PDS PARTNERS

BRIDGING RESEARCH TO PRACTICE

A journal of the

National Association for Professional Development Schools

NAPDS

PREPARE. DEVELOP. INQUIRE. LEARN.

PDS Partners:
Bridging Research to Practice

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Volume 17, Issue 2
Summer 2022
Guest Edited Online Themed Issue
Leveraging School-University Partnerships for Student Learning and Teacher Inquiry

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The Nine Essentials, Second Edition

Essential 1: A Comprehensive Mission

A professional development school (PDS) is a learning community guided by a comprehensive, articulated mission that is broader than the goals of any single partner, and that aims to advance equity, antiracism, and social justice within and among schools, colleges/universities, and their respective community and professional partners.

Essential 2: Clinical Preparation

A PDS embraces the preparation of educators through clinical practice.

Essential 3: Professional Learning and Leading

A PDS is a context for continuous professional learning and leading for all participants, guided by need and a spirit and practice of inquiry.

Essential 4: Reflection and Innovation

A PDS makes a shared commitment to reflective practice, responsive innovation, and generative knowledge.

Essential 5: Research and Results

A PDS is a community that engages in collaborative research and participates in the public sharing of results in a variety of outlets.

Essential 6: Articulated Agreements

A PDS requires intentionally evolving written articulated agreement(s) that delineate the commitments, expectations, roles, and responsibilities of all involved.

Essential 7: Shared Governance Structures

A PDS is built upon shared, sustainable governance structures that promote collaboration, foster reflection, and honor and value all participants' voices.

Essential 8: Boundary-Spanning Roles

A PDS creates space for, advocates for, and supports college/university and P–12 faculty to operate in well-defined, boundary-spanning roles that transcend institutional settings.

Essential 9: Resources and Recognition

A PDS provides dedicated and shared resources and establishes traditions to recognize, enhance, celebrate, and sustain the work of partners and the partnership.

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Do Partnerships Matter? The Need to Examine the Influence of Partnerships on Student Learning ad Teacher Inquiry

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Abstract: In the introduction to this themed issue of *PDS Partners: Bridging Research to Practice*, the Editors provide a rationale for individuals who are engaged in school-university partnership work to research and share their results related to the impact of partnerships on teaching and learning. The Editors also provide an overview to each of the articles in the themed issue.

KEYWORDS: mutually beneficial partnerships, professional development schools, reflective practice, school-university partnerships, student learning, teacher inquiry, themed issue

NAPDS NINE ESSENTIALS ADDRESSED:

1. A professional development school (PDS) is a learning community guided by a comprehensive, articulated mission that is broader than the goals of any single partner, and that aims to advance equity, antiracism, and social justice within and among schools, colleges/universities, and their respective community and professional partners.
3. A PDS is a context for continuous professional learning and leading for all participants, guided by need and a spirit and practice of inquiry.
4. A PDS makes a shared commitment to reflective practice, responsive innovation, and generative knowledge.
5. A PDS is a community that engages in collaborative research and participates in the public sharing of results in a variety of outlets.

Rationale for the Themed Issue

Welcome to our themed issue of *PDS Partners: Bridging Research to Practice*. The focus and title is School-University Partnerships to Support Student Learning and Teacher Inquiry. The issue includes 11 manuscripts that explore how school-university partnerships advance teaching and learning by supporting teacher inquiry and positively impact student learning. Scholars have called for research and examinations of how school-university partnerships can improve teaching and also influence student learning (Polly, 2017; Putman & Polly, 2021; Ridley et al., 2005; Tunks & Neapolitan, 2007).

Our hope is that this special issue helps to move the conversation forward to critically examine the question, Do Partnerships Matter? We ask this question in the current context of education with teacher shortages across the nation and a drastic increase in schools hiring unlicensed, lateral entry teachers, who are also called residents. Two years removed from the beginning of COVID-19 unfinished learning is plaguing schools and school districts, and school leaders are prioritizing actions and projects that are likely to improve student learning. That brings up the idea of school-university partnerships. If those of us who primarily work in teacher education programs wish to continue to have mutually beneficial partnerships with school partners in Pre-Kindergarten to Grade 12 (PK-12), there is a need to document and disseminate research studies and success stories of school-university partnerships.

The Second Edition of the NAPDS Nine Essentials (NAPDS, 2021) includes a specific focus in Essential 5 related to engaging in collaborative research and sharing the results in a variety of results. A critical time has arrived for those of us involved in partnership work to be more deliberate and intentional about conducting research and evaluation of our studies and sharing the results with the broader educational community. Will you join us in this important work?

Description of the Articles

Section 1: Innovations in School-University Partnerships

The first five articles in this issue examine supporting school discipline through a restorative, wraparound approach, transforming a school into an inquiry-based school, preparing pre-service teachers to engage in family-centered practices and collaborations, building sustainability through collaborations and partnerships, and leveraging practice-based teaching to support teacher candidate growth. We begin with Hart and Butler sharing mitigation strategies for racial disparities in schools and reimagining the partnerships between school, university, and community. The authors show how using a Dual Capacity-Building Framework for Family-School Partnerships, originally developed by Karen Mapp can sustain, heal, and promote positive relationships. The next article in the special issue is from Stork, et. al and it examines the designing of an innovation school that transforms a traditional school into an inquiry-based school. Stork and colleagues enacted a categorial analysis of the perspectives shared by the School University partnership participants that worked collaboratively to design the school. In the following article, McCorkle, Jennings, and Cloninger provide context and overview for the importance of clinical experiences and partnership support for pre-service candidates to develop the skills needed to implement research-based practices for engaging families. In the next piece, Sterrett et al. illustrate the work of a school-university partnership using the three green pillars,

defined by the U.S. Department of Education Green Ribbon Schools award designation, to support sustainability education. In the fifth article, Polly and Colonnese share the work of two mathematics teacher educators implementing practice-based teacher education in their mathematics methods courses and discuss implications for future partnership work.

Section II: School-University Partnerships in the Context of COVID-19

The next section of this special issue includes three pieces that focus on student engagement and STEM learning within the context of the pandemic. Peña, Benitez Hemans, and Susholtz share a teaching collaboration that occurred during the COVID-19 pandemic. The collaboration was an ELA-art-mindfulness project that occurred before and during the pandemic. The authors share the takeaways from the work and plans for future collaborations. Wieselmann, Sager, and Binford highlight adaptations their school-university partnership made during the COVID-19 pandemic to engage students in a six lesson, integrated science, technology, engineering, and mathematics (STEM) unit that was built for hybrid use. Wieselmann and colleagues discuss the lessons learned and implications. Ding et al. share the impact of their university partnership with the area's school district and non-profit organizations to address the US Department of Education's call to provide learning recovery from the significant learning disruption caused by the COVID-19 pandemic. They designed and are continuing to implement a collaborative project to support in-service and pre-service teacher candidates in using game-based learning, revising curricula, and attending to instructional effectiveness in middle school science classrooms.

Section III: School-University Partnerships in Mathematics and STEM Education

The next three articles in the special issue focus the work of school-university partnerships specifically in Science, Technology, Engineering, and Mathematics (STEM) Education. Selmer and Lindstrom present their work on teaching responsively in the mathematics classroom. Within a professional development school, their study analyzes the pedagogical reasoning of experienced teachers' analysis of students' mathematical written work. They note that the responses fell across a continuum of responsiveness and offer implications for how to use these approximations of practice to develop instructional practices. In the next piece, Swars and colleagues detail a 5-year project of supporting elementary teachers as Elementary Mathematics Specialists (EMSs). The authors provide context, professional development design, and discussion around how the project supports the partnership in mutually beneficial ways. The final piece of our special issue offers insight on the experience of developing a shared instructional vision to develop a new STEM focused prekindergarten (pre-K) through eighth-grade public school. Wilhelm, Gravell, and Pinilla discuss the rounds of activity that supported the creation of an instructional vision. The collaboration included a partnership between a university, a school district, an international company with a local presence, and a community that would support and be supported by a research-practice partnership over an extended time.

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Section I: Innovations in School-University Partnerships

Reimagining Wraparound Supports to Address School Discipline: A Restorative Approach

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Abstract: In this article, the authors explore how educators might mitigate racial disparities in school discipline by reimagining school-community-university partnerships through restorative wraparound supports aimed at addressing the social-emotional wellness of students and teachers in urban schools. Using the Dual Capacity-Building Framework for Family-School Partnerships, originally developed by Karen Mapp, we demonstrate how urban schools can develop strong, trusting, and sustainable partnerships with teacher preparation programs and community mental healthcare providers to promote healing and build positive student-teacher relationships that help foster more inclusive and equitable classrooms for students of color.

KEYWORDS: urban education, wraparound services, school discipline, restorative approaches

NAPDS NINE ESSENTIALS ADDRESSED:
Essential 4: Reflection and Innovation—A PDS makes a shared commitment to reflective practice, responsive innovation, and generative knowledge.

Essential 8: Boundary-Spanning Roles—A PDS creates space for, advocates for, and supports college/university and P–12 faculty to operate in well-defined, boundary-spanning roles that transcend institutional settings.

Reimagining Wraparound Supports in Urban Schools

One of the most important functions of a school is to meet the varying needs of students academically, physically, and socially/emotionally. In the United States, differences in school contexts are glaring, widely noticeable, and widely discussed. Long before, and since, the pandemic urban communities, students, and schools in particular have become a topic of great interest and inquiry. Scholars have studied the many variables that have both positive and negative impacts on students, their achievement, families, and the broader community. When we typically think of the term *urban education* most people think only of Black students. However, urban schools as Milner (2012) articulates, are much more nuanced. He suggests that the characteristics of urban schools are also connected to the "people who live and attend school in the social context, the characteristics of those people, as well as surrounding community realities where the school is situated" (p. 558). The plight of urban education has been well documented for decades (Children's Defense Fund, 1975; Landsman & Lewis, 2012; Kozol, 1991; Shaffer et al. 2018). While we recognize that there are many wonderful things happening in urban schools across the country, this article seeks to explain how educators can address the gaps in opportunity, achievement, discipline, and other various outcomes that plague urban schools and students by reimagining school-community-university partnerships through restorative wraparound supports.

The premise of this idea was developed in a doctoral seminar where I (the first author), along with several of my colleagues, engaged in conversations facilitated by the instructor (the second author) around power, privilege, and identity, and their impact on education. In this class, we collectively deconstructed concepts like whiteness (Anderson, 2020; Kendall, 2013), while also exploring the history of Black education (Anderson, 1988), racial inequities in school discipline (Losen, 2015), LGBTQ+ youth narratives (Mayo, 2014; White, 2015), and culturally sustaining pedagogies (Paris & Alim, 2017) and the ways in which each has influenced students' schooling experiences in urban settings. Amongst our cohort were classroom teachers, social workers, community organizers, and higher education administrators. We all came from varying backgrounds, having a diverse set of professional experiences and expertise. Empowered to address some of the challenges that plague urban schools, we began to conceptualize ways in which the educational challenges named above could be critically examined and ultimately dismantled. The diversity and breadth of our individual knowledge, coupled with our lived experiences, allowed us to think strategically around how each of our fields of professional practice could contribute to the literature on best practices for urban schools. We embarked upon co-constructing a framework that would examine wraparound services to reimagine their functionality as a school-community-university partnership that joins together university researchers, community professionals, and school educators to leverage their collective expertise in tackling racial disproportionality in school discipline through restorative practices.

To begin, this article seeks to review the extant literature around topics that have the potential to improve the schooling experiences of students in urban schools, particularly as it relates to the overrepresentation of Black students in school discipline. Research on the context of urban schools, teacher education, school discipline, social-emotional learning, and mental health services is extensive, and well-documented individually. However, there is limited understanding of how these scholarly areas work in tandem, in a practical way. The purpose of this article is to offer a developing conceptual framework that demonstrates how scholars, district

leaders, school staff, and community professionals can work together to support students' academic, behavioral, social, and emotional growth and development.

Literature Review

What is Urban Education?

Milner (2012) shares an anecdote of his visit to a small Midwestern school district to speak with district leaders and staff about "culture and teaching." When he arrived at the district office, the superintendent took him to visit what the district considered to be an *urban* school. Once they arrived at the school, the school was located in a rural setting not far from the district's central office. The population of the school was predominantly Black and Latinx. Some of the challenges of the school were low test scores, absenteeism, lack of motivation, and inconsistent parental involvement.

Milner (2012) shares this story for many reasons; most importantly, to underscore the need to have a common understanding and definition of "urban" education and schools. He provides a typology through which scholars and practitioners can discuss urban educational environments. The term *urban intensive* is used to discuss schools that are located in large cities such as New York, Los Angeles, Chicago, or Atlanta. *Urban emergent* areas are large, but not quite as large as those in urban intensive areas. Cities in this frame include Nashville, Tennessee; Charlotte, North Carolina; and Austin, Texas. Finally, schools that have *urban characteristics* describe those that are not located in large or medium-sized cities but may be experiencing similar challenges that may be associated with schools in larger, urban, or urban emergent areas. While these schools may be located in suburban or even rural communities, some of the challenges they may face include an influx of culturally and linguistically diverse students, or scarcity of resources to support schools and the community.

School Discipline Practices in Urban Schools

Disproportionality in school discipline is not new. In fact, over at least the past four decades, scholars have examined the disproportionate representation of Black students and school discipline (Taylor & Foster, 1986; Townsend, 2000). This gap was first discussed in 1975 by the Children's Defense Fund (CDF), which found: 1) during the 1972-1973 school year, more than one million students were suspended, and 2) one out of every eight African American students were suspended, compared to one out of every 16 White students, at least one time in that same school year (CDF, 1975). Since the publication of this seminal report, studies have continued to document the disparities in school discipline relative to gender, race, and grade level (Blake et al., 2015; Butler et al., 2012; CDF, 1975; Farinde-Wu, et al., 2022; Lewis et al., 2010; Skiba et al., 2002).

Under the administration of President Obama, new guidelines were issued around school discipline policies and practices. In 2014, both the U.S. Departments of Education and Justice worked to establish new guidelines that sought to eliminate disparities in school discipline practices. These policies were intended to be applied in ways that avoid discrimination against students on the basis of race, ethnicity, and/or gender (Blad, 2014). These guidelines also expected school leaders to find alternatives to exclusionary practices that strip students of valuable instructional time, such as suspensions. While the extent to which these guidelines have

impacted students and educators' practice is still unclear (Sanchez & Turner, 2017), the new guidelines turned national attention to a longstanding concern in urban schools.

To address this critical issue, schools, districts, and states have employed a number of strategies. These alternative practices take the form of policy and/or program-based interventions. Program-based interventions are often tailored to students' needs, and interventions can be adjusted depending on student responses (Steinberg & Lacoe, 2017). Examples of program-based interventions include the Response to Intervention (RTI) model, Schoolwide Positive Behavioral Interventions and Supports (PBIS), and the use of School Resource Officers (SROs). Steinberg and Lacoe (2017) also noted that, conversely, some reforms require changes in educational policy that help guide districts, teachers, and schools in their efforts to address student behavior. Examples of policy-based interventions include zero-tolerance mandates and student codes of conduct.

These types of policies and programs have largely contributed to what we widely call the school-to-prison pipeline. School districts and the juvenile justice system were not intended to work in tandem. However, over many decades, this correlation has become even more apparent—particularly to the detriment of some of the most vulnerable students (Mallett, 2015; Nicholson-Crotty, et al., 2009). The school-to-prison pipeline is "best understood as a set of policies and practices in schools that make it more likely that students face criminal involvement with juvenile courts than attain a quality education" (Mallett, 2015, p. 15). In a report by the Advancement Project et al. (2011), the pipeline operates both directly and indirectly. For example, in a direct way, schools adopt and misapply many zero-tolerance school discipline policies. Consequently, by criminalizing several disciplinary infractions, students are directly placed in the juvenile justice system. Indirectly, and likely more detrimental, are the policies and practices that stifle students' access to high-quality, culturally relevant/responsive practices, and engaging instruction (Gay, 2002; Ladson-Billings, 1995). These policies and practices may cause students to become disengaged in school through suspensions, expulsions, and/or dropout.

Teacher Education and Preparation for Urban Schools

In 2018, there were approximately 26,000 teacher education state-approved programs in the United States (Kuenzi, 2018). Of those programs, about 70% are considered traditional programs. That is, "they are contained within schools of education at institutions of higher education" (Kuenzi, 2018, p. i). The majority of teacher education programs utilize a similar curriculum and process for preparing their candidates for the classroom. Candidates are engaged in classes led predominantly by White faculty, complete field or clinical experiences in predominately White schools, and participate in student teaching for a sustained period of time typically under the supervision of White clinical educators (Grant, 1994; Talbert-Johnson, 2006; Weinstein et al., 2004). While state agencies of education most often control what is taught (i.e., curriculum) in teacher education programs, the schools and colleges of education design the ways in which they engage (i.e., instruction/pedagogy) students. Using current scholarship, practice, and policy around how K-12 students learn best, teacher education faculty design curricula to respond to those ever-changing needs (Kuriloff et al. 2019).

