Board 335: Native American Teachers' Pre-post Participation Experiences in Online Coding Curriculum and Professional Learning

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Experiences with broadening computer science participation in schools that serve Indigenous students

Abstract

This research paper provides findings from the National Science Foundation (NSF) awarded project titled Let's Talk Code. Let's Talk Code aims to broaden the computer science participation of Indigenous serving teachers and their students in the Northern Arizona and New Mexico region of the United States. The Computer Science (CS) for All Research-Practice Partnership (RPP) of Let's Talk Code provided professional learning workshops for non-computer science Indigenous serving teachers. The experiences of a subset of teachers (3 pseudo-named Mister, Master, and Mayor) who had participated in 40 hours of professional development are examined. Further, the experiences of students ($N_{\text{Mister students}} = 37$, $N_{\text{Master students}} = 6$ $N_{\text{Mayor students}} = 37$) who participated in computing activities with the trained teachers are explored.

Keywords: Indigenous, Computer Science Education, Participation. Professional Learning

1. Introduction

This research paper provides findings from implementing the Professional Development or PD model of the NSF-awarded project "Let's Talk Code". The goal of these PD workshops was to increase teacher's confidence and capability in integrating culturally relevant computing and coding experiences within their curriculum and instruction. Here, we set our focus on the impact of the PD. Through the PD, teachers were engaged in computing and coding professional development via Code.org. The teachers were then asked to apply what they learned about coding by developing and implementing culturally relevant computing and coding experiences for their students. Here, we share early findings from three of the teacher participants and their students' experiences, concerns, and key lessons learned surrounding the PD model of Let's Talk Code.

1.1 Background

The Let's Talk Code project began with the underlying goal of facilitating the teaching and learning of coding in Indigenous-serving schools and districts. Its underlying structure follows the Research-Practice Partnership (RPP) design and attempts to turn the teaching of computer science education into an RPP effort between the teachers, who are mostly novice computer scientists, and workshop organizers and computer science experts (Hovermill et al., 2023). RPPs in education are shown to be a promising approach for expanding the impact of research in enhancing pedagogical practice (Coburn & Penuel, 2016). To build capacity for Indigenous research and pedagogy, RPPs can be used as an effective approach where the research is informed and updated based on partnerships with relevant communities of learners (Gittelsohn et al., 2020; Lin, 2022)

The name of the project was inspired by the contributions of Indigenous military personnel known as "Code Talkers" (Office of the Director of National Intelligence, 2023) who have contributed their language skills during their military service. The Let's Talk Code project aims to support teachers of Indigenous students to infuse culturally relevant learning experiences involving coding within their curriculum and instruction. By creating culturally relevant learning spaces, Indigenous learners are more motivated to engage in educational environments (Anthony-Stevens et al., 2022). When spaces lack that relevance, on the other hand, students and teachers may limit their efforts or altogether withdraw from participation (McKinley, 2018). During the Let's Talk Code project, non-CS teachers attended two-phase workshops. Participants first learned about coding basics through Code.org activities and then planned instructional lessons that incorporated coding within their non-CS courses and in their Indigenous-serving schools. We thus aim to share findings on the experiences of a subset of teachers and their associated students. In doing so we aim to answer the research question:

What are the teachers' and their students' perspectives on the efficacy of the Research–Practice Partnership (RPPs) professional development model for computer science education in Indigenous-serving schools?

1.2 Literature review

Research–practice partnerships or RPPs offer a useful strategy for education and closing the gap between research and practice (Datnow et al., 2023). Research partnership is a non-traditional approach to help joint reflection and reciprocal learning between professionals (Eisen, 2001). Partnership with teachers for professional development has been found beneficial as it can allow collaborative work in the classroom to be relevant to practice (Jung & Brady, 2016). This could be particularly useful for teaching in rural areas where there is often a lack of resources and support (Jung & Brady, 2016). The RPP model enables the teachers to put themselves in the position of students firsthand and co-design curriculum and teaching with the learner in mind (Campbell et al., 2019). In topics that are new to the teachers, such as coding for non-CS courses, the RPP method may allow the teacher to immerse in the learning process and get firsthand experiences of challenges and needs before practicing them with their students.

