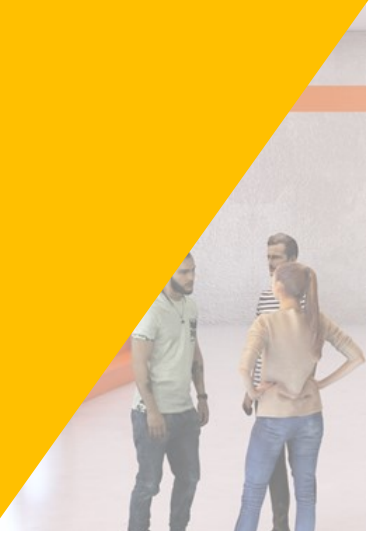

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Via Francesco Satolli, 30 – 00165 - Rome, Italy

Edited by

The Organizing Committee the 2nd International Conference of the Journal Scuola Democratica

https://www.rivisteweb.it/issn/1129-731X

Published by: ASSOCIAZIONE "PER SCUOLA DEMOCRATICA"

Via Francesco Satolli, 30 – 00165 – Rome, Italy

Published in Open Access

This book is digitally available at:

https://www.scuolademocratica-conference.net/proceedings-2/

How to cite a proceeding from this Volume. APA citation system:

Author, N., Author, S., (2021). Title, in *Proceedings of the 2nd International Conference of the Journal Scuola Democratica "Reinventing Education",* VOL. 2, *Learning with New Technologies, Equality and Inclusion,* pp-pp

978-88-944888-8-3

Co-Constructing and Sharing STEAM Knowledge through a Culturally Relevant Literacy-Based Early Childhood School-University Partnership

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ABSTRACT: *Through school-university partnerships that situate learning within culturally relevant educational experiences, faculty, preservice teachers, and school-based educators are able to co-construct and share scientific knowledge. This knowledge consists of pedagogical content knowledge and funds of knowledge that include both knowledge and skills developed in cultural context that have evolved historically. In early childhood education, culturally relevant Science, Technology, Engineering, Arts, and Mathematics (STEAM) learning experiences are particularly important for young children's cognitive and social emotional development. This paper describes how intentional co-planning and collaboration to celebrate the US Read across America Day provided over 100 preschool children in eight classrooms with access to STEAM lessons virtually led by university preservice teachers in partnership with educators in the school. These activities engaged children in exploring art, computer science, physical science, engineering, and mathematics within the context of a culturally relevant version of the fairy tale Goldilocks and the Three Bears. Lessons implemented as part of school-university partnerships support Black and Latinx children's development of a sense of belonging in STEAM. Further, these experiences enhance teacher candidates' abilities to engage in culturally responsive STEAM teaching while receiving ongoing guidance and education from university faculty and school-based educators. Teacher education programs within higher education institutions should embrace school-university partnerships as contexts for the development of shared scientific knowledge and discourse since the benefits are twofold. First, children and teachers gain access to, and engage with, innovative STEAM experiences. Second, preservice teachers learn culturally relevant research-based instructional strategies through university coursework situated in authentic learning experiences; thus, their learning as teacher candidates is enhanced through planning, implementation, evaluation, and critical reflection.*

KEYWORDS: *Culturally Relevant Education, Equitable Science Education, Early Childhood Education, School-University Partnerships, STEAM Education, Preservice Teacher Development.*

This work is being supported with funding from the National Science Foundation (CSforAll Award #2031394). Any opinions, findings, and conclusions or recommendations expressed in this materials are those of the authors and do not necessarily reflect the views of NSF.

Introduction

Increasing access to science, technology, engineering, arts, and mathematics (STEAM) education for Black and Latinx children requires collaborative frameworks across higher education institutions, schools, families, and community organizations. Collaboration that fosters culturally relevant scientific knowledge enriches the educational experiences of young children, teachers, families, and other community partners. Further, school and community-based experiences provide valuable opportunities for preservice teachers to develop teaching practices, especially in light of a growing emphasis on practice-based teacher education (Ball, Forzani, 2009).