While the literature around the influences of teacher preparation programs on teacher performance and student achievement are neither well documented nor widely studied, there is evidence supporting the value of certain components of a teacher education program (King &

Butler, 2015; Darling-Hammond, 2006). Recent studies have highlighted the importance of many factors that can contribute to teachers being prepared for and successful in urban settings. Factors such as high-quality field experiences in diverse settings, service-learning, lab schools, critical consciousness in pre-service candidates, knowledge of asset-based pedagogies, and candidate identity development have been identified as components of teacher education programs that have the potential to set students up for success when they serve in urban school settings (Grant, 1994; Schauer, 2018; Talbert-Johnson, 2006; Villegas & Lucas, 2002).

The Dual Capacity-Building Framework for Family-School Partnerships

Over the last few years, schools and districts across the country have focused on fostering greater family engagement as a critical role in education reform. To further address this, Drs. Karen Mapp and Paul Kuttner (2013) designed the *Dual Capacity-Building Framework for Family-School Partnerships*. Mapp and Kuttner described the framework as "a scaffold for the development of family engagement strategies, policies, and programs" (p. 6). The framework is not a set of directions or even a blueprint stakeholders can use to plan programs and initiatives, but rather it serves as a compass "laying out the goals and conditions necessary to chart a path toward effective family engagement efforts that are linked to student achievement and school improvement" (p. 6). The Dual Capacity Framework includes four primary components that are essential to building effective and meaningful family-school partnerships. These components are:

- A description of the *capacity challenges* that must be addressed to support the cultivation of effective home-school partnerships;
- An articulation of the *conditions* integral to the success of family-school partnership initiatives and interventions;
- An identification of the desired intermediate capacity *goals* that should be the focus of family engagement policies and programs at the federal, state, and local level; and
- A description of the capacity-building *outcomes* for school and program staff as well as for families.

Adapting the Dual Capacity Framework as a Restorative Wraparound Approach for School Discipline

The Dual Capacity Framework has the potential to foster family-school partnerships in meaningful ways which can improve many outcomes for students and their families. The same could be true of an adapted Dual Capacity Framework designed to build and strengthen school-community-university partnerships to address racial disproportionality in urban schools. There are many factors that may lead to students engaging in behaviors that are not consistent with school and district norms and expectations. Through a reimagined wraparound approach , redesigning what wraparound services look like in practice has the potential to support all students, especially Black students. The four components discussed in the Dual Capacity Framework for Family-School Partnerships can be adapted to reflect the needs of schools and students relative to school discipline. For example:

- There are many challenges that serve as the antecedent for many behavioral challenges. Identifying these *challenges* through restorative processes, designed to improve intercultural communication and mitigate conflict, is a critical component of this reimagined approach to wraparound services. If the challenges are appropriately

identified, service providers could work with schools to provide culturally responsive, evidence-based support and interventions.

- Likewise, optimal *conditions* for school discipline are critical. Creating a school climate and culture that promotes community building, positive student-teacher relationships, a safe learning environment, and equitable responses to student misbehavior is integral. Partnerships between schools, community diversion programs, and school discipline scholars could help to establish alternative responses to exclusionary and punitive discipline practices.
- Clearly identified and socialized *goals* are equally important. It is critical to ensure that everyone (students and their families, schools, and the community) is working in tandem toward the same goal, with the same expectations. For instance, within this adapted model, it is a reprehensible practice to use 3rd-grade reading scores from standardized assessments to determine where to build prisons (Mid-South Literacy, 2016).
- Finally, identifying and articulating expected and anticipated *outcomes* of student behavior serves as an important accountability measure for all stakeholders. Becoming more asset-focused, that is recognizing the resources of students, families, and surrounding community and using this knowledge to create more inclusive learning environments, will work to improve student achievement, reduce suspensions and expulsion, and lower dropout rates.

There are also other components to be considered such as ensuring academically rigorous classrooms, the role of teacher education and preparation programs, social-emotional learning, and mental health services. Mapp and colleagues (2017) share a number of strategies that, if leveraged intentionally and deliberately, will help reshape how families engage with schools. Similar strategies can be employed to support how these relationships can be extended to the community (schools to community) and then from the community to researchers and faculty (community to universities) in their efforts to close the school discipline gap, and ultimately dismantle the school-to-prison pipeline.

Recommendations for Practice

Recommendations for Teacher Education

Teacher education and preparation programs (EPPs) play one of the most important roles in ensuring that teachers are prepared to serve as classroom teachers. The onus is largely on these programs to help candidates obtain the necessary knowledge, skills, and dispositions needed to be successful in all classrooms, most notably those which are becoming increasingly diverse. With regard to the adapted framework for restorative wraparound supports used to address school discipline, EPPs will serve a vital role. First, it is critical that programs produce candidates who are culturally responsive. While the majority of teachers are White, middle-class, monolingual English speakers, this is not representative of the student population in many schools today, as students of color currently represent the numerical majority in public elementary and secondary schools (Hussar et al., 2020; Irwin et al., 2021). EPPs should work to gain an understanding of where, and in what ways, they engage their students in the work of building cultural competence around culturally responsive and restorative practices.

Likewise, it is equally important that EPPs ensure that their candidates are regularly in high-quality field experiences in multiple, diverse settings. This practice not only gives candidates the opportunity to see students at different levels, but also allows them to see the policies and practices that contribute to student misconduct, and how veteran teachers respond. Another critical aspect of this framework, relative to teacher education, is the understanding that faculty members remain engaged in K-12 schools. The research-to-practice gap is widening steadily. This may further perpetuate a disconnect between teacher education faculty and K-12 schools. (Re)building intentional relationships between universities and schools and school districts is vitally important in our adapted Dual Capacity framework.

Recommendations for School Districts

This type of work will require schools and districts to reflect intentionally and deliberately on their current realities. Staff should examine school discipline data through a critical lens, cogitating on what the data indicates and how this shows up in schools. The Office of Civil Rights dataset, which collects national discipline data and disaggregates the data by state, school district, and school, would be particularly useful in understanding the degree of racial disproportionality in exclusionary discipline practices. Likewise, a thorough review of policies and practices will be required. Restorative, rather than punitive, practices have been known to be more effective in decreasing racial disparities in school discipline (Jain et al., 2014). Furthermore, school districts should also begin the process of co-creating goals and expectations with students and their families, educators, community professionals, and researchers. Once these goals have been established, consistent progress monitoring should be employed as an accountability mechanism to ensure that these collective goals remain at the forefront of education. Co-constructive efforts might include facilitating professional development for educators by university faculty, engaging students and families in creating new discipline policies, and working to ensure that the school climate and culture are equitable for student success.

Discussion

Racial disparities in exclusionary school discipline practices, and reform efforts to address them have been long documented (Children's Defense Fund, 1975; Hess, 2011; Vincent et al., 2015). Studies over the last four decades have placed a keen focus on marginalized populations of students—namely, students of color and those experiencing poverty—seeking to better understand why and how these disparities in suspensions exist (Lewis et al., 2012; Lustick, 2021; Nolan, 2011). From government initiatives to school and district-level programs and policies, many stakeholders have attempted to close the school discipline gap and provide alternatives to suspensions and expulsions through restorative practices (Gbolo & Grier-Reed, 20219; Losen, 2015; Steinberg & Lacoe, 2020). While some have experienced varying levels of success, the need for a more robust, sustainable, and practical approach is evident.

In silos, scholars from several fields have shared studies that examine school discipline data, practices, and policies that offer solutions, of some sort, to address the disparities in exclusionary practices (Lewis et al., 2010). A framework–in which several areas of research and practice intersect– to address school discipline in urban schools has the potential to not only impact students while they are in schools but can change the trajectory of their lives and society

as a whole. Such a framework, grounded in culturally responsive approaches and restorative philosophies, would draw on literature, best practices, and cross collaborations from mental health professionals, educators, community leaders, schools/colleges of education, and others to find intentional ways to 'wrap around' students and their families, building strong school-community-university relationships in which students, particularly Black students, can thrive.

What Does (Could) This Look Like?

At present, such implementation does not exist in totality, however there are examples of researchers, practitioners, and communities engaging in portions of this work in singular ways. In an ideal world, a partnership would be established between a College of Education (CoEd), a local school or district, and the community. Leaders from all groups would engage in conversations to understand the needs of each other, and how they can work collaboratively to ensure that their efforts support students, teachers, and the local schools. The following are examples of what these collaborative partnerships could look like in practice:

- The CoEd and school district leaders can work to intentionally prepare teacher candidates (both graduate and undergraduate) for 21st-century classrooms but equipping them with the knowledge, skills, and dispositions to be culturally responsive teachers, and ensuring that candidates have diverse, high-quality placements to engage in clinical practice.
- CoEd faculty, community leaders/experts, and school district leaders co-facilitating professional development sessions for both teacher candidates, school staff, and families around topics of mental health supports for teachers and students, restorative practices, and family-school partnerships.
- All stakeholders engaging in relationship and trust-building activities to understand the assets, current reality, and challenges faced by each institution. These activities should all center the ways in which the groups can work to support schools and students address school discipline challenges.

Conclusion

Through a careful and thoughtful review of the extant literature around school discipline, we find that there have been many efforts to address the disparities in exclusionary sanctions in urban schools. These efforts, facilitated by schools, government initiatives, and other stakeholders show effectiveness to varying degrees. Stakeholders have turned to programs—such as PBIS—to support their efforts in addressing this critical issue (Benshoff, et al., 1994). Some have turned to policies–such as zero-tolerance– in hopes to create ideal classroom environments (Camacho & Krezmien, 2019). However, the disparities remain and, therefore, a more comprehensive approach to address these disparities has the potential to begin closing the school discipline gap. We have sought to introduce school-community-university partnerships, through an adapted version of the Dual Capacity Framework, to propose a further examination of a restorative wraparound that works towards addressing racial disparities in school discipline. Through this approach, we introduced and discussed best practices that educators, community professionals, and university faculty could leverage in their collective efforts to close the school discipline gap and ultimately dismantle the school-to-prison pipeline.

Author Bios

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Designing an Innovation School: Perspectives from a School-University Partnership

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Abstract: Members of an Innovation School committee from Florida Gulf Coast University and the School District of Lee County share their individual and collective perspectives on designing a new traditional public school as an inquiry-based innovation school through an articulated partnership. Perspectives are shared through the lens of narrative inquiry and combined through a categorial analysis. This paper focuses on the essentials the themes from our shared perspectives have addressed to date. Narrative expressions are used to identify the accelerators, barriers, and next steps.

KEYWORDS: design-based research, innovation, inquiry-based, literacy, professional development schools, student agency, school-university partnerships

NAPDS NINE ESSENTIALS ADDRESSED:
Essential 1: A professional development school (PDS) is a learning community guided by a comprehensive, articulated mission that is broader than the goals of any single partner, and that aims to advance equity, antiracism, and social justice within and among schools, colleges/universities, and their respective community and professional partners.

Essential 2: A PDS embraces the preparation of educators through clinical practice.

Essential 3: A PDS is a context for continuous professional learning and leading for all participants, guided by need and a spirit and practice of inquiry.

Essential 4: A PDS makes a shared commitment to reflective practice, responsive innovation, and generative knowledge.

Essential 5: A PDS is a community that engages in collaborative research and participates in the public sharing of results in a variety of outlets.

Introduction

In August 2018, Florida Gulf Coast University (FGCU) and the School District of Lee County (SDLC) executed a Memorandum of Understanding (MOU) which articulated a shared understanding of the need to create a contemporary innovation school to develop, demonstrate, and cultivate new ways of learning. The impetus for the Innovation School was driven by a collective vision to create "a superb laboratory to experiment with the initiatives designed to improve student achievement" (Levine, 2006, p. 106). The goals of the PK-8 Innovation School include learner-centered, inquiry-based learning experiences where students have opportunities to become confident individuals, creative innovators, socially responsive problem-solvers, ethical entrepreneurs, and insightful leaders who thrive in an increasingly technological world. The MOU also specifies that the innovation school will serve as the primary Professional Development School (PDS) for the region to support in-service and pre-service teachers, school and district-level leaders, and teacher education and educational leadership faculty for continuous improvement in their research-based practices. The Innovation School is expected to become a model that can be replicated throughout the school district and in other educational settings across the state and nation. The Innovation School is scheduled to open at the beginning of the 2025-2026 school year.

In this paper, members of an Innovation School committee from FGCU and the SDLC share our individual and collective perspectives on our journey to date for designing a new traditional public school as an inquiry-based innovation school through an articulated partnership. Our perspectives are shared through the lens of narrative inquiry, combined through a categorial analysis where themes have been abstracted from the completed stories (Beale, 2013, as cited in Merriam & Tisdell, 2016). We share our stories as well as our actions and doings in our committee work, all of which are narrative expressions (Clandinin & Connelly, 2000). These narrative expressions guided us to discover the themes aligned to the National Association of Professional Development Schools Second Edition of the Nine Essentials, which include a comprehensive, articulated mission, clinical preparation, professional leading and learning, reflection and innovation, and research and results (NAPDS, 2021). While the Innovation School will ultimately incorporate all of the National Association of Professional Development Schools Second Edition of the Nine Essentials (NAPDS, 2021), this paper focuses on the essentials the themes from our shared perspectives have addressed to date. We also used our narrative expressions to identify the accelerators, barriers, and next steps discussed in this paper.

Context

FGCU is a comprehensive public university, offering undergraduate and graduate degree programs of strategic importance to the local area and beyond. The university's mission emphasizes innovative, student-centered teaching and learning, embraces diversity, nurtures community partnerships, values public service, encourages civic responsibility, and cultivates habits of lifelong learning and the discovery of new knowledge (FGCU, 2016). The College of Education (COE) prepares graduates for a wide range of careers from traditional PK-20 education to informal learning environments, programs for children with special needs, instructional design, educational media, and eLearning. COE programs are fully and nationally accredited, including the doctoral program for teachers, educational leaders/administrators, and other professional school personnel. The SDLC is a PK-12 public school district. In the 2020-2021 academic year the school district included 118 schools and more than 95,000 students. It is the 32nd largest school district in the nation with students from over 141 countries who speak more than 147 different languages. The student demographics in the school district are racially diverse; 41.4% Hispanic/Latino, 36.6% White, 14% Black/African-American, 1.7% Asian, and 0.2% Multi-Racial (SDLC, n.d.).

Our committee work has been centered around the Innovation School's vision to create innovative leaders and lifelong learners who positively impact an ever-changing society and its mission to foster educational learning opportunities that inspire individuals' innovative thinking, creative expression, collaborative engagement, effective communication, and critical thinking into action. Through innovation, research-based practice, and public engagement, the Innovation School will foster individuals to become innovative leaders and lifelong learners who hold emotionally sound and socially inclusive dispositions in the human community. These individuals will inspire people and organizations to improve the quality of life in our community, the state, the nation, and beyond.

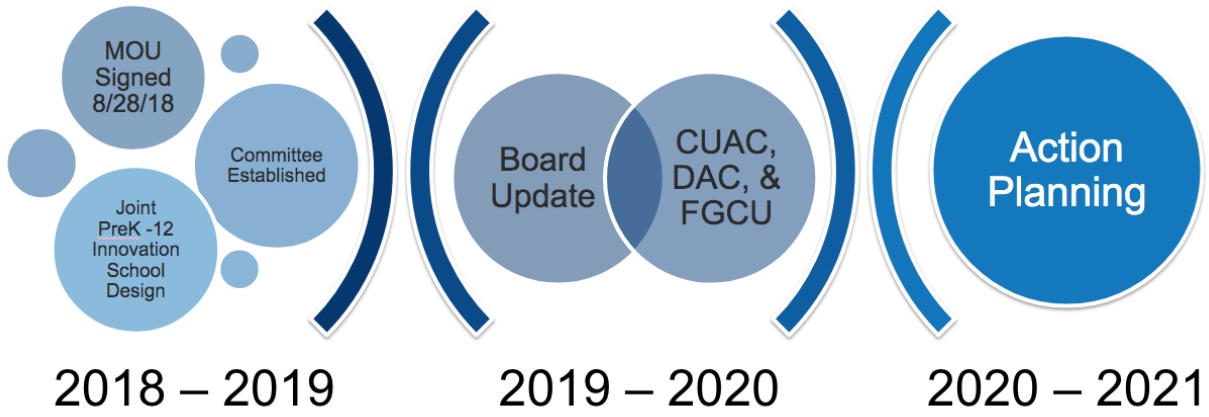
Members of the PK-8 Innovation School committee ("the committee") include faculty and administration from the COE and school district leaders. Our committee has been meeting regularly since Fall 2018. We started our work by acknowledging our shared commitments and collaborative responsibilities, articulated in the MOU signed by both the university and the school district:

- Explore and identify a strategic location for the Innovation School to serve the district's diverse population.
- Consult in the architectural design of the Innovation School to support inquiry-based learning experiences in technologically innovative, open, and integrated spaces.
- Cultivate a culture of community-based relationships including business and industry partners for transformative PK-12 education in the region.
- Establish a joint organizational structure that supports shared leadership and administration of the school.
- Build a formal evaluation system supported by the state's Legislature and the Department of Education.
- Articulate and support establishing model residency programs for pre-service and in-service teachers, current and aspiring school and district leaders, and COE faculty to strengthen field-integrated practices as part of a PDS.
- Promote and support innovative research activities, research-based teaching, and learning practices.

