives
Navajo Four Sacred Mountains	Understand Navajo Four Sacred Mountains and students create their App related to Navajo Culture
Hopi Arts	Provide local arts and let students bring arts from their community
Heart of the Hopi	Know local food and their names in Navajo language; students debug and build on the App.
Elements of Plot	Explain a traditional Navajo story and provide assessments. Students will reuse the App to provide other Navajo Stories.

Table 3: Teachers' Code.org APPLab Projects

6.3 Student Survey Results

Figure 3 showed the average responses from two items before and after the in-classroom implementation: 1) how much do you know about coding? and 2) how interested were you in coding? These two survey items were selected and modified based on the CS student engagement scale[2]. We used a paired-sample t-test to analyze the students' responses. Using a statistical threshold of $p < 0.01$, we found a significant difference in these two items: 1) how much do you know about coding? (t(38)=8.79, $p < 0.01$, M=1.44, SD=0.92) and 2) how interested were you in coding? (t(38)=3.33, $p < 0.01$, M=0.77, SD=1.21).

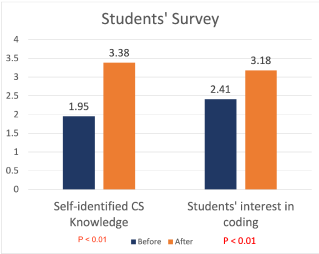

Figure 3: Students' Pre/Post-survey

6.4 Lessons Learned

6.4.1 Make the goal explicit and actionable for teachers to follow. Teachers who joined the project had limited experience in programming. They taught traditional subjects in their classroom, such as math, science, and ELA. When they arrived on the first day of the PD, they were scared about learning programming and unsure what to do. They asked the instructor to slow down the lecture and noted down everything the instructor presented for the lesson. For example, when the instructor taught the variables and conditional logic, the instructor used the text-based language to demonstrate the fundamental coding process. Teachers were confused and tried to copy every syntax in the instructors' program. They also asked other mentors to repeat the syntax and type it into their program if they missed it. However, the demonstration was designed to show teachers the basic CS concept instead of copying and pasting syntax. During our PDs, there exist discrepancies between the teachers and us. Teachers were being taught code to create a lesson plan, but they often assumed that they needed to reteach EVERYTHING we teach them, which overwhelmed them in the PDs. Reflecting on this experience, we suggested clarifying the goals of the PD and designing actionable activities for teachers to follow. For example, we could provide the PD project goals, and what they would teach in their classroom at the beginning of each PD day.

6.4.2 Have plenty of resources prepared for teachers. We found it helpful if we provided work examples and resources when teachers began to create their apps and lesson plans. When the first group did the PD and implementation, there were not enough prepared resources for teachers to use. After the first group finished the PD and implementation, we created Canvas modules to provide detailed materials for the five APP-making phases, including video instruction, worked coding examples, and a step-by-step APP-making process. When we conducted the PD for the second group, we followed these modules one by one and used multimedia to demonstrate how to design and code the App. While teachers were creating their Apps, we also provided a cheat sheet for teachers to use for the APP-making process. The whole PD for the second group ran more smoothly than the first group. Thus, we suggested that preparing well-rounded PD resources and materials for teachers to use during PD was very important for these teachers who had limited experience in programming.

6.4.3 Teachers as agents to connect CS learning and students' culture. For the whole process, the teachers became important agents in incorporating and demonstrating the combination of CS learning and culture. Each teacher in the PD designed their APP based on culture. When they presented these Apps in the PD, our group also learned more about the culture, such as traditional stories, food, arts, etc. When these teachers taught their students the lessons, they knew both CS knowledge and how to promote their culture.

6.4.4 The RPP project makes the local community more connected. In this RPP project, we had teachers from native-serving high schools and mentors from Northern Arizona University. Four undergraduate mentors came from different cultures. Through the PD activities and mentors facilitating teachers in the local school; teachers, mentors, and students have had opportunities to be exposed to diverse cultures. When mentors led the PD activities and facilitated the teachers' programming process, teachers and mentors could interact with each other's culture. When mentors encouraged the lesson implementation in the local schools, students had more exposure to diverse cultures. Through this RPP project, connections among the local community became stronger.

6.4.5 More professional development is needed for the Native-serving group. As stated in the result section, teachers' confidence and CS skills significantly differed between pre and post-survey implementing the five-day lessons for their students. The data indicated that students increased their interest in programming, and their self-identified CS knowledge improved. This improvement in the teachers' and students' survey showed the vital function of the RPP project for the Native-serving group. However, the low score for each teacher's survey item also indicated more PD is needed in the future. Teachers had the most insufficient confidence in teaching

programming to their students. Suppose we conducted more PD for the Native-serving group. In that case, teachers might have more confidence in promoting CS education in their group, and students could have more opportunities to access high-quality CS education.

6.5 Limitations and assumptions

As all studies have limitations, we have limitations for the RPP as well. First, students' data were limited. We collected students' survey data and did not collect their projects. Second, this study only presents one group of teachers who participated in the PD and their in-class students. It could not indicate all indigenous communities.

7 CONCLUSION AND FUTURE WORK

This experience report provided a detailed description of the PD, how teachers implemented the five-day lesson plan in their classrooms, and partial results of the RPP project. The results indicated significant differences in teachers' confidence, self-identified CS skills, and students' interest in CS learning after participating in the project. In the future, we will continue to provide more PD for the community and involve more teachers and students in the RPP project.

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