1. Supporting Early and Equitable Access to Scientific Knowledge through School-University Partnerships

School-university partnerships that include early childhood teacher education programs and community-based preschools allow for the co-construction and sharing of scientific knowledge. Supporting early and equitable access to culturally relevant STEAM education within a partnership framework reduces some of the social and structural barriers that impede the development of scientific knowledge and sense of belonging among Black and Latinx children. Further, when STEAM education is taught in culturally relevant ways, there are improved outcomes for children from marginalized populations, including an increased interest in pursuing and obtaining scientific careers (Aronson, Laughter, 2016; Newton et al., 2020). In general, culturally relevant education means that teaching and curricula leverage cultural considerations from Black and Latinx children's homes, families, and communities as assets in supporting student learning to alleviate social and structural barriers (Ladson-Billings, 2009; Moll et al., 1992).

Successful partnerships are complex and require extensive time, long-term commitment, and clear communication. The mismatch between university-based and school-based experiences presents challenges because preservice teachers sometimes receive conflicting messages about teaching and learning in these different spaces (Zeichner, 2010). Partnership building involves the establishment of common goals between school and university faculty and staff. Goal development occurs across time and requires ongoing sharing of cultural norms, differing perspectives, and priorities (Tsui et al., 2009). Facilitating meetings that are accessible and encourage dialogue centered around shared decision-making ensures voices of teachers, faculty, preservice teachers, and families are considered in the building and implementation of partnership activities (Alfred, 2002). Preparing preservice teachers requires various stakeholders (e.g., teacher educators; families and

communities; classroom teachers) to work together towards a shared vision for teaching and learning (See, AMTE, 2017). When partnerships are designed thoughtfully and include shared goals for teacher education, they cultivate a series of intentional experiences that enhance the learning of preservice teachers (Darling-Hammond, 2017).

2. Field Experiences for Preservice Teacher Development

Effective teacher preparation programs approach preservice teacher development through school and community partnerships that prioritize diverse field experiences (Zeichner, 2010). These field experiences foster preservice teachers' knowledge of how professional decision-making is dependent on cultural contexts of the classroom, schools, and communities. Fieldwork should be embedded in content and methods-based courses offered early and often within university program curricula (Bornfreund, 2011). Teacher preparation programs with practice-focused curricula encourage preservice teachers to develop knowledge from action. Through authentic field experiences, preservice teachers are given opportunities to observe, implement, and receive constructive feedback on ‘high leverage practices’ that cannot fully be understood through coursework alone (Ball, Forzani, 2011). In early childhood STEAM education, high leverage practices include being able to identify patterns and trajectories of thinking, and common misconceptions that emerge, when children encounter experiences that foster new ideas about science, technology, engineering, arts, and mathematics (Ball, Forzani, 2011).

Within ongoing field experiences, preservice teachers should be provided with opportunities to educate culturally, ethnically, linguistically, and socioeconomically diverse children. These experiences, co-led by experienced school-based mentors and university instructors, support preservice teachers in identifying their own biases (Whitebook et al., 2009), developing culturally relevant pedagogy, and engaging in reflective practice. This type of professional development is especially critical in preservice teachers' acknowledgement of their own discriminatory profiles of children and families (Long et al., 2014). Acknowledging these profiles is a necessary step in the development of pedagogy that is rooted in equitable educational experiences for young children.

To support teacher candidates' emerging understandings about how children, families, neighborhoods, and communities are central to teaching and learning, field experiences should exist within a range of contexts, from individual classrooms to community-based organizations (Zeichner, McDonald, 2011). The COVID-19 pandemic reduced considerable numbers of school-university-community partnership activities and required many to move to virtual environments (Hodges et al., 2020). This resulted in the reduction or elimination of field

experiences, such as practicums and internships, for many preservice teachers, and highlighted the critical role fieldwork has in the development of preservice teachers (Choate et al., 2021). While an increase of virtual learning led to significant challenges, hybrid spaces can provide an alternative to traditionally disconnected university- and school-based experiences by building bridges between academic and practitioner knowledge, and show promise for bringing together various stakeholders in mutually beneficial ways (Zeichner, 2010).