- Develop a full document to outline the responsibilities of curriculum, finance, food service, human resources, instructional technology, operations, professional development, and research/service centers.

To date, the committee has identified a tentative location and initial design for the PK-8 Innovation School. At a school board briefing on March 23, 2021, the committee shared an update on its milestones, shown in Figure 1.

Figure 1
PK-8 Innovation School Committee Milestones through March 23, 2021



In the following sections, we share our perspectives from the themes aligned to the National Association of Professional Development Schools Second Edition of the Nine Essentials, which include a comprehensive, articulated mission, clinical preparation, professional leading and learning, reflection and innovation, and research and results (NAPDS, 2021). While the Innovation School will ultimately incorporate all of the Nine Essentials, this paper focuses on the essentials the themes from our shared perspectives have addressed to date.

Elements of Our Innovation School

A Comprehensive Mission

According to the National Association of Professional Development Schools, a PDS is a "community that is actively co-constructed by the partners" (NAPDS, 2021, p. 11) and "describes the shared promises of a collaborative community" (p. 15). Our reflections in this section describe our commitment to co-construction and collaboration. The Innovation School is truly an integration of academic and practitioner knowledge. Our MOU specifies that the innovation school will serve as the primary PDS for the region to support in-service and pre-service teachers, school and district-level leaders, and teacher education and educational leadership faculty for continuous improvement in their research-based practices.

Melissa Rodriguez Meehan (MM): The committee met bi-weekly discussing ideas, and together, we drafted a proposal with our collective vision. We continue to use this proposal as a

guiding document through this design process. This proposal went through various rounds of revisions as the team members discussed and debated what should be included. There were times where disagreements had to be resolved, but considering the mission of the Innovation School, "foster educational learning opportunities that inspire individuals' innovative thinking, creative expression, collaborative engagement, effective communication, and critical thinking into action", we were able to come to a consensus, particularly on the importance of this school being student-centered and providing for student agency. This mission aligns with the goals of ensuring a student-centered learning environment, which the team kept emphasizing as being crucial to the success of the Innovation School. The Innovation School, to me, is a beacon of hope, an opportunity to reimagine schools in our region, and to show the world what can be possible with collaboration, cooperation, determination, and resilience.

Helen Martin (HM): The committee convened in August 2018 with respective members from the FGCU and the SDLC. Committee members brought unique and varied expertise and experiences to the committee. Experiences ranged from classroom teacher, school-based administrator, district level leadership, college of education faculty, and higher education administration. Expertise of the group spanned across curriculum and instruction, educational leadership, educational technology, early childhood education, science, and literacy. Leaders of the committee united a diverse team around a common vision of a "utopia" for teaching and learning.

To unite the committee around a common vision of a "utopia" for teaching and learning, the committee leaders organized bi-monthly meetings around a series of proactive, yet reflective questions surrounding the committee members' own vision and experiences for teaching and learning. The first question included, "When I think about an Innovation School, I imagine…" and viewing and reacting to Sir Ken Robinson's video: "Are schools killing creativity?" The proactive questions led committee members to engage in conversation surrounding the current state of PK-12 public education, school-university partnerships, and teacher preparation programs. The collective participation of the group in critical discourse resulted in powerful educator learning and the emergence of disparate visions for the school-university partnership.

In spite of these meaningful discussions, the committee still held competing visions for an Innovation School and a school-university partnership. To continue the professional learning, we examined and explored innovative models for teaching and learning across the globe. Resources included *Creative Schools* by Sir Ken Robinson, *Teach Like Finland* by Timothy D. Walker, and *The Class* by Heather Won Tesoriero. We also examined videos of university school partnerships, such as the University of Chicago Laboratory Schools. In addition to reading books and viewing videos, we engaged in the identification of high-quality environments for teaching and learning within the region and beyond. Committee members visited different public schools within the SDLC, a community organization that provides wraparound services to school-age children and families, a state university laboratory school, and High Tech High, a public charter school in California. During each location visit, committee members observed classrooms, interviewed administrators, students, faculty, and staff when available. Through these experiences, we identified powerful aspects of architecture and physical layout, student progression, curriculum, assessment, parental involvement, professional learning, and instruction for students observed within these environments. The powerful aspects identified through reading, viewing videos, and visiting campus led us to collectively identify key pillars to include within the Innovation School. The opportunity for active and experiential learning increased our

collective knowledge and allowed us to converge around a core set of beliefs regarding teaching and learning.

Adam Molloy (AM): The Innovation School seeks to add to traditional community education approaches through the addition of university resources (interns, research, staff) in a traditional public-school setting. By collaborating with the College of Education at FGCU, the Innovation School design moves beyond its brick-and-mortar foundation, becoming more of a learning center that relies on outside partners to transform the educational experience and improve student outcomes. The Innovation School framework allows the school to be more open to involvement to not just FGCU staff and students, but to outside community organizations that can address necessary school needs.

By incorporating outside citizen involvement and prioritizing the educational experts at FGCU, we recognize that the localized issues in education would be best addressed by those developing the solutions. We have conducted needs assessments relative to the development of the school and its program offerings. The MOU appreciates the importance of shared facilities and the construction of a new school that honors community use of the school.

Clinical Preparation

Clinical practice supported through a strategic partnership in a well-resourced and designated site is a design principle for high-quality teacher preparation (Petrilli et al., 2019). Our perspectives shared in this section describe the ways the university's teacher preparation program is addressing some of the frameworks identified for the Innovation School. The Triple E (Experiential, Exploratory, Expeditionary) model and Universal Design for Learning (UDL) framework mentioned in this section focus on learner-centered approaches with an emphasis on removing barriers, allowing learners to access content and demonstrate proficiency in a variety of ways. As we move closer to the Innovation School opening date in fall 2025, we will use our work in the sub-committee described in this section to fully embed clinical practice into teacher preparation through our established university-school district partnership.

MM: The university and school district are targeting and developing specific professional development areas which will allow both pre-service and in-service teachers to explore UDL and Triple E frameworks. In an effort to prepare all teachers for the Innovation School and ultimately throughout the district, pre-service teachers are completing reflective discussions and assignments about UDL and what it means to incorporate student voice and choice in classrooms. This approach is also modeled for them in their teacher preparation program, as their input is requested and valued. Furthermore, pre-service teachers in my child development and social studies methods courses are given the space and opportunity to be creative, collaborate with their peers, and think critically about important educational topics. They are also given opportunities to choose how they complete their work, who they complete it with, and choose resources that best support their learning. I want them to experience these approaches, where they are not simply having knowledge transferred to them, but where they are really constructing their own knowledge and making the most appropriate decisions for their unique learning experiences; they are often co-constructors of the courses. An emphasis on inquiry-based approaches, such as project-based learning (PBL), is also included in the curriculum offered to pre-service teachers. Exposing pre-service teachers to this approach, even if just "planting seeds" in their minds, helps set the foundation for their future learning in the program, and future implementation in their classrooms. We hope that as these approaches

continue to be modeled for them, the more comfortable they feel and more likely they are to implement them in their future classrooms.

Nate Turcotte (NT): As a faculty member in an Educational Technology program at a university that has close ties to the school district and investment in the Innovation School, another challenge we are prioritizing is training our pre-service teachers to use effective and research-based approaches to technology integration (e.g., TPACK, SAMR) in addition to introducing them to emerging technologies (e.g., AR/VR), as well as programs like Hour of Code, Padlet, and Flipgrid, among others. We believe that providing our teacher candidates with these valuable experiences with technology will not only impact the Innovation School but the school district as a whole as many of our teachers end up being hired by the district upon graduation.

The professional development sub-committee has already begun to address many of these concerns but we, on the university side, must also verify that our pre-service educators are learning how to properly integrate technology into their future classrooms and are being exposed to the various technologies that continue to evolve. Also, once the school is built, there will be continued importance placed on my role, as there will be plenty of opportunities to work with the Media Specialist and the teachers to advocate for the use of technology in a pedagogically sound manner and provide research-backed strategies for technology use.

Professional Learning and Leading

Team Building and a Community of Practice (CoP)

In our Innovation School committee work, we are focused on team building. We recognize that the school district and the university working together disrupts traditional hierarchies and roles present in either institution, opening new doors, avenues, and opportunities for all (NAPDS, 2021, p. 13). As we continue to explore professional learning opportunities with the goal of making them available to all of the stakeholders involved in our partnership, we recognize that our work shares concepts of team building with concepts of a community of practice (CoP). Our perspectives in this section describe how our team has collaborated to identify areas for personal and collective growth and furthered our work to determine the manner in which professional learning occurs (Frazier et al., 2015).

Michele Garabedian Stork (MS): Committee members have focused on our common goals, our core values, and our shared beliefs. Has it always been easy? Of course, no. This is hard work that has forced us to try to find compromise between what could be if the committee could incorporate everything we know from the evidence about high-quality, equitable, inquiry-based learning experiences for all students and the current high-stakes accountability, compliance-focused learning environment that exists today. I am convinced the compromise exists even in a landscape of financial and political barriers, and the results can contribute to a transformational change in public education.

During my ten years working in PK-12 district administration, I saw first-hand the challenges of incorporating evidence-based best practices while meeting a myriad of barriers (i.e., unfunded mandates, decreasing numbers of teachers, high-stakes testing). There have been many times when our committee has had difficult conversations; for example, the committee discussed whether the Innovation School would be required to use the district curriculum and district-developed instructional guides. Initially, university faculty felt the Innovation School should have the freedom to use any curriculum and district staff felt the Innovation School had to

use the district-adopted curriculum in order to more easily disseminate our successful practices throughout the district. After several lengthy conversations, we collectively decided to use the district curriculum but integrate innovative pedagogical strategies focused on inquiry-based learning, such as PBL, UDL, and play-based learning. This collaborative decision was made because of our commitment to our shared vision, dialogue, and most importantly mutual trust. After four years, these key concepts are infused in our committee's way of work and help guide us when differing views are presented. While our committee has established itself as a team working towards the distinct end goal of opening an Innovation School, we do not foresee our committee dissolving once the school opens as would be the way a team is typically defined (Frazier et al., 2015). We believe our way of work has evolved over the past four years into a CoP. A CoP is ''defined by knowledge rather than by task and exists because participation has value to its members'' (Wenger, 1998, as cited in Frazier, 2015, p. 43). This value is demonstrated through our shared vision, dialogue, compromise, and mutual trust.

HM: Professional development is a key lever to increase teacher effectiveness. As teacher effectiveness increases, student achievement increases (Nye, et al., 2004). The pathway to increasing teacher effectiveness is not always clear. However, the most effective professional learning results in changed teacher attitudes, beliefs, and instructional practice (Desimone, 2009). To approach the design of an innovation school, leaders first started with changing the perspective of school-university partners.

All teams progress through predictable stages of team development: forming, storming, norming, performing, and ending (Tuckman, 1965). A team's ability to quickly progress through the forming, storming, and norming phases ultimately determines the success of the team. The forming and storming stages of team development served as a barrier to the school-university partnership. School and universities alike experience natural silos through department membership. School representatives and university representatives often struggle to understand each other's reality as practitioner and/or scholar. Initially, the lack of relationships between the committee members served as a barrier to designing an Innovation School. Through meaningful and collective participation in professional learning, our team was able to enter the performing phase and create a common vision for innovative teaching and learning within the region and beyond.

Reflection and Innovation

Innovative Pedagogy

An inquiry-based perspective accompanies the idea of innovative practice, as PDS participants should embrace a culture of examining how the design, implementation, and refinement of innovations influence each PDS participant as well as the teacher candidates and P–12 learners (NAPDS, 2021). In this section we share our visions for the design and implementation of the Innovation School's physical space and its connection to student-centered, innovative approaches to teaching and learning. We acknowledge the importance of ongoing reflection as part of our work, both in and on our actions (Schön, 1987, as cited in NAPDS, 2021).

Cynthia (Dawn) Martelli (DM): Many define literacy as the ability to read and write. However, is it that simple? During my twenty-one years of teaching reading to students in public schools and to teacher candidates in higher education, I realized that the context of literacy is constantly changing. There are a variety of definitions and many different types of literacy.

During the Innovation School committee meetings, a new question arose: What does it mean to be literate in the 21st century? To be literate in the 21st century revolves around being literate in a multitude of ways where not only must one know how to read and write print texts, but one must also acquire the skills, understanding, and an open mind to innovation in the transformation and advancements of technology.

We unanimously decided that literacy would be the core of the innovation school. A place was needed for students to have access to unlimited resources and technology that support a wide range of student reading needs, abilities, and interests; a place for the development of attitudes and skills to enable students a space to create, build, work and to become independent, lifelong readers and learners; and a place for teachers to collaborate in the development of curriculum and instruction that would support students in the achievement of curricular and instructional goals. This place would be an open and interactive media center, and it would be the centralized activity hub or meeting area of the Innovation School.

As the design image developed among the committee members, this central media center design evolved into a main area that is completely open to the corridor and can spill out into that space with a second area that can be opened or closed through sliding glass panels, providing just enough solid wall to accommodate book collections while giving more floor space to content creation and activities. A modernized media center would incorporate design elements for inquiry-based explorations and embrace personalized learning as a tool to unlock the capabilities of every student thus allowing them to excel in their natural skills while giving additional support for identifying areas. There would need to be a variety of spatial options to support the ever-changing needs of students. The media center would support experiential learning through project-based learning and hands-on strategies allowing students to collaborate and explore their curiosities through inquiry and exploration. Technology has impacted the way students collaborate, share, and interact, creating the need for the media center to be learner-centered where students have unlimited access to various types of literature to assist them in their learning.

The heart of the centralized media center needs an informational literacy specialist. The committee created a position where the informational literacy specialist's responsibilities would include collaborating with students and other members of the learning community to determine learning and informational needs; joining with teachers and others to identify links across student information needs, curricular content, learning outcomes, and a wide variety of print, nonprint, and electronic information resources; and creating and maintaining an inviting, safe, inclusive, and respectful learning environment that fosters intellectual inquiry.

The goal of the school's media center as the information hub of the school is to provide academic support to students and teachers in the form of print materials, online resources, literacy enrichment, information literacy instruction in the context of the curriculum, and technology support. The informational literacy specialist and teachers will promote reading for information and pleasure and strive to ensure students become effective producers and users of ideas and information.

MM: Student agency is at the heart of our Innovation School partnership, woven into discussions and proposals of both the design of the building and the pedagogical approaches we expect to integrate. In learning environments where student agency is prioritized, educators view students as problem solvers, capable of constructing their own knowledge (Vaughn, 2020). The learning environment belongs to the students, not just the teacher. Self-determination theory

(Ryan & Deci, 2000) aligns with student agency as it supports students' need for autonomy, competence, and relatedness, which are vital in promoting positive social development and academic growth. Student agency includes learning through opportunities and activities that are meaningful and relevant to learners, giving them voice and choice throughout the learning process. Furthermore, learning environments that include student agency create structures and processes where students' perspectives inform teaching and learning practices (Cook-Sather, 2020).

One guiding principle that would support this mission, is a focus on authenticity and relevance. With an inquiry-based approach, the Innovation School will foster student questioning and curiosity in student-centered environments which provide opportunities for students to create meaningful, relevant work while making connections and applying their knowledge beyond the classroom. Students will have a variety of opportunities to explore their interests and solve real-world problems within their community.

The choice aspect in the classroom is one way to increase student motivation by appealing to students' need for autonomy and competence (Beymer & Thomson, 2015). Furthermore, meeting students where they are through developmentally meaningful and culturally congruent learning experiences is a foundational component of this partnership, and ultimately this school. In addition to pedagogical approaches, the design of the building is critical to the success of this school. The proposed design of the building includes assuring a physical learning environment that supports students' choice-based learning, honoring individual, small group, and large group spaces for dynamic learning engagement. The flexible learning environment will provide spaces for students to make decisions about how to explore their work while allowing teachers to accommodate students' individual needs. We hope to remove both physical and 'invisible' barriers to learning. These spaces will foster creativity, collaboration, and critical thinking among both learners and teachers.

NT: Given the mission and vision of the Innovation School, particularly its learner-centered focus through inquiry-driven methods, PBL became a natural support for leveraging educational technology effectively. Additionally, both the Triple E model and the UDL framework could conveniently include educational technology to position students as active constructors of their learning. For example, we envisioned students using technology to represent their learning in ways that were meaningful to them. This meant although students could be working on a project with the same goals, their use of technology and their final products could differ greatly.

Among the team, there continues to be complete agreement in using student-centered approaches that integrate technology. As I reflect back on our committee meetings, I can recall several instances where we discussed the importance of the Informational Literacy Specialist position and the media center space being a hub for the school. This space, and the prospective person in this role, would be responsible for collaborating with teachers and would serve as a resource for teachers looking to integrate appropriate technology for their students. In turn, this position and space is both critical to the design of the school and can serve as a metaphor for how we are conceptualizing how the school will function. We believe that centering on the media center will enable diverse uses of technology that will ripple throughout the rest of the school.