To infuse culturally relevant Indigenous experiences, various efforts have been made at K-12 and higher education levels (AISES, 2023; Kapor Center, 2021). Ryoo (2019) explores the pedagogy that can support the "Computer Science for All" movement that has taken hold in the United States. The authors suggest that youth, particularly ones belonging to under-represented groups such as students of color, young women, and low-income students are in particular need of learning on computer science education as they often lack less access and support (Salmon, 2023). The findings of work by Ryoo (2019) reveal that: "(1) demystifying CS by showing its connections to everyday life; (2) addressing social issues impacting both CS and students' communities; and (3) valuing students' voices and perspectives" (p. 1) are useful in motivating and engaging youth in CS education.

Implementing culturally relevant professional development opportunities through research-practice partnerships seems a useful approach to gaining more understanding of the challenges surrounding the integration of Coding within Indigenous classrooms (Stevens, 2016). The

infusion of culturally relevant contexts and problems may help teachers connect with students with more meaning and impact. Prior work has examined the infusion of culturally relevant practices by merging a cognitive apprenticeship with an indigenous approach and the Circle of Courage, to enhance the academic and professional development of Native students and build a scientific learning environment in the health sciences (McMahon et al., 2019). Innovative approaches have been used more so than addressing equity issues through the choice of culturally relevant materials and activities (Kafai et al., 2019).

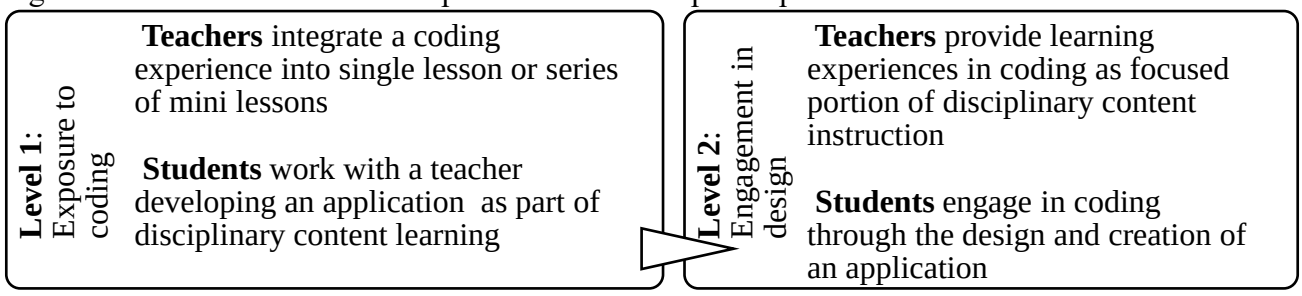
2. Methods

We study the self-reflection and products of three teachers (whose pseudonyms are Mister, Master, and Mayor) from Indigenous-serving schools. These teachers each participated in 40 hours of professional development sessions. The three teachers then taught a week of classes focused on culturally relevant computer science and coding topics. The experiences of their students were further collected and analyzed ($N_{\text{Mister students}} = 37$, $N_{\text{Master students}} = 6$ $N_{\text{Mayor students}} = 37$). This research paper reflects on surveys completed post-professional development. Teachers were provided with a questionnaire after completion of the 40 hours of training and iterative design-based curriculum development process and before they began teaching their students. Consenting students also completed a survey after experiencing the coding lessons their teachers developed and shared their experiences. Data collection included information on teaching materials developed by the teachers, teacher-related survey data, and student-related survey data. The data analysis focuses on two aspects of the work, namely the applications developed by three teachers and their experiences, as well as the findings of their student surveys. While more teachers and students participated, we were only able to reflect on these three teachers and their students at the time of writing this paper.

2.1 Overview of research-practice partnership professional development

An overview of the research-practice partnership is presented in Figure 1. This model of professional development had a sense of plan, do, and review approach to impact teaching and learning positively. A purposive sample of teachers who participated in both pre- and post-survey sessions and completed 40 hours of training was used for data analysis. Our key methodological objective is to draw on teachers, and their associated students', perspectives to understand their needs and challenges when experiencing application development and coding firsthand and getting exposure to computer science education. Almost all of the teachers had limited experience in coding and computer science education and thus the professional and curriculum development served as a learning and teaching preparation experience for the teachers.

Figure 1. Overview of the teacher professional development process



2.2 Data collection

Prior work reveals that a foundation for success among Indigenous in STEM lies in a bonded conceptualization of Native identity (Page-Reeves et al., 2017). LTC teachers were given the freedom to infuse Indigenous identities into their learning activities. As such, some of the applications developed by the teachers, and shared with their students, incorporated culturally responsive aspects. Further, data were collected from the teachers through a consistent set of closed-ended questions presented in pre- and post-participation surveys. The questions presented had been validated through previous studies (Fancsali et al., 2020). Similarly, the student data were collected using instrument questions that were validated by prior studies (DeLyser et al., 2016).