3. The Evolution of a Culturally Relevant STEAM Partnership

Several common models for hybrid spaces exist that seek to bridge university-based and school-based experiences, including bringing teachers to campus or offering teacher education courses in schools (Zeichner, 2010). Our partnership work takes a different approach to closing the gap between university-based and school-based experiences. Namely, we strive to embed preservice teachers' school and community STEAM experiences in ways that are mutually beneficial for preservice teachers, teacher educators, school partners, and communities. In other words, we aim to develop collaborations that are grounded in models for community-engaged teaching and learning. Community-engaged teaching and learning is defined by the use of institutional (i.e., university) resources to address challenges facing communities (i.e., community-based preschools). More specifically, the resulting partnership must address needs defined by the community partners, integrate goals co-created by university and community partners for student (e.g. preservice teacher; preschooler) learning; utilize ongoing and critical reflection; situate learning within an authentic community setting; and clearly define reciprocal benefits for all partners (Doberneck, Snitgen, 2019).

Here, we describe the evolution of a community-engaged school-university partnership aimed at increasing access to culturally relevant STEAM education for Black and Latinx preschoolers in urban communities near the university. While this partnership also includes significant family and community involvement, we narrowed our focus here to emphasize how we supported preservice teacher development through intentional field-based curricula and co-constructed culminating events that were facilitated both in person and virtually.

3.1. Background

In 2017, Harper began collaborating with the East Tennessee STEM Hub (Hodge, 2019), a partnership of educational, business, scientific, and research organizations, that aims to promote STEM education regionally. Initial collaborations focused on providing opportunities for preservice teachers enrolled in elementary mathematics methods courses to gain field-based experiences that supported innovative mathematics teaching and learning. Towards that end, Harper designed a major course project

for a graduate-level, elementary mathematics methods course taken by preservice teachers seeking initial licensure in elementary/primary teaching, early childhood, and special education. The major course project supported preservice teachers to learn about STEAM resources in children's communities, to design an integrated STEAM lesson leveraging children's community and cultural experiences, and to facilitate that lesson at an informal family STEM event hosted by a local preschool or elementary school (for more details, see Harper et al., 2021a). The school-community-university partnership helped ensure sustainability of family STEM events and facilitated relationship-building between Harper and school partners, including Greene and a principal from a participating preschool. Accordingly, Greene and the principal requested that Harper and the East Tennessee STEM Hub help coordinate an event in 2019 to celebrate *Read Across America* at the preschool.

Read Across America is an annual event that was initiated in 1998 by the National Education Association (NEA). *Read Across America* is the largest annual celebration of reading in the US (Snider, 2021). Historically, this event was in celebration of the life and work of the children's book author Dr. Seuss, however, more recently the focus has shifted and the event has been dedicated to amplifying diverse voices and focusing more on inclusion (e.g., Gonzalez, 2021). *Read Across America* events and programming promote equitable access to literacy for all individuals and prioritize supporting children in the development of a sense of belonging in literacy through culturally relevant books and materials. While there are program activities that occur throughout the year, special events are held annually in early March.

To incorporate sustainable *Read Across America* events into the existing school-community-university partnership beginning in 2019, Harper developed a major course assignment for the undergraduate-level, elementary mathematics methods course taken by preservice teachers seeking initial elementary/primary licensure. For this course assignment in 2019 and 2020, preschool partners selected a focal text for STEAM lessons, prepared a space for the event, and created a rotation schedule so that all preschoolers could participate. Harper and preservice teachers prepared for the event by planning five STEAM integrated lessons that connected to the chosen text. In 2019, the school selected *The Three Little Pigs*; in 2020, they selected *Three Billy Goats Gruff*. Preservice teachers self-selected into five groups, and each group planned a lesson that integrated characters and events from the chosen story with an emphasis on one of the following content areas: science and mathematics; technology and mathematics; engineering and mathematics; art and mathematics; or mathematics. At the events in 2019 and 2020, preservice teachers and East Tennessee STEM Hub partners facilitated the lessons at stations (i.e., five lessons ran concurrently in a single classroom), and small groups of preschoolers rotated through the stations, spending approximately fifteen minutes on each lesson.

Following the event, preservice teachers revised their lesson plans based on their facilitation experience and published the lessons (Harper, 2021).