Research and Results

In this section, we describe our approach to research not only once the Innovation School opens, but as part of its development process. Our goal is to use our findings to improve practice and outcomes for all learners, contribute to improvement within the Innovation School and to the field of education, simultaneously renew both the SDLC and FGCU and inform educational policies (NAPDS, 2021). Identifying our challenges will not only improve our own process but may contribute to improving others who take on the work of designing a traditional public school as an inquiry-based innovation school through an articulated partnership.

Charles Wang (CW): Educational design research (EDR), according to McKenney and Reeves (2019), is a genre of research or a family of research approaches that "strive towards the dual goals of developing theoretical understanding that can be of use to others while also designing and implementing interventions to address problems in practice" (p.18). Scholars believe that EDR has demonstrated considerable potential because it advances design, research, and practice concurrently (McKenney and Reeves, 2018; Wang and Hannafin, 2005). Through EDR and with educational practitioners in the field, researchers engage in the collaborative research processes that design and implement educational interventions systematically to improve the design while they "ultimately seek to advance both pragmatic and theoretical aims affecting practice" (Wang & Hannafin, 2005, p. 6).

Establishing the Innovation School as a partnership between a university and local school district itself is innovative. The nature of this grand task determines there are multiple and multifaceted challenges ahead. Although we are very confident and capable of completing this task, the ways and approaches we take will impact the results we have at the end. As educational researchers, we believe in a scientific and pragmatic research approach to explore and provide solutions to problems in order to meet the challenges of establishing the Innovation School. This is because the challenges we face are not just limited to those of curriculum and instruction that can be addressed with standard empirical research through controls or manipulations of various existing factors in the classroom.

In the sections below, our narrative expressions are used to identify the accelerators, barriers, and next steps for the Innovation School. Accelerators are described as supporting our goals for the Innovation School to provide learner-centered, inquiry-based learning experiences where students have opportunities to become confident individuals, creative innovators, socially responsive problem-solvers, ethical entrepreneurs, and insightful leaders through civic modeling, informational literacy, educational design research, and education change theory. Barriers to our Innovation School goals are shared including issues in teacher preparation, the impact of COVID-19 on instructional practices and student learning, the role of educational technology, and challenges in family-school connections. Lastly, next steps are shared including how our team plans to involve students and community members and continue to expand professional development opportunities.

Accelerators

AM: The significance of the community in education is related to the responsibility of public schools to develop the capacity of students to participate in a democratic society, as agents connected to diverse people and organizations. The Innovation School collaboration will assist in not just teaching the state standards but also tap into the civic modeling inherent in opening up schools to community participation. Since the Innovation School is planned to be built in a

student assignment zone that has a high percentage of academically vulnerable students, the partnership has the potential to generate more parental involvement in the school. FGCU interns will supplement traditional staff, providing extra interventions to best support student achievement.

DM: The ability to find and use information, informational literacy, is the keystone of lifelong learning. Creating a foundation for lifelong learning is at the heart of the centralized media center of the Innovation School. The heart of the media center needs an informational literacy specialist. Just as the media center has moved far beyond a room with books to an active, technology-rich learning environment with an array of information resources, the informational literacy specialist focuses on the process of learning rather than dissemination of information. The centralized media center combines effective learning and teaching strategies and activities with information access skills. Information availability will undoubtedly continue to cultivate into the next century, which will make the media center even more essential to help its users acquire the skills they will need to harness and use information for a productive and fulfilling life. The informational literacy specialist can use the information literacy standards for student learning to create and maintain a design for a broad learning community—students, teachers, administrators, parents, and the neighborhood—that will support lifelong learning.

CW: Conducting EDR while designing the Innovation School is new and challenging to us. At the same time, it is rewarding with real problems solved and with new understandings obtained. We have learned so much from our progress as well as our challenges in this grand endeavor by conducting EDR with the Innovation School. After almost four years of work, we are confident in our approach to conduct EDR to support the establishment of the Innovation School, we are confident with our EDR results and merits in solving critical problems, and we are confident in establishing the Innovation School for student success.

MS: The study of efforts at school change over the last several years have led to a growing body of literature on new theories for school change (Day et.al, 2016; Fullan, 2009; Reinholz & Andrews, 2020). Glickman, et. al (2018) refers to these as education change theory. This body of research shares some key concepts, capacity, commitment, and support. The benefits of having the committee meet regularly and consistently since 2018 has built our capacity and commitment to design a truly innovative school through dialogue, trust, and a defined vision. The Innovation School partnership between the university and the school district demonstrates the external and internal support necessary for change.

Barriers

MM: The overall vision and mission of the Innovation school comes with a variety of barriers to successful implementation and sustainability of these innovative practices. Financial implications, teacher shortages, and declining enrollment in teacher preparation are some to consider. Additionally, to the removal of power dynamics and control and compliance policies that have not always allowed for this type of learning environment. We hope to combat some of these barriers by receiving ongoing community and legislative support and identifying areas for improvement in terms of professional development and teacher support.

HM: Committee membership continues to change. As a result of changes in members, team dynamics continue to shift. Throughout the almost four-year period, the district has transitioned to a new Superintendent and Chief Academic Officer. The Dean of the College of Education unfortunately passed away, and an interim Dean has joined the committee. New

leadership from both the school-university sides creates a barrier for the Innovation School The barrier includes a need for a strong onboarding plan to bring new team members up to speed on the professional learning, so they can quickly commit to the mission and vision.

The past two years ushered in a myriad of innovations for teacher professional learning. These innovations disrupted the notion of a "sage on the stage." With the transition to remote teaching and creation of innovative instructional models, expert practitioners and scholars learned alongside novice teachers and their students. With school shutdowns and work from home, educators gained access to professional learning around the clock and across the globe. In spite of these innovations, education continues to face insurmountable challenges that include a dwindling workforce and students suffering academically and socially-emotionally. In order to design an Innovation School that is relevant and responsive to the challenges faced by the profession, the professional learning of the committee will continue to investigate and research the impact of COVID-19 on the profession and exemplary models of response.

NT: Of course, the use of any emerging technology and unfamiliar pedagogical methods can provide significant barriers that need to be considered. For instance, after joining the committee, I found the committee having frequent conversations establishing the importance of providing proper professional development opportunities. Indeed, professional development became such an important topic to the team that we decided to create a professional development subcommittee that would develop topics of interest (e.g., UDL, PBL, etc.). As this committee develops training, we continue to think about the role of educational technology in supporting teaching and learning.

AM: There are several barriers to establishing the Innovation School as an effective community school model. Lohmann, Hathcote, and Hogan (2018) identified parental knowledge and attitudes, disparity between families and schools, current family situations, and logistical issues as the four major barriers to establishing a family-school collaboration. These barriers have the potential to prevent the Innovation School from developing into a community education site. Since FGCU staff will be serving as the outside community organization, there is still a need to have additional parental and community involvement.

Next Steps

MM: Although the support for pre-service and in-service teachers is a top priority, the committee seeks to have stakeholder input in the design process. Various stakeholders will be included in the process. However, we will begin with the students, and ask for their input and expertise into what they feel "school should be". More specifically, past, current, and future students will have opportunities to share how they envision their schools, what was wonderful in their PK-12 experiences, and what they wished they would have had. Students will reflect on their own learning experiences and assist in creating a school that is truly for them. As we move forward, an emphasis on learner-centered approaches to promote and support student agency will remain and we are looking forward to the opportunity to have direct input from students, demonstrating to them that student agency is truly an integral piece of this school.

AM: The next steps for the Innovation School and the community at-large are connected. Effective communication between the Innovation School team and prospective parents from before open enrollment to after assignment will be crucial. Parents and the larger community will need to understand what the Innovation School is and how it is different in its design and programming. This can be accomplished through shared community resource events, the

SDLC's Parent University, and in a collaboration with the Student Assignment Office. The Community Engagement Plan for the Innovation School focuses on building engagement infrastructure, community partnerships and effective communication, shared FGCU and SDLC communication materials, and in-person forums to engage and inform.

HM: As the Innovation School team enters a new phase to turn vision into reality, professional development becomes a priority. As the committee grows, the team seeks to build new team members' understanding of the collective mission and vision and prior understandings. As the committee seeks to staff the school, university partners will begin to create and pilot professional development modules for Lee teachers. Pilot professional development opportunities include simulations in classroom management, early childhood support for student voice, choice, and play, an introduction to UDL, and application of UDL. The committee will pilot these opportunities at the SDLC's Summer Professional Learning Series for teachers where over 1,400 educators will have the opportunity to choose between 350 sessions during a five-day period. Educators who attend sessions led by the committee will then choose to continue to engage in job-embedded professional development throughout the school-year. Job-embedded support will assist teachers in applying strategies learned during the summer sessions. Committee members will collect data and feedback from participants to inform future professional development offerings. Feedback and learnings from participants will be used to refine professional development offerings and eventually create a core menu of professional development for teachers and leaders who will one day teach students and lead the Innovation School.

Conclusion

In this article, members of an Innovation School committee from Florida Gulf Coast University and the School District of Lee County share their perspectives on our journey to date for designing a new traditional public school as an inquiry-based innovation school through an articulated partnership. Their stories guided us to identify the themes aligned to the National Association of Professional Development Schools Second Edition of the Nine Essentials, which included a comprehensive, articulated mission, clinical preparation, professional leading and learning, reflection and innovation, and research and results (NAPDS, 2021). Our narrative expressions were used to identify the accelerators, barriers, and next steps for the Innovation School.

While the Innovation School will incorporate all of the National Association of Professional Development Schools Second Edition of the Nine Essentials (NAPDS, 2021), this paper focuses on the essentials the themes from our shared perspectives have addressed to date. We look forward to continuing our committee work as part of a learning community guided by our shared vision to foster individuals to become innovative leaders and lifelong learners who hold emotionally sound and socially inclusive dispositions in the human community. These individuals will inspire people and organizations to improve the quality of life in our community, the state, the nation, and beyond.

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Preparing Pre-Service Educators for Family Collaborations: Developing Partnerships to Support Learning

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Abstract: A description of a partnership between a university's child and family development program and a local program is provided. Through this partnership, pre-service educators participate in home visits to learn strategies to support effective communication, collaboration, and implementation of evidence-based practices to enhance the learning of young children who may have developmental delays and their families.

KEYWORDS: child development, community partnership, community-university partnership, early intervention, family, family development, partnerships

NAPDS NINE ESSENTIALS ADDRESSED:

Essential 1: A professional development school (PDS) is a learning community guided by a comprehensive, articulated mission that is broader than the goals of any single partner, and that aims to advance equity, antiracism, and social justice within and among schools, colleges/universities, and their respective community and professional partners.

Essential 2: A PDS embraces the preparation of educators through clinical practice.

Essential 4: A PDS makes a shared commitment to reflective practice, responsive innovation, and generative knowledge.

Introduction

Pre-service educators in programs for early childhood (EC), early intervention (EI), and early childhood special education (ECSE) are trained to work with children from birth up to age eight (Division for Early Childhood [DEC]; National Association for the Education of Young Children [NAEYC]). The educational curriculum needed for working with young children with disabilities and their families is vastly different from what is needed for general early childhood or school-age special education. For example, some of the unique criteria include (a) collaboration with families, (b) an understanding of the variety of settings in which children are served, (c) knowledge and awareness of the provision of services and support that may be used across developmental domains, and (d) an understanding of how teaming occurs with professionals from other disciplines (Gallagher et al., 2014).

For this skill development needed in the fields of EC, EI, and ECSE, students need to know how to implement evidence-based practices (EBPs), as well as recommended practices (RPs; DEC, 2014); however, concerns have been expressed about the ability to transfer this knowledge into practice (Bruder et al., 2013, McLeod et al., 2021; Odom, 2009). Consequently, coursework that includes the use of clinical placements is critical in supporting the knowledge and implementation that future EI/ECSE professionals will need (Busher et al., 2015; La Paro et al., 2018). In order to address this need, partnerships with community programs may support the learning needs of pre-service educators in the aforementioned fields. The purpose of this manuscript is to (a) provide a context for the unique learning needs of pre-service educators in these disciplines, including a historical and legislative background, (b) review the need for high-quality clinical placements, (c) provide an overview of Part C services, (d) describe the development of a partnership to support the learning needs of pre-service educators, (e) delineate the development of learning opportunities that align with course objectives, and (f) share benefits and challenges that have developed through the partnership. Specifically, this manuscript will describe how the partnership between a University's Special Education and Child Development department and a local Part C program has been formed to provide the experiences pre-service educators need to translate their knowledge into implementation when they enter the workforce. The University and the Part C program are in a metropolitan area in the southeastern United States. The local Part C program will be referred to as the host agency.

Context for Unique Learning Needs

Legislative History and Context for Early Intervention

The work of EI/ECSE professionals and the unique support they provide is predicated on Part C of the Individuals with Disabilities Education Act (IDEA), which assists states in operating a comprehensive statewide program of services for individuals with disabilities. Part C is specific to services for infants and toddlers who may be at risk for or diagnosed with developmental disabilities, ages birth through 2 years, and their families. Provisions for infants and toddlers with disabilities first appeared in legislation in 1986 when Congress identified an "urgent and substantial need… to enhance the capacity of families to meet the special needs of their infants and toddlers with handicaps" (Education of the Handicapped Act, 1986, p. 1145). Thus, due to the focus on building family capacity, the preparation of personnel to support children and families who receive Part C services requires a perspective that differs from the preparation of school-age children.

The field of EI (i.e., Part C) encompasses many disciplines and practices (e.g., occupational therapy, physical therapy, speech–language pathology, social work) due to the variety of disciplines and fields of study needed to support the individualized, diverse needs of infants and toddlers with disabilities and their families. Research and legislation have laid a foundation for how services are delivered. Three primary components are natural environments, family-centered practices, and teaming (Bruder, 2010; DEC, 2014). One challenge facing the field is that personnel preparation programs across study disciplines do not have effective pre-service training models to adequately prepare students to implement recommended practices for partnering with families as they enter the workforce (Bruder & Dunst, 2005; Bruder, 2010; Kyzar et al., 2019). Therefore, personnel preparation programs may consider ways to strategically focus on ways to incorporate natural environments, family-centered practices, and teaming into their curricula.

Natural Environment and Part C

IDEA requires that early intervention services be implemented in natural environments, which are defined as settings that are natural or typical for a same-aged infant or toddler without a disability and may include home or community settings (IDEA §303.126; Tomeny et al., 2021). The focus also supports families within the context of natural routines and activities, using interest-based child learning, and enhancing parent responsiveness to promote child learning (Dunst et al., 2001; Workgroup on Principles and Practices in Natural Environments, 2008). The emphasis on natural environments helps to assure that young children with disabilities and their families will be included in everyday home and community activities, and that early intervention services will not be delivered in places that will isolate the child or their family (Bruder, 2010; Dunst et al., 2014). Furthermore, the provision of services in a natural learning environment assists families in understanding the important role of being responsive in everyday activities and supporting child interests as the foundation for child learning to improve child outcomes (Dunst et al., 2001; Frantz et. al., 2018).

Family-Centered Practices

In addition to focusing on the provision of services in natural environments, the preparation of pre-service educators must include an emphasis on how to partner with families in delivering the supports and services needed to facilitate optimal child and family outcomes (IDEA, 2004). Family-centered practices were introduced into early intervention literature over 25 years ago (Dunst et al., 1994; Shelton & Stepanek, 1994) and have been characterized as beliefs and practices that treat families with dignity and respect, are individualized, flexible, and responsive (Dunst, 2002). When practitioners work with family members in ways that respect their values and choices, and include the support necessary to strengthen family functioning, family-centered practices are being implemented (Dunst et al., 2007). This approach emphasizes the influence of the family system on the child. Subsequently, services must be provided with a consideration of the family context and young children cannot be viewed apart from their families (Bailey et al., 2012). As such, the preparation of pre-service educators includes considerations of the needs for both children and their families.

Teaming

Teamwork is also central to the work in early intervention (DEC, 2014; IDEA, 2004; Workgroup on Principles and Practices in Natural Environments, 2008). As young children grow and develop, convergence among the various developmental milestones occurs across domains (e.g., cognitive, communication). Due to the interplay between areas of development and the complex needs of infants and toddlers with disabilities, early intervention practitioners represent various disciplines (e.g., speech-language pathology, occupational therapy, early childhood education and special education). In addition to early childhood education and special education, discipline-specific professionals should have knowledge and expertise across all the traditional developmental domains, and teaming practices (Bruder, 2010; Shelden & Rush, 2013). To improve the effectiveness of those providing early intervention, researchers suggest that services be delivered through an integrated team approach (Hanson & Bruder, 2001). Teaming practices also support practitioners across disciplines with improving their knowledge of the implementation of the recommended practices in early intervention, such as natural learning environment practices and family-centered practices (Bruder & Dunst, 2005; King et al., 2009; Shelden & Rush, 2013). Additionally, the use of effective teaming practices during the process of administering assessments and developing child and family outcomes may result in decreased stress for the family (Lieberman-Betz et al., 2019).