Competence is assumed to be one of three fundamental psychological needs, so the feelings or perceptions of competence concerning an activity or domain. The Perceived Competence Scale (PCS) is a short, 4-item questionnaire, and is one of the most face-valid instruments designed to assess constructs from Self-Determination Theory. Two examples of studies that have used the PSC are Williams et al. (1998) for the management of glucose levels among patients with diabetes and Williams and Deci (1996) medical students learning the material in an interviewing course. The alpha measure of internal consistency for the perceived competence items in these studies was above 0.80.

3. Results and Discussion

This section shares the culturally relevant teaching and learning material developed by the 23 teachers upon participation in the 40 hours of professional training followed by an analysis of pre-post participation survey data.

3.1 Teaching and learning material created

Here we present an overview of the three teacher's application development. The key application the first teacher (Mister) developed and asked the students to work with is called the "Binary and Numeric Converter" (Mister, 2023), where a code is written for an online application to allow converting between numeric and binary numbers, appropriately. Master aimed to have students understand the fundamentals of application and user interface design, how to create an application, and how to incorporate International Baccalaureate (IB) Learner Collaboration Project data and research into a successful education tool. In taking the course students were expected to design their application with content from the IB Collaboration Project with sports science, incorporate feedback from their peers, and test and deploy the application to the public. The content key points were understanding simulation, collaboration, user interface design, and Python coding for application design. Master found the difficult points to be time, buy-in, confusion about the project model, and tech difficulties with Anvil. Mayor asked students to develop an application called "Pikachu Probabilities" (Mayor, 2023). The idea behind the application is to have students learn about probability through engaging Pikachu examples. Students had time to play with Code.org and an example application and go over basic key programming languages. Students also individually worked on creatively designing their applications.

3.2 Analysis of pre-post teacher's participation survey data

Teachers participating in professional learning were asked after the professional learning to rate their perceived degree of confidence in their ability to learn and teach computing and coding to their students. The studied teachers demonstrated a shift in their confidence because of their course activities. The teachers' rated confidence slightly decreased from before to after participation. Drawing connections between computing and coding and Indigenous culture was the lowest confidence level of the teacher. This finding highlights a need for continued design revisions and levels of support in the final iterations of the professional development model such that it is culturally relevant. Table 1 provides a descriptive summary of the teachers' ratings towards teaching and learning coding.

Table 1. Overview of the teacher's reflections, 1) Not Confident, 2) Somewhat confident, 3) Confident, 4) Very Confident, 5) Extremely Confident:

Questions asked from each teacher	Mister	Master	Mayor
How confident do you feel in: [Learning about computing and coding]	4	5	3
How confident do you feel in: [Teaching computing and coding skills to my students]	4	2	2
How confident do you feel in: [Integrating computing and coding into my curriculum]	5	2	2
How confident do you feel in: [Making computing and coding relevant to my students]	4	3	3
How confident do you feel in: [Drawing connections between computing and coding and Dine's culture]	2	1	1
How confident do you feel in: [Using computing and coding to engage students in problem-solving]	5	3	3
Rate your current degree of confidence in: [Solving a computing task]	3	3	3
Rate your current degree of confidence in: [Developing a computer application]	3	2	1
Rate your current degree of confidence in: [Writing code using a textual language]	3	3	2
Rate your current degree of confidence in: [Writing code using a drag-n-drop tool]	4	4	2
Rate your current degree of confidence in: [Relating written code to algorithms]	3	2	1
Rate your current degree of confidence in: [Troubleshooting and fixing errors related to code]	3	3	2
Rate your current degree of confidence in: [Finding help (in-person/online) while writing code]	4	3	2
Average	3.62	2.77	2.08

3.3 Analysis of pre-post Students' Participation Survey Data

Table 2 provides a descriptive summary of students' ratings towards teaching and learning coding. Students were asked after the course to rate their perceived degree of confidence in their ability to computing and coding. The studied 37 students demonstrated a shift in their knowledge about coding. The student interest in coding also increased for two of the teachers.

For the remaining questions, that is:

- I will be able to get a good job if I learn coding.
- I will use coding in many ways throughout my life.
- Coding is of no relevance to my life.
- Taking a class in computer science and coding is a waste of my time.
- I feel like I "belong" in computer science.
- I consider myself a scientist, technologist, engineer, or mathematician.
- I take pride in my coding abilities.