3.3 Redesigning Partnership Activities to Promote Sustainability

In 2021, the COVID-19 pandemic limited the ability to structure the collaboration as done previously in 2019 and 2020. As a result, we developed a new structure to guarantee sustainability of the partnership. Namely, the facilitation of the *Read Across America* STEAM event was adopted by the *Culturally Relevant Robotics: A Family and Teacher (CRRAFT) Partnership for Computational Thinking in Early Childhood* (Harper et al., 2021b). The CRRAFT Partnership was established to support computational thinking and a sense of belonging in STEM in early childhood. The project brings together university researchers and teacher educators across both STEM education (Harper) and early childhood education (Caudle, Quinn), administrators from the district and two partner preschools, teachers, an instructional coach (Greene), and Black and Latinx families. Situating the *Read Across America* STEAM events within the work of the CRRAFT Partnership allowed for restructuring of the collaboration by embedding the involvement of preservice teachers within early childhood teacher preparation and expanding the school partnership to include classroom teachers. The COVID-19 pandemic necessitated these changes, but in ways that promoted the continued success of the partnership endeavour.

FIG. 1. *Children participating in STEAM activities during Read Across America Event*

Through a collaborative effort in 2021, three university faculty, five early childhood preservice teachers, a preschool instructional coach employed by the school district, and 16 preschool teachers and educational assistants co-constructed and shared culturally relevant STEAM lessons. These lessons were taught to over 100 preschool children located in eight classrooms at a preschool in close proximity to the university. Due to the

COVID-19 pandemic, this event was facilitated through virtual and on-site teaching. Preservice teachers, university faculty, and the instructional coach co-taught the lessons virtually while teachers and teaching assistants facilitated the same lessons, at the same time, in the preschool classrooms.

Constructionism informed the development of the lessons. «Constructionism proposes that people learn better when provided with opportunities to design, create, and build projects that are personally and epistemologically meaningful» (Bers, 2008, 16). The lessons focused on computer science, physical science, engineering, and mathematics activities within the context of a culturally relevant version of the fairy tale *Goldilocks and the Three Bears*, written and illustrated by John Kurtz (2004). This version of the fairy tale follows the traditional storyline, but presents Goldilocks as a young Black girl who is called Goldilocks because of the gold beads she wears in her hair. This modification helped make the story more culturally relevant for the preschoolers given that 90% of the student population is Black, and Harper knew from previous interactions that the young girls at the preschool often wore beads in their hair (also see Fig. 1). Accordingly, using this particular version of the fairy tale affirmed preschoolers' racial and cultural backgrounds as assets in the story, which aligns with a key tenet of culturally relevant pedagogy (Ladson-Billings, 2009). The STEAM lessons were integrated and provided opportunities for children to sort bear parts to create different sized bears, use robot mice to navigate through a coding map of the bears' cottage, sort items into soft or hard sensory bins, and design a bed that would be sturdy enough for Goldilocks (Harper et al., 2021c). Each lesson included a focus on four Tennessee Early Learning Developmental Standards (2018a). The lessons positioned children as creators by prioritizing problem-solving, collaboration, and expression (Bers, 2021), which also aligns with the tenet of culturally relevant pedagogy that emphasizes student learning and achievement (Ladson-Billings, 2009). While using the robots and engineering beds, children were asked key questions to encourage design thinking and critical reflection: (1) Why was it important to make a plan first?; (2) What kinds of changes did you have to make? Why?; (3) How did you make those changes?; and (4) What worked for you? In the other two lessons that involved sorting and categorizing, children were encouraged to share their artwork and describe what made their chair ‘just right‘ for them or why they made the bears certain sizes. The classroom interactions within these lessons led children to share about both the process and products of their STEAM learning.

The preservice teachers worked with university course instructors to prepare the materials and practice the lessons. Before the lessons were facilitated, the materials were delivered to each classroom and the teachers spent time reading and discussing the focal book with the preschool children. Preservice teachers and university instructors virtually introduced each lesson and the preschool teachers and

educational assistants supported the children in using the materials. The preservice teachers, instructors, instructional coach, teachers, and teaching assistants asked questions and engaged with the children throughout the lessons. The preservice teachers were encouraged to be responsive in ways that extended the children's thinking and supported a sense of belonging in scientific learning.