DEC's Recommended Practices (RPs) and Family Practices

Recommended Practices (RPs) from the Division for Early Childhood (DEC) of the Council for Exceptional Children (CEC; 2014) guide practitioners to work with families in ways that develop existing parenting knowledge and skills, and promote the development of new parenting abilities that will enhance parent confidence and competence. The RPs include seven topic areas that provide guidance for practitioners, including (a) Assessment, (b) Environment, (c) Family, (d) Instruction, (e) Interaction, (f) Teaming and Collaboration, and (g) Transition. As a key component in preparing pre-service educators in EI focuses on partnering with families, an emphasis on the 10 recommended family practices for practitioners (see Table 1) will be an integral part of their curricula. Family practices encompass three themes, including (a) family-centered practices, (b) family capacity-building practices, and (c) family and professional collaboration (DEC, 2014). Additionally, family practices refer to ongoing activities that (a) promote the active participation of families in decision-making related to their child (e.g., assessment, planning, intervention); (b) lead to the development of a service plan (i.e., a set of goals for the family and child and the services and supports to achieve those goals); or (c) support families in achieving the goals they hold for their child and the other family members.

Local Part C Program / Host Agency

As previously noted, the provision of Part C consists of states operating a comprehensive statewide program of services. For this state in the southeastern United States, a statewide program administers the federal grant funds for the provision of EI services across 16 local programs. The local program, or host agency, described in this manuscript is a one-county catchment area that serves a large urban area. The host agency serves approximately 2800 families a year and has 105 full-time staff including (a) service coordinators, (b) developmental specialists, (c) speech-language pathologists, (d) occupational therapists, (e) physical therapists, (f) social workers, (g) psychologists, (h) nutritionists, (i) interpreters, (j) administrative staff, and (k) support staff.

The primary role of the host agency is to provide service coordination, eligibility evaluations, and child and family assessment to enroll children into the program. Each family is assigned an early intervention service coordinator (EISC) at referral (Knowledge and Skills for Service Coordinators, 2020). EISCs are the first point of contact for families and serve as the primary and single point of contact for families during their referral and ongoing enrollment (IDEA, 2004). After referral, the child and family receive multidisciplinary evaluations (Shelden & Rush, 2013) and assessments to assist with completing the Individualized Family Service Plan (IFSP; IDEA, 2004). The IFSP outlines how the early intervention team, which includes the family, will work together to address the needs identified for the child and family, and the services to be provided for the family. The EISC role is distinct as they need to bring the expertise of navigating the EI system, "using family-centered practices, linking families to community resources, fostering strong family-professional partnerships, and facilitating and documenting the EI process" (Knowledge and Skills for Service Coordinators, 2020, p. 4). The service coordination role in this state is a dedicated role (Bruder & Dunst, 2008) and can be filled by a variety of disciplines (e.g., Birth - Kindergarten Education, ECSE, Child and Family Studies, Social Work, Nursing, and other human service fields). Therefore, the pre-service preparation for all team members, including service coordination, should be grounded in knowledge of recommended and evidence-based practices.

Pre-service Preparation for Educators

The preparation of pre-service educators involves consideration of many different concepts, including (a) the content that educators should know when they begin teaching, (b) how students can attain licensure, (c) an understanding of the developmental needs of children, and (d) how a program can meet the needs of the community program or educational setting. Once these constructs have been identified, faculty within an institution may focus on ways in which pre-service educators can become knowledgeable and confident in applying content learned within their pre-service programs to their work with children and families. Specifically, faculty should be intentional in targeting ways pre-service educators learn and how to make connections between research and practice (Odom, 2009).

One way to accomplish this is through the use of high-level preparation practices (i.e., clinically-rich field experiences, clinical supervision; Dunst et al., 2019). These practices, along with active student participation and engagement in knowledge and skills acquisition, may be particularly salient in supporting pre-service learning for individuals pursuing careers in EC, EI, and ECSE. Thus, opportunities to participate in clinical placements, which should ideally include a range of settings across a child's natural environment, allow pre-service educators to progress towards higher levels of learning as they observe professionals "illustrate" EBPs and then "reflect, understand, and self-monitor" (Early Childhood Personnel Center [ECPC], n.d.) their observations. Through the use of reflective practices, faculty can support pre-service educators by scaffolding (Shabani et al., 2010) their understanding of EBPs through feedback and discussion.

Where and How We Apply Learning

Within institutions of higher learning (IHEs), faculty are able to provide pre-service educators with the foundational knowledge needed for their future careers. This learning may be enhanced with opportunities to deepen their understanding of core concepts through active learning experiences in clinical or practicum settings. Barnett and Ceci (2002) discussed ways content and context can be transferred; specifically, they identified "what," "when," and "where" transfer of knowledge occurs. In their review of the six dimensions for context (i.e., knowledge, physical context, temporal context, functional context, social context, modality), they put forth the dimensions of knowledge domain, physical context, and temporal context have been deemed the most important. Therefore, they surmised that information gained, how it was applied to settings outside of school, and the retainment of knowledge were particularly relevant. As pre-service educators focus on learning to implement EBPs and RPs in a child's natural environment, the opportunity for clinical placements to take place in a home setting may be particularly salient.

Application of Adult Learning Strategies

In supporting families across routines within natural environments, early interventionists employ the use of adult learning strategies to support families in using EBPs to facilitate their children's learning. While pre-service educators within the CHFD program have multiple opportunities to learn about content within their university program of study such as the sequence of child development, how to write lesson plans, how to assess child development, and foundational principles about family theory, consistent with previous research (Kyzar et al., 2019), these courses do not have an emphasis on how to communicate and partner with families. As graduates exit pre-service preparation programs, this becomes problematic as a primary focus of working with young children in early intervention programs is building family-capacity and learning in pre-service programs is enhanced through rich clinical experiences.

Student Learning Outcomes and Practicum Placements

Student Learning Outcomes

In considering how to incorporate various facets of pre-service preparation for professionals who will enter the fields of EC, EI, and ECSE, many factors are considered (e.g., DEC standards, EBPs, RPs, how and where we apply learning). Teacher educators need to consider how to incorporate these components of pre-service preparation and identify the overall outcome for future graduates. Recently, researchers have placed a higher priority on student learning outcomes (SLOs; Nasrallah, 2014), which are used by faculty and programs to guide the direction of academic achievement (Maher, 2004). The use of SLOs provides guidance to teacher educators in knowing how to organize the course, make decisions about learning strategies and consider ways to evaluate student learning (Sadler, 2016). Moreover, the use of SLOs may assist teacher educators in using a more student-oriented approach to their instruction (Hadjianastis, 2017; Nasrallah, 2014).

Practicum Placements

Through the incorporation of SLOs into designing programs and courses, teacher educators will need to focus on ways to provide optimal learning opportunities for pre-service educators with a specific focus on how to develop family professional partnerships (FPPs; Kyzar et al., 2019). The development of skills needed to form FPPs may be learned most effectively through practicum

experiences which allow pre-service educators to observe and learn from professionals who are experienced in partnering with families and using EBPs to support their work (McLeod et al., 2021; Mtika, 2011). The use of practicum experiences is significant in the preparation of pre-service educators as professionals model how to use standards and practices during their interactions with young children and their families (Beck & Kosnick, 2002; Saclarides & Munson, 2021). Thus, the need to identify partners with high-quality programs and to develop a partnership is critical to supporting the needs of pre-service educators in achieving their student learning outcomes.

Need for Partnerships with Quality Programs

How to Develop a Partnership

The development of a partnership may take some time and arise in a number of ways. Partnerships between community organizations/educational programs and universities can grow through the identification of shared interests and the prioritization of supporting future educators/leaders. Finding someone to partner with may or may not happen immediately. It may involve meeting colleagues at a conference, at a community service event/organization, or it may develop from relationships made between former students and faculty members. The partnership may also develop as a result of relationships and connections formed between colleagues (past or present) and members of professional organizations. Being social, taking the time to get to know others, and focusing on having positive relationships with others are all necessary ingredients for developing a partnership.

Partnerships and Implementation of EBPs

In our partnership, the second and third authors, both administrative leaders of the host agency, were graduates of the University who received funding through a personnel preparation grant for a master's degree and an infant toddler certification; furthermore, they prioritized maintaining connections with faculty in the Special Education and Child Development department. They served as guest speakers, adjunct faculty, and on review panels to provide feedback on the quality of our educational programs. They have also provided support and mentorship for students completing internships with their program. As a newer faculty member, the first author was given the privilege of serving on the thesis committee of one author, in part, due to prior experience as a Part C provider and service coordinator.

The opportunity to meet and collaborate with one another in roles as a graduate student and faculty member created a context to connect and learn about one another, including a genuine interest in supporting the development of both pre-service educators and graduate students. As the relationship grew, the first author learned more about the high quality of work and service provided by the second and third authors in supporting children and families in our community through the host agency. Additionally, the first two authors had the opportunity to serve on several master's research committees together. Through this role of chairing and serving on graduate research committees, the first author learned more about ways the host agency embeds RPs and EBPs into their work and recognized potential for collaboration to support the development of pre-service educators.

Incorporation of Family Professional Partnerships into a Pre-service Program

As part of their program of study, undergraduate students within the child and family development program take two required courses about family development: "Families as the Core of Partnerships" and "Approaches to Family Supports and Resources." These courses each have a specific role in developing a pre-service educator's understanding of how to meet the needs of families with young children. In the first course students take, Families as the Core of Partnerships, the focus is on (a) family systems, (b) the developmental process of parenting through a child's life, (c) formal and informal support systems, and (d) family-driven, family-professional collaboration partnerships. As pre-service educators progress through the program, the second course they take is entitled "Approaches to Family Supports and Resources." This course builds upon previous learning through the application of research and theory so that students learn to implement EBPs for children and families both in home and community settings. Additionally, pre-service educators complete a field-based clinical assignment of approximately 20 hours in settings with infants, toddlers, and/or twos, their families, and/or prenatal families who are culturally, linguistically and ability diverse. As the selection of high-quality clinical placements (Dunst et al., 2019) is particularly relevant in helping pre-service educators transfer knowledge they learned in university classroom settings into the real-life settings and natural environments of young children, the partnership with a program who has the capacity to demonstrate the use of EBPs and RPs with fidelity and an interest in supporting the learning of future professionals must be prioritized.

Development of Home Visitation Project

Through the process of developing and preparing to teach a course, a teacher educator should closely examine the student learning outcomes within a course for alignment with required assignments or activities. Therefore, in examining the SLO's within the "Approaches to Family Supports and Resources" course, the first author noted the SLOs (see Table 2) identified for the course and observed that in meeting these student learning outcomes, pre-service educators would need the opportunity to observe the implementation of high-quality EBPs in authentic settings that could provide "rich-clinical learning experiences." Based upon previous interactions with the host agency, an inquiry was made to determine interest and willingness to provide support through clinical placements to support pre-service educators within this program.

Development of Assignments

After the initial inquiry about proceeding with a partnership to support pre-service educator learning, administrators within the Part C program verified their interest with the university and sought permission from the public health department (which oversees their agency), as well as the university's Office of School and Community Partnerships. Once approval was granted by all parties, both program administrators and the university instructor discussed the types of assignments that would best align with the SLOs and DEC's Recommended Practices, and considered assignments for other courses within the program. Upon reflection, the authors of this manuscript recognized that students (a) had minimal opportunities to learn about assessment practices for children under the age of three, (b) did not have an opportunity to observe an Individualized Family Service Plan (IFSP), and (c) did not have an opportunity to observe an intervention session that utilized coaching and adult learning strategies to build family capacity and meet the family practices guidelines emphasized by the Division for Early Childhood (DEC).

Therefore, it was agreed to focus on (a) the development of assignments that would address each of these gaps, (b) the provision of opportunities to meet with the service coordinator prior to and after these observations to deepen their understanding about how to prepare for meetings and collaborative opportunities with families, (c) the provision of opportunities for reflection by the student after each observation, and (d) the use of checklists created by the Early Childhood Technical Assistance (ECTA) Center to objectively observe how the recommended practices are used during interactions with families. The checklists from the ECTA Center were selected due to their alignment with DEC's Recommended Practices and the needs of pre-service educators to deepen their knowledge and understanding of assessment practices, creating IFSPs, and providing intervention sessions with families.

The first observation related to their understanding of assessment. Through the assessment course taken earlier in their program of study, students primarily learned about assessment that takes place in pre-kindergarten classrooms and with children age 3 and older; therefore, we agreed that an assignment focusing on how assessment practices are used with children birth to age 2 would be an important opportunity that demonstrated alignment with SLOs for this course. In addition, the use of a checklist developed by the ECTA Center would be a way for students to observe how the EI practitioner's use of assessment practices with families aligned with DEC's Recommended Practices. Thus, the "Engaging Families as Partners in Their Child's Assessment" provided a way for students to objectively measure the use of these practices (https://ectacenter.org/~pdfs/decrp/ASM-2_Engaging_Families_Partners_2018 .pdf).

The second observation related to their understanding of how an IFSP is facilitated and how families are supported in expressing their concerns, priorities, perspectives, and to be a part of the goal-writing process. Through this observation, an alignment with several SLOs was made. Additionally, two checklists, "Informed Family Decision Making Practices Checklists"(https://ectacenter.org/~pdfs/decrp/FAM-2_Inf_Family_Decision_2018.pdf) and "Family Engagement Practices Checklist" (https://ectacenter.org/~pdfs/decrp/FAM-3_ Fam_ Engagement_2018.pdf) from the ECTA Center were used to help students objectively measure how these practices were used during the meetings.

Finally, the third observation related to how service coordinators and/or other team members used coaching and adult learning strategies during an intervention session. Through this observation, an alignment was made with several SLOs within this course. Similar to the second observation, two checklists, "Family Capacity Building Checklists" (https://ectacenter.org/~pdfs/decrp/ FAM-4_Fam_Capacity-Building_2018.pdf) and "Family Centered Practices Checklist" (https://ectacenter.org/~pdfs/decrp/FAM-1_ Fam- Ctrd_ Practices_2018.pdf) were used to assist students in objectively measuring how these practices were used during the meetings.

For each set of observations, pre-service educators were asked to provide a short reflection of insights and perspectives gained as a result of these clinical experiences. In addition, pre-service educators and EISCs met to provide an overview of what to expect during the visit and to reflect/share insights of what happened during the visits. After completing the final observation, an overarching reflection was required that summarized their overall impressions (see Table 3) and pre-service educators asked EISCs to sign a log documenting their attendance and participation at the visits (see Table 4).

Pre-Service Educators' Takeaways from Home Visitation Project

Pre-service educators enrolled in pre-service programs focusing on EC, EI, and/or ECSE are often young women who report that a majority of the people they have interacted with in their lives have similar life experiences, religious and cultural beliefs, and backgrounds. They also state that because of their age they have concerns that families will think they are too young to know what they are talking about when they try to share information about child development or ways the families can promote learning at home. Through this project and collaboration, pre-service educators often complete the clinical placement and comment that this experience was not what they expected; furthermore, they state that they have an increased confidence in their abilities to talk with and collaborate with families. In particular, they typically share their surprise at the informality of the IFSP meetings, the communication skills used by the service coordinators and other team members in supporting and encouraging families, and that they enjoyed seeing how research and RPs discussed in class (i.e., assigned course readings, textbooks) could be applied in real settings with real families.

Through the process of their observations, several pre-service educators had opportunities to observe ways to support families who need interpretation services and observe a range of professionals (e.g., occupational therapist, audiologist, nutritionist, vision specialist, psychologist, speech-language pathologist) partner and support families and shared a range of perspectives gathered through this experience. One pre-service educator also noted that they appreciated the support of staff in processing emotions that families and professionals experience when discussing a diagnosis that may be challenging. They stated how helpful it was to finally see support to families using natural learning environment practices and delivered in a family-center capacity. Their reflections indicated they were able to observe what they had been reading was put into action and they were excited to see professionals doing what they had just read about through assigned course readings. Witnessing how the professionals helped the parents respond and process was viewed as being particularly helpful.

CDSA Perspectives of Partnership

Perspectives of Administrators

Partnerships between this host agency and the University's Child and Family Development program have long existed in the community. Current learning initiatives with pre-service educators are the result of long-standing relationships with faculty, former graduates and new professionals who are committed to providing quality introductions to early intervention systems. Administrators at the host agency are committed to spending time and other resources to support students because they understand how critical building future EI professionals is to the field. The host agency has volunteer systems in place to support pre-service educators from various fields, but it is at the discretion of department goals and capacity to support students. Program administrators must weigh staffing needs, program strategic planning goals and other factors to determine how many initiatives staff can realistically support. The host agency provides speakers to undergraduate and graduate level courses, approves staff for outside employment as adjunct faculty, supports undergraduate and graduate student interns and serves on university advisory boards and committees. Administrators also understand that supporting student learning is a long-term commitment that does not demonstrate immediate reward but contributes to the betterment of services to children and families over time.