The responses were on the somewhat confident or confident rating on average. This result may signal the need for further enhancement and development of teaching computer science education to increase students' confidence and interest in coding.

Table 2. Overview of the student's average reflections, 1) Not Confident, 2) Somewhat confident, 3) Confident, 4) Very Confident, 5) Extremely Confident:

Mean values of students' scores	Mister N= 37	Master N= 6	Mayor N= 37
Before this coding activity, how much did you know about coding?	3.35	3.17	1.92
Now, how much do you know about coding?	3.59	3.50	3.03
Before this coding activity, how interested were you in coding?	3.41	3.83	2.27
Now, how interested are you in coding?	3.41	4.17	3.14
I will be able to get a good job if I learn coding.	3.70	3.67	-
I will use coding in many ways throughout my life.	3.22	2.50	-
Coding is of no relevance to my life.	2.22	1.67	-
Taking a class in computer science and coding is a waste of my time.	2.11	3.33	-
I feel like I "belong" in computer science.	3.11	3.50	-
I consider myself a scientist, technologist, engineer, or mathematician.	3.30	3.33	-
I take pride in my coding abilities.	3.11	-	-

This research paper aims to present efforts on supporting computing education within Indigenous-serving schools in the Four Corners region through research-practice partnership professional and curriculum learning. Analysis of teachers who engaged in 40 hours of learning along with students who participated in the teachers' classes revealed both strengths and limitations. Our findings suggest that teachers' confidence slightly decreased upon completing the professional development. The students of diverse experience levels generally found the lessons to be helpful and created confidence in their learning and interest in coding.

The teacher's findings may highlight the importance of RPP teaching and learning. Seldom may teachers put themselves in the position of students and complete a coding project from start to finish. We summon that the RPP program may be more detailed than a process a teacher typically goes through for curriculum development, leading to more awareness of teachers' understanding and confidence in what they may or may not know. The students' findings may highlight the importance of coding courses for Indigenous-serving schools, and how it may help students learn and find interest in coding. Overall, the findings of our research present key suggestions and areas for future work. Examples include:

- Consider working with out-of-school-type programs that have more flexibility in their curriculum and opportunities to teach new topics through new modalities.
- Look into science and art competitions across the indigenous-serving schools as a possible model for working with educators and schools.
- Demonstrate to teachers how coding can connect to their curriculum as a core part of the professional development course to address the needs and interests of the majority set of teachers (who are not interested in developing a full CS course).
- Invite students to present at the American Indian Science and Engineering Society (AISES) regional conference.
- Host a professionalism day across the indigenous-serving schools which could be proposed as a Coding Day during which students could rotate through student-level coding activities (this is dependent on principal buy-in but could be very effective in reaching students)

4. Conclusion, limitations, and future work

This research paper shares some findings from the National Science Foundation (NSF) awarded project "Let's Talk Code" which aims to broaden the computer science participation of Indigenous teachers and learning of students in Indigenous-serving schools. Culturally relevant experiences have been an important factor for Indigenous populations and integrations in the curriculum. Here we focused on a subset of surveys conducted to understand teachers' experiences, specifically comparing pre-post professional training. Teachers and their students were provided with a questionnaire after completion of a professional development course. Findings reveal that students generally found the lessons their teachers created to be helpful and created confidence in their learning and interest in coding. The contribution of this work is in sharing some of the findings from the Let's Talk Code project and identifying areas of challenges and improvement for future work.

We should also acknowledge the limitations of this study. Prior work suggests that teachers hold thoughtful knowledge that can address areas of curriculum believed to neglect Indigenous students and their needs (Vaughn, 2016). Our survey questions could thus benefit from more direct prompts and observations of suggestions to make the data science curriculum more culturally relevant and holistic. Further, our current analysis does not utilize data from more diverse groups of rural and urban Indigenous-serving schools and does not compare the different types of PD programs (e.g., standard, cohort) that were conducted.

For the future, we aim to make more comprehensive and holistic data collections by making collection and use of student and teachers' feedback more continuous, effortless, and adaptive.

This may be achieved by using artificial intelligence conversational agents who may come to collaborate with the teachers and students and help humans share their concerns, motives, and goals in a more ongoing and transparent manner. Further, such agents may be instructed to evaluate curriculum from multiple aspects of data science content, culturally relevant experience considerations, academic integrity social well-being, and so on.

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