4. Discussion

Taking a community-engaged approach to partnership work benefits university preservice teachers, practicing preschool teachers, and preschool children in mutually beneficial ways. Planning lessons that integrate and promote problem-solving, creativity, collaboration, and analytical and computational thinking among young children helps prepare preservice teachers to meet the demands of innovative and integrative STEM teaching. Simultaneously, these experiences alleviate the challenge practicing teachers face when asked to supplement required curriculum and celebrate special events. Further, preservice teachers benefit from implementing their lessons in an authentic, yet supportive, co-teaching environment (Harper et al., 2021a), which simultaneously provides preschool children and their teachers opportunities to make meaningful STEM connections. These mutual benefits also align with the current push in Tennessee for full integration of STEM education in schools as a way to ensure that all children, particularly those from economically disadvantaged backgrounds or minoritized racial/ethnic groups, can take advantage of vast opportunities in STEM fields. Namely, this partnership targeted three priority areas identified by the state's strategic plan (Tennessee Department of Education, 2018b): (1) the integration of state science and mathematics standards with STEM practices; (2) development of teachers' capacity for STEM integration in classrooms; and (3) community and postsecondary partnerships that provide meaningful STEM connections for students.

Research into community-engaged teaching and learning shows the multiple benefits experienced by students (i.e., preservice teachers), community partners (i.e., preschool teachers and students), and the institution (i.e., university); however, numerous challenges also arise in partnership work situated within university courses (Littlepage, Gazley, 2013). We have outlined many of the benefits of this specific partnership above, including preservice teachers' professional growth; the preschool's access to new technologies and resources from the university; and more efficient teacher preparation at the university. We also wish to acknowledge that several challenges arose in sustaining and redesigning this partnership, and we close by providing some insights into how we addressed those challenges or plan to do so in the future. Anticipating and proactively addressing challenges allows all partners to prioritize sustainability when planning partnership work.

Preservice teachers found managing the necessary commitments (e.g., planning lessons, preparing materials, practicing lessons) difficult, and many expressed anxiety about teaching in the new (i.e., virtual) setting. To ease the first challenge, we sought to integrate the necessary commitments into the course curricula as much as possible, using some class time to prepare materials and practice lessons. We had originally planned for preservice teachers to design and plan the lessons themselves, as we had done in 2019 and 2020; however, the 2021 preservice teachers were earlier in their university coursework and less experienced in school classrooms due to COVID-19 restrictions. Therefore, we decided Harper would plan the lessons instead, and we continued to offer mentorship from experienced university educators during lesson implementation. Preservice teachers were joined by university educators for the virtual lesson facilitation, but we found that the preservice teachers needed little assistance. Instead, the classroom teachers and educational assistants offered most of the necessary support and mentorship.

Involving classroom teachers actively in the facilitation of the lessons also helped address a sustainability challenge faced by the preschool and the university, namely the pedagogical demands of extending culturally relevant, integrated STEAM opportunities beyond the isolated partnership event and securing funding to provide resources for future events. We sought to address these concerns by providing open virtual access to the STEAM lessons developed in our partnership activities, from this year and previous events, in order to allow for ongoing use among teachers, children, and families, not only in our local communities, but within communities around the world. Early childhood teacher educators also have the option to integrate these lessons into their curricula and field experiences. An additional advantage of using lessons designed by Harper in 2021 was that lessons were intentionally planned to use low-cost, readily-available materials (e.g., loose parts; printed materials), with the exception of the robot mouse for the computer science activity.

We found that integrating partnership work into the university teacher preparation curriculum, sharing outcomes of partnership work freely and publicly, and intentionally attending to barriers, such as cost and resources, help maintain the school-university partnership without relying on the involvement of specific individuals. By emphasizing reciprocity and sustainability, the rich opportunities for the co-construction and sharing of scientific knowledge we have described here will endure year after year. Looking forward, we continue to engage in continuous improvement as we seek ways to disseminate this knowledge in ways that are more accessible and culturally relevant for all young children and their families.

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