Partnership Impact on Hiring Early Intervention Service Coordinators

The host agency views itself as a learning organization and supports staff in pursuing professional development and higher education. Staff create individual development plans for leadership development, higher education goals, and other professional aspirations. EISCs have been alumni of undergraduate and graduate programs in the Child and Family Development program. In recent years, several staff have been recipients of fellowships via a personnel preparation grant. Graduates from the university have also come to work at the host agency as new early interventionists as a direct result of their experiences with this university's program. Staff who have graduated from this university's program have consistently taken on leadership in the organization and have also moved on to lead other community organizations who collaborate with the child and family program. Having local programs that offer pre-service educators specific instruction in early intervention and pre-service experiences has significantly improved recruiting of qualified new staff, as well as other organizations that support early intervention systems.

EISCs understand that many early intervention professionals enter the profession as a direct result of a field experience or mentorship by someone already working in the field. EISCs often report they chose Early Intervention because they were taught by faculty who were passionate about EI and encouraged them to seek out this work. Those same staff are the first to volunteer to be that connection for current students wanting to learn about working with young children and families. EISCs for the host agency must obtain a certification to provide services to families. They are also required to have a four-year degree that includes competencies associated with (a) Child Development, (b) Family Development, (c) Screening and Assessment, (d) Interdisciplinary Family Service Planning, (e) Intervention Strategies, (f) Interagency and Community Process, and (g) Professionalism and Ethics. For this state, the accepted degrees are (a) Birth-Kindergarten Education, (b) Early Childhood Special Education, (c) Special Education, (d) Education, (e) Elementary Education, (f) Child Development, (g) Child and Family Studies, (h) Counseling, (i) Human Development, (j) Family Relations, (k) Family Studies, (l) Family and Consumer Sciences, (m) Nursing, (n) Psychology, (o) Social Work or (p) another human services field. EISCs must also receive a minimum of 30 contact hours of ongoing professional development/technical assistance opportunities annually to maintain certification.

EISCs who volunteer to support pre-service educators benefit in several ways as a result of their participation. Having an observer allows the service coordinator the opportunity to articulate the work they do with families and self-reflect about early intervention visits where students have observed. EISCs are exposed to best practice self-assessment tools and are able to answer questions they are asked, as well as receive feedback from the pre-service educator on impressions of the impact of their work on families. EISCs benefit from the enthusiasm and inquiry through these interactions, and it often reminds them why they want to do work in the field. Moreover, EISCs frequently get positive feedback from the pre-service educators which encourages staff and positively reinforces the effort it takes to include them in their already challenging work.

Benefits of Partnership for Host Program/Agency

Ongoing host agency and university partnerships offer many benefits. Pre-service educators, as well as graduate students, who choose to complete research with the host agency's staff or clients offer new perspectives on the field. Student publications and presentations at conferences often include program staff and university faculty in collaboration; these partnerships strengthen work across the community. Strong relationships with the university open the door for

future research collaborations, as faculty areas of interest often align with agency needs and strategic plans. These relationships forged over time improve success on other community projects and model collaboration instead of the siloed approach that often occurs when programs attempt to work together.

Challenges with the Collaboration and Partnership

Although numerous benefits have been noted by pre-service students, host agency staff and administrators, and university personnel, there are ongoing challenges acknowledged by stakeholders. As we continue through the partnership, we have identified some concerns and ways to address them. This fall, data will be collected from both EISCs and pre-service educators about their perspectives of this partnership and learning opportunity.

First, when EISCs are approached to support pre-service educators, it is sometimes challenging to find enough staff to support this initiative each semester. EISC's have busy caseloads and work responsibilities; thus, having enough time to support pre-service educators at times creates hesitations to volunteer. Furthermore, through their support they meet with pre-service educators prior to and after a visit to reflect on interactions with families and decisions made. Another concern is that when new CDSA staff are hired, they need to observe experienced colleagues, and there is not unlimited availability to support their learning requirements of both parties.

Second, scheduling visits that coincide with the needs of college students is challenging. The majority of pre-service educators are juggling multiple commitments (e.g., heavy course load during the semester in which this practicum occurs, completion of a separate internship, preparing for certification and student teaching, jobs, family commitments). With the pandemic, home visits have been virtual which has made scheduling somewhat easier; however, both program administrators and university faculty wonder about missed opportunities for learning about diverse cultures and the learning that happens when you are actually inside the home.

Third, communication between pre-service educators and program staff is sometimes challenging. Emails are sometimes missed and will go to spam. Additionally, different ideas exist between both groups about how quickly to respond to emails and some of the pre-service educators are still developing email etiquette. Furthermore, there is a quick email response culture at the host agency that is not always shared by the pre-service educators.

Fourth, although pre-service educators are encouraged from the onset of this project to plan ahead and schedule visits as soon as possible, not all follow through on this suggestion. Families of young children have busy lives and are often experiencing considerable stress and concern in learning about their children's developmental needs. Consequently, their schedules may change rapidly and visits may be rescheduled at the last minute. Due to their limited experience in supporting families enrolled in Part C, pre-service educators do not always recognize the need to schedule visits sooner rather than later.

Finally, due to the pandemic, figuring out how to support virtual learning and missing out on learning opportunities that can be provided in the home has presented obstacles and challenges in supporting pre-service educators. The host agency generously purchased tripods to support virtual visits. However, some in-home learning experiences have been missed. For example, through virtual visits, pre-service educators did not get to experience the following (a) seeing children and families in person (i.e., how does a young child greet/interact with a stranger), (b) discovering what may be happening in the rest of the home during a visit, (c) considering what

happens with siblings during the visit, (d) determining what happens when you are not in charge of the home or neighborhood, (e) considering how to you handle collaborating with families when minimal furniture and play materials are in the home, (f) identifying ways to respond to all of this in a respectful manner that is family-centered (g) developing increasing awareness of one's own implicit biases through the process of encountering diverse populations, and (h) deciding what to do when the TV is loud.

Conclusion

The purpose of this manuscript was to describe the development of a partnership between an early intervention program that supports the needs of young children with or at risk for developmental disabilities and their families and a university program that prepares pre-service educators to support children and their families from birth through age eight. Specifically, this manuscript (a) provided a context for the unique learning needs of pre-service educators in these disciplines, including a historical and legislative background, (b) reviewed the need for high-quality clinical placements, (c) provided an overview of Part C services, (d) described the development of a partnership to support the learning needs of pre-service educators, (e) described the development of learning opportunities that align course objectives, and (f) shared benefits and challenges that have developed through the partnership. The incorporation of practicum experiences is an integral part of a teacher education program and high-quality practicum experiences are needed to help bridge the disconnect between research and practice (Beck & Kosnick, 2002; Dunst et al., 2019; Odom, 2009). As previously noted, minimal research exists about the preparation of pre-service educators to collaborate and partner with families (Kyzar et al., 2019). Thus, a need exists in our field to share experiences about the benefits and challenges of creating learning opportunities for future professionals in our field. The development of a partnership to support pre-service educators in learning to apply evidence-based and recommended practices, particularly with families, is a topic which needs continued focus, research, and attention. At this time, more than ever, children and families need the support of highly-qualified, well-prepared professionals.

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Learning and Leadership through Sustainability Education: School-University Partnerships Supporting Collaboration and Student Voice

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Abstract: In an era of accountability, it is vital that schools can define their success in ways that transcend a single high-stakes testing day at the end of the school year. While student growth and proficiency are important educational measures, also focusing on health and wellness, stewardship of resources, and sustainability education, offers a unique and collaborative opportunity for learning communities to engage partners, reflect on goals and practices, and empower students, staff, and community members as change agents in the work. Sustainability education informs the preparation of educators and the collaboration of educators, community members, policymakers, and university personnel. This article offers insights and examples presented by a school-university partnership seeking to vitalize the three green pillars defined by the U.S. Department of Education Green Ribbon Schools award designation amid a pandemic setting.

KEYWORDS: Sustainability education; school leadership; school-university partnerships

NAPDS NINE ESSENTIALS ADDRESSED:
Essential 3: A PDS is a context for continuous professional learning and leading for all participants, guided by need and a spirit and practice of inquiry.

Essential 4: A PDS makes a shared commitment to reflective practice, responsive innovation, and generative knowledge.

Introduction

Schools can define their success beyond a test score. While student growth and proficiency are important educational measures, seeing a larger perspective that also takes into account health and wellness, stewardship of resources and sustainability education offers a unique and collaborative opportunity for learning communities to engage partners, reflect on goals and practices, and to empower students, staff, and community members as change agents in the work. This work was further empowered when multiple stakeholders from two different schools and a partner university joined together to focus on sustainability during a pandemic.

This collaborative learning community occurred in Wilmington, North Carolina, amongst D.C. Virgo, a K-8 lab school that the University of North Carolina Wilmington operates; Wrightsville Beach Elementary, a K-5 elementary school that is a part of New Hanover County Schools, and the University of North Carolina Wilmington (UNCW), a regional state university. The unique aspects of the coastal community provided a common element of "love of place" and innovation. Each school, however, was quite different, as their strengths and unique composition provided a different positionality from the other. This article will overview the collaborative efforts of all three schools, overview the U.S. Department of Education Green Ribbon Schools (ED-GRS) pillars, and highlight specific efforts that span inquiry and partnership work to engage students.

D.C. Virgo Preparatory Academy (DCVPA) is a school of about 200 K-8 graders in downtown Wilmington. The student body is over 90% minority, and over 95% receive Free-or-Reduced lunch. The school transitioned from a public middle school to a K-8 public lab school as a result of 2016 state legislation that was written to “re-define and strengthen university partnerships with public schools, improve student outcomes, and provide high-quality teacher and principal training" (UNC System, n.d., para. 3). This mandate resulted in a complete redesign of a preparatory lab school where collaboration between the university, New Hanover County Schools, and community partners resulted in a community-based school that opened in 2018. The building is noticeably dated yet well-maintained, with an open outside design, located in an urban area of the Burnt Mill Creek watershed (D.C. Virgo Preparatory Academy, 2021).

Just a few miles away is Wrightsville Beach Elementary School (WBS), a public elementary school of 271 students in grades K-5. The student body is 8% minority, and only 8.5% of the student body is eligible for Free-or-Reduced lunch. The school was recently renovated to maximize classroom views of the intercoastal waterway and has a new second-floor addition to provide natural lighting, outdoor learning areas allowing for learning gardens, and a pier to the

waterway for students to engage in marine exploration such as kayaking and fishing (Wrightsville Beach Elementary, 2021).

The University of North Carolina Wilmington is the state's coastal university, enrolling 17,915 students. The Wilmington campus is a part of the UNC System which is comprised of 16 universities. The student body is 21% minority, and 26% of students are Pell recipients. As an R2 Doctoral University, the institution takes pride in ties to the southeastern regional part of the state and the natural coastal surroundings and resources (The University of North Carolina Wilmington, 2021). The culture is shaped by diversity and globalization, ethics and integrity, and excellence and innovation. Through engagement, inquiry, and worldly exploration, experience and critical thinking are supported holistically in the student experience. These three schools, though distinctly different, share a common identity as a U.S. Department of Education Green Ribbon School awardee.

Defining a "U.S. Department of Education Green Ribbon School" – A Review

In 2012, the U.S. Department of Education (E.D.) launched U.S. Department of Education Green Ribbon Schools (ED-GRS) to recognize schools that showed progress in the following three pillars:

1. Pillar One: Reducing environmental impact and costs;
2. Pillar Two: Improving the health and wellness of schools, students, and staff; and
3. Pillar Three: Providing effective environmental and sustainability education (U.S. Department of Education, A, n.d.).

The ED-GRS is considered a "public engagement initiative structured as a federal recognition award for school sustainability," which "helps to facilitate state and local collaboration around school facilities, health, and environmental education" (Falken, n.d., p. 1). The framework for these three green pillars is further outlined in the ED-GRS *State Implementation Toolkit*, which describes the pillars in depth along with the application process as follows:

- Pillar One takes into account items such as reduced or eliminated greenhouse gas emissions, using an energy audit, efficiency improvements, conservation measures, water quality and conservation, reduced waste, and expanded use of alternative transportation.
- Pillar Two considers the health, nutrition, and outdoor physical education for students; health, counseling, and psychological services for both students and staff; family involvement; an integrated school environmental health program; safe buildings and grounds.
- Pillar Three encompasses interdisciplinary learning about the key relationships between environmental, energy, and human systems; use of the environment and sustainability to develop STEM content knowledge and thinking skills; and development of civic engagement knowledge and skills and students' application of such knowledge and skills to address sustainability issues in their community (Falken, n.d.)

The award is a public engagement recognition; it does not have funds or other incentives. Schools, districts, early learning centers, and postsecondary institutions apply to their state education authorities for their nomination to E.D.; there are state-specific requirements. States then submit their nominees to the Department of Education for final consideration (U.S. Department of

Education, B, n.d.). To date, over 340 schools have been recognized as well as over 60 school districts and over 35 Institutes of Higher Education (such as colleges, universities, and community colleges) (U.S. Department of Education, A, n.d.).

Research that examined recipients of the ED-GRS award perceived several benefits from green efforts (i.e., gaining a greater understanding of the ED-GRS framework, self-assessing work in the green pillars, promoting staff coordination and collaboration, to pursuing additional curricular and operations improvements) (Sterrett, Imig, & Moore, 2014). The ED-GRS pillars are evident by movement and dance breaks intentionally built into the school schedule, outdoor classrooms maintained by volunteers and custodial staff, and eco-friendly teacher workspaces (Sterrett, 2016).

Key strategies can include forming a Green Team to focus on aspects such as:

- engaging in energy savings efforts ranging from lighting conservation to rain collection
- reducing waste
- exploring outdoor learning gardens
- aligning curriculum, and
- sharing out the message about sustainability efforts to the school community (Sterrett & Imig, 2015).

These strategies offered a roadmap to consider the next steps as a collaborative team of partners engaged in sustainability work together.

Leadership is important for green school efforts, especially in seeking to become a "vibrant place for learning how to live more sustainably" (Kensler, 2012, p. 794). Kensler and Uline (2017) observe that today's school leaders are preparing students for new and unique challenges and leadership and can "design and lead new eco-centric models of school that not only serve the learning needs of students but also intentionally attend to the needs of local and global socio-ecological systems" (p. 14). From cultivating a vision for whole school sustainability to focusing on place, community, and partnerships, and from encouraging innovative teaching practices to supporting health and wellness initiatives, green school leaders "integrate sustainability ethics into their practice and thus facilitate students learning how to live in more sustainable ways" (Kensler & Uline, 2017, p. 39). This requires both understanding and intentionality in action. Additionally, this work also benefits from a collaborative partnership that strengthens this effort.

The UNCW PDS Model

The Professional Development System (PDS) School-University Partnership in the Watson College of Education (WCE) at UNCW is a complex set of collegial relationships forged among twelve P-12 school district partners and university programs, faculty, staff, and students. These longstanding professional relationships serve as the foundation of academic programs, providing WCE students a variety of diverse clinical experiences, site-based seminars, and a coaching and supervision model that is implemented across all educator preparation programs (UNCW PDS, n.d.).

PDS is based on the fundamental belief that, in order to improve student learning, we must work collaboratively to enhance the quality of teaching and leadership in our schools and educator preparation programs (UNCW PDS, n.d.). As a result, the WCE PDS is committed to designing

mutually beneficial opportunities for growth and simultaneous renewal, supporting a professional learning continuum. This continuum begins with the recruitment of future teachers and fosters the ongoing development of educators as they seek to transform P-12 teaching and learning in our region. In many cases, the relationships forged through our PDS serve as a foundation for identifying school and university-based needs and opportunities for innovation through collaboration.

Throughout the pandemic, many, if not all, of the core programming and initiatives supported through our PDS remained in place, allowing stakeholders the advantage of ongoing collaboration, innovation, and support. This included the dissemination of school and district-based needs assessments, opportunities for professional learning, research and grant partnerships, and, most significant to the green schools initiative, the identification, connection, and support of university faculty and school partners with the unique strengths and expertise needed to cultivate a successful ED-GRS partnership. The partnership also provided a relationship to share insights regarding the three green "pillars" that shaped the three schools' ED-GRS applications. Through the annual partnership needs survey, the PDS director convened a meeting between the associate dean and a partnership school, Wrightsville Beach Elementary, to discuss the ED-GRS framework and opportunities. Aware of the interest and expertise at D.C. Virgo and the university, the associate dean then convened a team of three schools to engage in a shared conversation about the three ED-GRS pillars and possible next steps.

Pillar 1: Efforts to Reduce Environmental Impact and Costs

At D.C. Virgo, it was clear that pursuing ED-GRS recognition would require multiple stakeholders to be engaged. A collaborative structure called the Support Team was instituted in Year 1 of its existence that included key school leaders such as the principal, assistant principal, operations coordinator, two teacher leaders, a school social worker, the University's College of Education dean, the associate dean, the PDS Director, and a Professional Experiences staff member. DCVPA demonstrated Pillar 1 through a student-led recycling program, water conservation efforts, and maximizing alternative transportation. An outdoor classroom that includes forward-facing wooden benches and a teaching podium station was available to use during the phased re-opening during the COVID-19 pandemic, where teaching and learning could continue in the outdoors with fresh air.

Efforts were taken before and during the pandemic to save energy and water. The intentional use of window blinds and transitioning to utilize more efficient light bulbs had helped result in energy savings, as had the benefit of rain barrels that captured runoff precipitation from the roof to water the surrounding landscape. Through collaboration with the New Hanover County school district to coordinate daily bus transportation (over 90% of students participated) and promote safe walking and biking as a viable option, an estimated 100,000 gallons of gas were saved annually than if each student was driven to school separately. The DCVPA assistant principal provided weekly composting instruction to upper elementary students and worked with them to collect and empty recycling bins strategically placed around the school (D.C. Virgo Preparatory Academy, 2021).

Just a few miles away, Wrightsville Beach Elementary School (WBS) had recently undergone a significant renovation to bring in more natural light, redesign learning spaces, and accentuate the barrier island natural surroundings that allow a beautiful and engaging outdoors. Students can now view the intercoastal waterway from their classroom windows, fish from the

dock, learn about the marsh ecosystem, and walk to Wrightsville Beach for sand sweeps and seashell collections. Similar to D.C. Virgo, a group of 3rd-grade students lead a school-wide recycling effort and produced overview videos to encourage sustainable practices. Multiple outdoor covered areas are available for classroom instruction, small group lessons and activities, and presentations. A sizeable outdoor site contains soil material from a phosphate mine, including fossils that date to the Eocene Epoch.

Photo 1
Students learning with raised garden beds at Wrightsville Beach Elementary

The landscape around the school was designed to include native plants and vegetation that do not require irrigation, and raised garden beds were installed to provide a hands-on area of learning for students. Upgraded plumbing was established through the renovation project to reduce water use through low-flow fixtures and waterless urinals. At WBS, one-third of students ride the bus, about 15% walk or ride bikes, and a significant number of students carpool, saving energy throughout the year. New drainage systems were installed to redirect stormwater drainage and reduce erosion in the area (Wrightsville Beach Elementary, 2021).

The University of North Carolina Wilmington reduced the campus's energy use and greenhouse gas emissions, using 2002 data as a baseline. The university led the UNC system in the goal set by the System Office to reduce energy by 30% in 2015. This was accomplished through performance contracting, the construction of new energy-efficient buildings, and retrofitting lighting, ensuring that over 95% of outdoor lighting bulbs are LED. The university continues to reduce its impact with educational programming, institutional commitments to reducing

greenhouse gases (such as plant-forward menus), and infrastructural improvements to create efficiency and resiliency. Waste diversion efforts are emphasized across the campus, such as water bottle refill stations bolstered by the Student Government Association. The campus was designed as a pedestrian-friendly area and supported various alternative transportation methods. In addition to a university shuttle system, bicycle infrastructure and a multimodal path connecting the two areas of interest in the community weaves through the campus.

Additionally, natural areas and landscaping are critical to this work, given its coastal location. UNCW partnered with the North Carolina Coastal Federation to work on stormwater projects via an EPA grant. The project included four rain gardens and retrofitting parking lots with permeable surfaces, which "allows stormwater to penetrate through, diverting it from the drain and the stormwater system that carries the untreated water directly to the Intracoastal Waterway" (University of North Carolina Wilmington, 2021, p. 4) and ultimately managing over one million gallons of water over a three-year period.

This work furthered the existing stormwater management efforts, such as utilizing reclaimed water for irrigation and planting native flora in all-new landscaped areas. The campus hosts a ten-acre wildflower preserve in the center of the main campus and over 330 acres of natural areas on the main campus and in satellite areas. These spaces are home to native, vulnerable species and are cared for with organic maintenance and a robust integrated pest management plan (University of North Carolina Wilmington, 2021).

Pillar 2: Efforts to Improve the Health and Wellness of Students and Staff

The D.C. Virgo learning community is focused on both the physical health and the social-emotional needs of students through prioritizing a "kinship model" to foster relationships amongst the school community. The school opened an Action-Based Learning (ABL) room by refitting a classroom with ABL equipment, involving the teaching staff in ABL training, and encouraging regular movement breaks throughout the school day to re-center students for learning. The school leadership team, which includes the school administrators, College of Education dean, teacher leaders, and other university faculty and staff, sought feedback from the community in designing and installing outdoor learning spaces.

Photo 2
Action-based learning room at D.C. Virgo Preparatory Academy

The school has incorporated essential restorative practices, resulting in reduced discipline referrals and subsequent time spent out of classroom instruction. All grades participate in a daily morning meeting that includes mindfulness and engages students as a part of a learning community. In the center of the middle school learning area is a restorative room where students can "take ten" to calm down, process elevated emotions, and return to the classroom setting ready to re-engage in learning (D.C. Virgo Preparatory Academy, 2021).

At nearby Wrightsville Beach Elementary, the school also has engaged in social-emotional learning and movement breaks. During the day, movement breaks using “Go Noodle” materials along with Mindset breathing techniques and “Chime time” promote focus and engagement, and the coastal proximity and climate allow for regular outdoor activities, ranging from kayaking on the adjacent intercoastal waterway to walking or running laps around the campus track.

Photo 3
WBS students and staff kayaking in the coastal waterway

Fifth-grade students at WBS learn to ride in tandem kayaks as a part of the school's annual Kayak Race. The school counselor uses an evidence-based sun safety curriculum to teach sun protection education for grades K-5. Families are encouraged to ride bikes to school and walk, and the school hosts running clubs for both boys and girls. Parent volunteers play a crucial role in the running clubs that have since spread to other schools, promoting positive emotional, social, mental, and physical development (Wrightsville Beach Elementary, 2021).

At UNCW, supporting and nurturing the mental and physical health of the university community is a top priority. The Healthy Hawks program includes the eight dimensions or pillars of health that include engagement, emotional, financial, intellectual, occupational, physical, spiritual, and sustainability. Sixty-seven different departments and organizations hosted Healthy Hawks programming, and over 40,000 community members participated in the related programming. The use of outdoor space to connect with nature and reduce stress is intertwined with the beautiful campus and coastal climate. A wildlife preserve is in the center of campus and includes over a mile of trails that meander through longleaf pines, beside a lake, alongside carnivorous plants, and amongst hardwoods.

Leadership supports the Environmental Health and Sustainability (EH&S) mission of "leading the university to a safe, healthy, and disaster-resilient culture by providing educational, technical and operational services to support the campus community" and addressing both "regulatory compliance and actual losses associated with environmental, health, and safety issues" An integrated approach involving EH&S and the Facilities Offices, senior management ensures that the university responds to immediate needs and plans for long-term implications of living and learning near a coast prone to hurricanes and potential ecological events (University of North Carolina Wilmington, 2021).

Pillar 3: Efforts to Ensure Effective Environmental and Sustainability Education

As a K-8 university-supported lab school, D.C. Virgo collaborates with UNCW faculty and staff, such as the UNCW Sustainability Peer Educators. They provide students with weekly presentations on sustainability topics such as how plants affect air quality, the importance of water, and recycling at home and school. Staff and university collaborators distributed "plant packages" to grow and monitor plants during the pandemic, and students were then able to transfer them to the garden bed at school. A community volunteer (and UNCW doctoral student) worked with teachers to introduce mycology in the science lab and revamp the outdoors learning garden. The weekly mycology session introduces the students to the concepts of mushroom tissue transfer to Petri dishes, transferring the mycelium culture to sterilized grain, and transferring the myceliated grain spawn to sterilized sawdust or pasteurized wheat straw substrates. Participating in activities involving all aspects of mushroom growing provides the students with a hands-on experience of microbiology concepts.

The outdoor learning garden provides students a hands-on learning opportunity to experience growing vegetables, herbs, and flowers. The plants intrigue the students, but equally intriguing are working with the soil and observing different bugs that are part of the small garden ecosystem. Watering the plants using rainwater collected from the school building's roof, planting, weeding, and cultivating are some of the regular garden activities. This work started with the middle grades and has expanded to include elementary grades and community volunteers, notably from the New Hanover County Master Gardener Volunteer Association.

Photo 4

DCVPA Students working with volunteers at the learning garden

DCVPA teachers and a university professor collaborated to teach Saturday sessions related to environmental and sustainability concepts such as meteorology, agriculture, STEM careers, and maritime. A National Science Foundations (NSF) Research Experiences for Undergraduates (REU) grant was awarded as a three-year effort to provide experiences for first-year university students and DCVPA K-8 students to understand the marine sciences better and spark interest in career pathways related to the environmental sciences. School and university leadership fosters and supports collaborative relationships to sustain this work, especially during unexpected closures pertaining to events such as a hurricane or pandemic (D.C. Virgo Preparatory Academy, 2021).

Wrightsville Beach Elementary School utilizes its coastal surroundings to enhance student learning through an engaging Marine Science Program that features team-building, problem-solving, citizenship, and responsibility. The school counselor also served as the Marine Science Coordinator, and the program grew over 20 years to include classroom education, community outreach, interdisciplinary learning, and citizen science projects. School leadership then collaborated to integrate marine science concepts into every grade level at the K-5 school.

All WBS classes regularly walk to Wrightsville Beach for beach sweeps, beach and dune investigations, and seashell collections. Taking learning walks to the salt marsh, maritime forest, dune, and beach allow 5th-grade students to learn about the Barrier Island and surrounding ecosystems. Teachers have professional development opportunities to advance environmental sciences. Community outreach plays a significant role in engagement efforts, such as shorebird sanctuary signage and extension classes for other district schools (Wrightsville Beach Elementary, 2021).

At UNCW, interdisciplinary learning is a crucial focus in promoting efforts such as the Sustainability Learning Community, a first-year learning and living community anchored in three courses that focus on the dynamic between people, planet, and profit. It includes outreach efforts such as implementing compost programs at local shelters. Green initiatives undertaken by the Sustainability Minor students include building a solar-powered charging station for campus events, surveying coastal businesses for sustainability practices, and creating a documentary of sustainable "points of pride" across the state of North Carolina.

Photo 5
UNCW Sustainability Learning Community Solar Charging Station

The university's focus on sustainability extends into the community. Engagement efforts include hosting regional Science Olympiad competitions, providing professional development workshops for in-service teachers; loaning STEM equipment to caregivers for the unique education community; and securing grant funding to bring programs like MarineQuest to rural, underserved schools. Civic engagement is also a focus; the Office of Student Leadership and Engagement (OSLE) creates opportunities for UNCW students, fraternities, and sororities to serve others in their communities. Examples include the Diaper Bank of North Carolina, Rise Up Community Farm, and Nourish NC. The UNCW Sustainability Garden donates fresh produce at the end of each growing season as a part of the Hawks Harvest initiative. Shared leadership efforts have strengthened partnership work and enabled sustainability efforts to thrive even amid crises such as hurricanes (University of North Carolina Wilmington, 2021).

Implications

Purposeful Partnerships

This unique, collaborative effort was made possible through shared leadership and partnership synergy. The PDS relationship between the university and the partner schools jumpstarted the conversation about pursuing ED-GRS recognitions. An initial conversation with the PDS director, principals, and associate dean expanded to include larger green teams of teacher leaders, university experts, and doctoral students. The green teams that came together from each school collaborated on thinking through the three green pillars and encouraged each other through the process while being continually mindful of the ultimate goalkeeping students at the forefront of the work. Green school efforts provide educational leaders a unique and vital opportunity to "deepen the relevance of the school experience for children and deepen their connection to local and global communities" (Sterrett et al., 2016, p. 81). Recognizing volunteers who played a crucial

role in maintaining learning areas, teaching a mini-lesson, or supplying compost materials helped encourage and foster shared ownership of the work (Sterrett, 2011).

Strength of Multiple Stakeholders

Shared leadership roles in this collaborative work helped realize challenges and opportunities, affirmed the work of students and staff, and further engaged community members. The role of teacher-leaders was pivotal, as they have the most frequent contact with students in school. The school administrators, including the principal, assistant principal, and coordinator, served as stewards of resources, from staff and volunteer time and expertise to physical plant and budgeting considerations, as overviewed by the assistant principal, community volunteer, and associate dean in this video clip. The school social worker helped strengthen school culture through restorative practices, as described by both students and staff in this video clip. Teacher leadership was key in championing these efforts and gauging student success and engagement. Teacher leadership occurs when a learning environment provides space for others outside the organization to present new ideas and experiences, as shared by this teacher overviewing mycology efforts. While leading, teachers should be willing to learn and display their openness to engage in new experiences. Through shared partnerships with sustainability experts, students were presented with chances to view the teacher as a learner and themselves as the educator.

Student engagement

The willingness to be open to new practices and experiences should lead teachers to diverse student learning and student success perspectives. For example, through the teacher's desire to learn and provide a space for mycology lessons within DCVPA sixth grade science classes, E.C. students were able to demonstrate to others their comprehension of scientific processes techniques utilizing verbal communication and modeling strategies. The DCVPA students' capabilities provided evidence to others within and outside the learning environment of how student leadership expands beyond the limitations of what others deem superior academic achievement. Teachers and students can foster learning relationships and a love of place, as overviewed in this video about the WBS Marine Science program. The development of sustainability education programs within the learning environment provided a context of how learning occurs richly and authentically.

The construction of the DCVPA recycling program resulted from student voice and activism. Encouraging students' voices led to the student-led recycling program, as highlighted in this video. The initial willingness and engagement of new ideas by DCVPA teachers have resulted in new visions of learning success and leadership. The eagerness to learn demonstrates how educators can develop sustainable partnerships to strengthen student learning experiences aligned with curriculum standards. The role of the College of Education partnership director and associate dean helped connect faculty expertise with partnership strengths and innovation. And the university sustainability officer provided insights regarding data and best practices and championed university student engagement in an ongoing manner.

Preparation and professional development

Leadership preparation and professional development should focus on sustainability efforts. Louv (2012) has highlighted the growing body of evidence on how outdoor experiences can enhance students' ability to learn and the positive impact on both physical and mental health, along with the fact that education must prepare a new generation of leaders to innovate "new sources of energy; new types of agriculture; new urban design and new kinds of schools, workplaces, and health care" (p. 183). Today's educational leaders can help prepare students to be that next-generation focused on innovation and sustainability. School-university partnerships can foster this work by providing time and space to share interests and expertise, consider new learning opportunities, and affirm collaborative work.

Conclusion

This shared sustainability work has resulted in student engagement and learning. Forged through partnership and strengthened by a shared vision of what it means to be a "green school," this effort, undertaken during the onset of the pandemic, affirmed the work of students, staff, and partners at the school and university. Both schools and the university not only completed the application process, but all three organizations also received the U.S. Department of Education Green Ribbon School (ED-GRS) recognition. After being invited to the fall 2021 ED-GRS ceremony in Washington, D.C., the U.S. Department of Education also selected them to be part of the "Green Strides Tour," in which federal and state officials visited the ED-GRS recipients as a part of a statewide tour (NCDPI, 2021). This tour highlighted how this effort brought partners together in the pandemic, connecting stakeholders with varying areas of expertise. The three pillars can provide a means to strengthen aspects of the partnerships, as depicted in Figure 1.

Figure 1
ED-GRS Pillars as connectors of engagement and collaboration

Shared conversation of sustainability education		
Pillar 1 **Reducing Environmental Impact**	**Pillar 2** **Improving Health and Wellness**	**Pillar 3** **Environmental Education**
"How can we be good stewards of our resources?"	"How might we encourage healthy choices and habits for students and staff?"	"How might we consider ways to infuse environmental education in teaching and learning?"
Weekly composting instruction at DCVPA School-wide recycling effort at WBS Waste diversion efforts such as water bottle refill stations at UNCW	Action-Based Learning and regular movement breaks at DCVPA. Regular outdoor activities, such as kayaking on the intercoastal waterway at WBS A wildlife preserve in the center of campus includes over a mile of trails at UNCW	Teaching mycology in the science lab and revamping the outdoors learning garden at DCVPA Marine-Science Program features team-building, problem-solving, and responsibility at WBS A first-year Sustainability Learning Community anchored in three courses at UNCW

The application and subsequent recognition tour highlighted student and staff leadership in this work. Students were engaged in leading the recycling collections, and their voices came through as they led the tours. The process, and the recognition, provided a sense of affirmation and pride that went beyond mere test scores. The shared sustainability partnership work itself defines the three learning communities. It has created a new overlap, bringing students and staff together by focusing on hope, agency, and commitment to critical societal issues that span health and wellness, sustainability practices, and stewardship.

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Using Practice-Based Teaching Experiences to Leverage Teacher Candidate Effectiveness

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Abstract: Concerns about the lack of connection between university-based teacher education courses and clinical experiences have long been shared. Practice-based teacher education has been offered as one way to connect these two aspects of teacher education closer together. However, descriptions about how to implement practice-based teacher education in ways that support student learning in clinical experiences is lacking. In response to this area of need, this article describes how two mathematics teacher educators implemented practice-based teacher education in their mathematics methods courses. One course took place in a university setting with a clinical component while the other took place during a mediated field experience, in which the course and clinical practice experiences took place in an elementary school. Implications and considerations for future school-university partner work are shared.

KEYWORDS: Practice Based Teacher Education, Elementary Mathematics Teacher Education, Mediated Field Experience, University and School Partnerships

NAPDS NINE ESSENTIALS ADDRESSED:
Essential 2: Clinical Preparation, A PDS embraces the preparation of educators through clinical practice.

Essential 8: Boundary-Spanning Roles, A PDS creates space for, advocates for, and supports college/university and P–12 faculty to operate in well-defined, boundary-spanning roles that transcend institutional settings

Introduction

"You could ask, 'How many vertices does the shape have?'" one of my students shared. "Oh, you can also ask them about the number of sides!" another student contributed. The teacher candidates were identifying different questions they could ask that would elicit and deepen their third-grade students' thinking about shapes. As we wrapped up the discussion, I asked my teacher candidates if they were ready to work with their third-grade math buddies – I was met with a very enthusiastic "Yes!"

The opening story exemplifies the enthusiasm that many teacher candidates (TCs) have about their field experiences and provides a small glimpse into the essential intentional preparation needed for TCs to support student learning during these clinical practice experiences. Research has shown that field experiences, a substantial portion of teacher education programs, provide important opportunities for teacher learning (Zeichner, 2010). Yet, one of the major challenges facing teacher education is the lack of coordination between the clinical and course work experiences (Campbell & Dunleavy, 2016; Zeichner & Bier, 2015). Such a lack of connection between these two aspects of teacher preparation programs lessens the potential growth for TCs and the impact TCs can have on student learning during their field experiences.

Concerns about a lack of connection between the field placements and university courses have been ongoing in teacher preparation programs (Wasburn-Moses, Kopp, & Hettersimer, 2012; Zeichner, 2010). A contributing factor to the disconnect between the clinical and coursework is that teacher education typically takes place in two distinct contexts, the university and in a school, with TCs responsible for navigating between the two settings (Britzman, 2003). Additionally, the classroom teacher in the clinic placement may be unfamiliar with the teaching methods taught in the university course and/or with methods for educating TCs (Zeichner, 2010). As a result, TCs may not receive the support in their clinic placement for translating or recognizing the practices learned in their coursework, such as the practices shared within mathematics methods course.

Further, teacher education courses have emphasized learning about teaching rather than centering the practice of teaching (Hurlbut & Krutka, 2020). As a result, TCs may only learn how to implement specific teaching practices if they happen to experience them in their field placement or complete a related assignment. TCs' development of the skills critical for effective teaching is then left up to chance (Forzani, 2014). Because classrooms and teaching styles vary widely, there is much variance in what TCs experience in their field placement.

Practice-based teaching has been advanced as one way to address the gap between university courses and field experiences and importantly bring the work of teaching to the center (Ball & Cohen, 1999). A practice-based approach to teacher education focuses on designing and implementing rich learning opportunities for TCs in university-based methods courses and field experiences (Ball & Forzani, 2009; Janssen et al., 2015). The intention of this approach is to more closely link the experiences within the university classroom and the clinic placement. Importantly, practice-based teacher education (PBTE) focuses on TCs acquiring the skills necessary to teach students in ways that support their learning (Peercy & Troyan, 2017) However; there is limited work that describes how teacher educators have engaged with practice-based pedagogies (Kazemi et al., 2016).

One risk that researchers have identified with practice-based teacher education is that an emphasis on core teaching practices can peripheralize equity and justice (Philip et al., 2019).

Recognizing this risk, we sought to ensure that our focus on practice-based teaching contributed rather than detracted from promoting equitable teaching practices in schools. Additionally, all of the PBTE work at our university is set in the context of equity-based teaching practices. The focus on equity aligns well to the National Council of Teachers of Mathematics' Principle of Access and Equity (NCTM, 2014), which contends that students need access to high-quality mathematics experiences aligned to grade-level Standards, qualified teachers, and supports that will contribute to all students' mathematics achievement and success. Gutierrez (2009) has argued that equity-based mathematics teaching includes experiences that develop learners' identity as learners and doers of mathematics, instances where learners have power to make sense of mathematics, access to high-quality teaching, and supports are put in place that leads to all students' mathematics achievement.

The purpose of this manuscript is to share how two elementary mathematics teacher educators integrated PBTE approaches set in the context of equity-based teaching practices to develop the mathematics pedagogies of TCs. The PBTE approach used by both mathematics teacher educators included rehearsals as well as strategically designed clinical practice activities, in partnership schools. First, we will present a background of PBTE and rehearsals. Then we will share two vignettes. The first describes how a mathematics teacher educator integrated PBTE pedagogies within a university-based mathematics methods course with intentionally-designed clinicals in partner schools. The second vignette describes how PBTE was infused within a mediated field experience (MFE). A MFE is an approach to teacher education that provides TCs with opportunities to engage with the instructional practices learned in teacher education courses in a real classroom with the support of a mathematics teacher educator (Pinter, 2021). The two vignettes of the teacher educators implementing PBTE will be used to highlight the ways that practice-based teacher education can support TCs in learning and improving their methods for teaching mathematics and importantly, how the TCs applied the methods to support student learning during clinical practice experiences in partner schools.

Synthesis of Related Literature

Overview of Practice-based Teacher Education

Over the past decade, there has been growing momentum for restructuring teacher education programs to focus on the practice of teaching (Ball & Forzani, 2009; McDonald et al., 2014). While the turn to PBTE is not new (Zeichner, 2012), some argue the current emphasis on core practices within practice-based teaching is a unique emphasis (Forzani, 2014). In recent work focused on PBTE, it is "less concerned with where teachers' training takes place and more with what teachers are helped to learn and how they learn it" (2014, p. 358). The emphasis on what and how TCs are learning can help to refocus teacher preparation on teaching the practices necessary to support student learning.

A model that describes the elements of PBTE is described in Table 1. Researchers at the University of Washington (Teacher Education by Design, 2014) as part of the Teacher Education by Design project conceptualized PBTE with the learning cycle that includes four stages: Introduce, Prepare, Enact, and Analyze. Each of these cycles was included in both the university-based and mediated field experience course sections described in this article.

Table 1
Learning Cycle of Practice-based Teacher Education (Adapted from TEDD, 2014)

Stage of the Learning Cycle	Description of the Stage
Introduce	Teacher educator introduces a teaching practice through modeling, analysis of video, or decomposing specific aspects of the teaching practice.
Prepare	TCs plan an instructional activity and get feedback on it. This includes the activity as well as questions they would pose. TCs rehearse (practice) teaching the lesson to a small group or whole group of colleagues. TCs receive feedback on specific aspects of their rehearsal.
Enact	TCs teach the instructional activity to students. TCs collect student work and/or other artifacts when possible.
Analyze	TCs reflect on their enactment using specific prompts focused on the instructional practice. TCs use student work and/or other artifacts to support their analysis of their enactment. The focus can be on their teaching and/or students' learning.

Eliciting and Interpreting Student Thinking

The core practices for PBTE were identified as commonly used teaching practices critical to student learning that cut across content areas and grade levels (TeachingWorks, 2020). One of the core practices is eliciting and interpreting student thinking (Gotwals & Birmingham, 2016; TeachingWorks, 2020; Shaughnessy & Borest, 2018a). While eliciting and interpreting student thinking is a practice used across content areas, this practice has been defined specifically for mathematics (TeachingWorks, 2020). The National Council of Teachers of Mathematics (NCTM; 2014) notes that "effective teaching mathematics uses evidence of student thinking to assess progress toward mathematical understanding" (p. 53). Such that teachers elicit student thinking beyond whether an answer is correct or not correct (Crespo, 2000) and respond to student ideas in ways that probe and further their conceptual understanding of mathematics (NCTM, 2014).

The process of eliciting and interpreting student thinking is important to the formative assessment process (Shaughnessy & Boerst, 2018b; Wiliam, 2007). Formative assessment is the process of gathering and analyzing information about student understanding related to a specific learning goal and then using this information to decide how to best move student learning forward (Black & Wiliam, 2009). Such a process is important for increasing student learning (Black & Wiliam, 2003). Teachers who effectively engage in the formative assessment process elicit and interpret students' thinking to assess student understanding, make-in-the moment instructional decisions, and also use this information to plan subsequent lessons (NCTM, 2014).

Since eliciting and interpreting student thinking happens in the moment and is responsive to student's mathematical thinking, it is a complex practice for TCs to develop (Colonnese et al., 2022; Shaughnessy & Boerst, 2018b). Research has shown that TCs who have increased

opportunities to learn and apply content specific teaching practices are more effective (Lustick & Sykes, 2006). Further, previous studies found that TC's skills related to eliciting and interpreting student thinking were possible to develop while teaching lessons in small groups instead of to a whole classroom of children (Polly, 2021). TCs also often desire and benefit from coaching and additional in-classroom support to help them pose tasks and questions that allow opportunities for them to elicit their students' thinking (Reinke et al., 2022). Thus, it is important for teacher educators to provide multiple opportunities for TCs to practice this teaching method and to draw connections between their university and school-based field placements.

Implementing Practice-Based Teacher Education

Grossman et al. (2009) identified three components necessary for teaching instructional practice: representations, decompositions, and approximations of practice. Representations refer to the different ways the practice is enacted. Decomposition is breaking the practice into parts for both teaching and learning and approximations are opportunities for TCs to engage in practices that are proximal to actual teaching practice. The three components offer an initial framework for designing rich learning experiences to engage TCs in the core practices such as eliciting and interpreting student thinking.

Rehearsals have been advanced as one kind of rich learning experience to engage TCs in the decomposition, approximation, and representation of the core teaching practices (Colonnese et al., 2022; Ghousseini, 2017; Polly et al., 2019). Rehearsals of teaching practice typically take about fifteen minutes and provide TCs with an opportunity to try out the practice with guidance from the course instructor before enacting this practice with students (Lampert et al., 2013). Because the rehearsals occur in the university classroom, the teacher educator can pause at important moments to help TCs realize specific aspects about the practice and discuss instructional decisions (Colonnese et al., 2022; Kazemi et al., 2016). The ability to pause also allows the TC to stop, ask questions, and confer with their peers and the course instructor. The brief discussions provide TCs an opportunity to consider different actions and the consequences of those actions.

In an analysis of rehearsals, Kazemi et al. (2016) shared three insights to leading rehearsals: fostering a culture of making practice public; opportunities for approximations and enactment in the actual classroom of the instructional activities; and the proximity of the rehearsal and enactment with students. Designing rehearsals with these three insights can help to maximize the potential for TC learning and refinement of the instructional practice. Important to leading the rehearsal is the intentionality of the experience including the activities that happen before and after the rehearsal, the instructional activity selected, and the choices made in the moment by the teacher educator.

Our aim is to describe how we used rehearsals, using vignettes, in two different structures of mathematics methods courses to highlight how we supported our TCs in developing their ability to elicit and interpret student thinking. We share these vignettes to provide other teacher educators with examples as to how rehearsals can be implemented with the common purpose of improving TC practice and their potential to support student learning in clinical placements.

Description of Practice-Based Teacher Education Activities

Context for Our Work

The vignettes shared in this article are situated within the first of two mathematics methods courses in a teacher education program that prepares individuals to teach elementary school (Grades Kindergarten through Grade 6). TCs typically take 5 courses during this semester: the mathematics methods course, a literacy course focused on phonics and early literacy skills, a course on diversity and multicultural education, a child development and learning theory course, and a course on instructional planning and assessment. The first mathematics methods course focuses on mathematics content and pedagogies for primary grades. As a college, we elected to focus on three core practices, eliciting and interpreting student thinking, small group work, and whole class discussion. Then within our department we decided the first mathematics course, which is the focus of this article, would focus on eliciting and interpreting student thinking because we saw this as foundational to the other two practices. The vignettes shared in the next section are from two different sections of the first mathematics methods course (Section A and Section B). The teacher educators of the two courses co-designed the course with one other mathematics educator and regularly collaborated and shared instructional activities.

University-Based Mathematics Methods Course

Section A of the mathematics methods course took place at the university with an intentionally-designed clinical practice component in partner schools. Section A had 21 TCs. The TCs met three times a week for fifty minutes for in-person activities. As part of the clinical practice experiences, TCs completed 30 hours of activities that included mathematics and literacy. The mathematics activities are described in Table 2.

Table 2

Clinical Practice Activities in University-based Mathematics Methods Course

Clinical Activity	Description
Observations	Observe 2 mathematics lessons and complete a form in which you describe the mathematics tasks, the actions of the teacher, the grouping of students (whole group, small group, partners).
Assessment of 2 students	Complete 2 number sense assessments with 2 students each. Students should vary in terms of their performance in mathematics class.
Teach a number talk	Teach the number talk (dot images or equations) that you rehearsed during class. Reflect on students' responses and the extent to which you elicited student thinking.
Small Group Problem Solving Lessons (3)	Teach the same small group (3 to 5 students) 3 lessons focused on word problems. You should adjust future lessons based on student performance in your lessons.
Teach a notice/wonder/do OR a 3 Act Task	Use the library of 3 Act Tasks (gfletchy.com) OR use your own picture/video to teach a notice/wonder/do or a 3 Act Task to students.

Mediated Field Experience

Section B of the mathematics methods course was part of a MFE. The MFE took place at a local elementary school to strategically connect the university-based instruction with the expertise of the school-based educators (Zeichner, 2010). The 23 TCs met twice a week for an hour and fifteen minutes. The course instructor engaged the TCs in learning and practicing mathematics methods for forty-five minutes and then the TCs spent thirty minutes working with second- or third-grade students. The TCs started the semester working one-on-one with a student and then transitioned to teaching a small group. The classroom teachers and the course instructor selected this structure because the TCs were at the initial stages of learning methods for teaching mathematics. As a result, one student would allow the TCs to try out methods for eliciting student thinking and find out what worked for their particular student without also managing a small group. The teachers and course instructor also felt this was an important opportunity for the TCs to develop positive relationships with the students and for the students to receive one-on-one instruction. The mathematics activities are described in Table 3.

Table 3
Clinical Practice Activities in the MFE Course

Clinical Practice Activity	Description
One-on-one tutoring	Work with an assigned math buddy to support mathematics learning. Responsible for eliciting and interpreting student thinking. TCs complete a weekly log to record their observations.
Observation	Observe the course instructor teach a whole class lesson. Participate in a class discussion to identify the tasks, questions used to elicit student thinking, and analyze why instructional decisions were made during the lesson.
Assessment of 1 student	TCs complete two one-on-one assessments with one student. The first assessment focuses on fact fluency and the second assessment on problem-solving. TCs reflect on their ability to elicit student thinking. TCs interpret and analyze the information gathered through the assessment.
Small Group Problem Solving Lessons (6)	TCs collaboratively analyze their assessment results. TCs then made groups of 2-3 students, using their assessment data and knowledge of the student, to plan six lessons to teach. The TCs were each responsible for being the lead teacher for three of the lessons and serving as an observer focused on what students are doing for the other three of the lessons. TCs adjusted lessons based on student needs.
Mathematics Game	TCs develop a mathematics game based on the concepts and skills they have identified as areas that their students need extra support. TCs will identify the big mathematical idea and questions to ask students as they play the game to elicit mathematical understanding.

Table 4 provides an overview of one of the PBTE learning cycles that occurred during Section A and B of the mathematics methods course. There were several PBTE cycles that the TCs engaged in throughout both mathematics methods courses. We decided to describe the number talk in Section A and the one-on-one interview in Section B because they each represented two different kinds of instructional tasks that can be used during a PBTE learning cycles. Our intent was to demonstrate the different ways that the instructional tasks offered TCs opportunities to rehearse, practice, and receive feedback on eliciting and interpreting student thinking.

Based on the current research and our initiatives in our educational preparation program we decided to examine TCs experiences. We framed this examination around the broad research question: What did TCs report about their experiences during PBTE learning cycles and clinical experiences teaching mathematics to elementary school students? In the rest of this article, we briefly describe the methods of examining TCs experiences as well as vignettes based on the data collected during the experiences.

Methods

Since the current research states that there is potential and benefit to both field mediated course experiences and intensive, intentionally-designed clinical practice activities the goal of this article is to not directly compare the two approaches. Additionally, our goal with this paper is to provide a description of what TCs did and their experiences. Therefore, in the following section we share a vignette from Section A that further describes the word problem learning cycles as well as a vignette from Section B that describes the one-on-one interview. We selected these vignettes to demonstrate the different ways that TCs can be engaged in the PBTE learning cycles. In each vignette we share the stages of the learning cycle and take-aways from our TCs.

Since the authors were also the course instructors, the data sources for these vignettes came from course instructor's instructional materials housed in the university's Learning Management System as well as course assignments that TCs completed. The primary assignment that was used was TCs reflection about their clinical field experiences.

Table 4
Description of the Learning Cycle in these Vignettes (Adapted from TEDD, 2014)

Stage of the Learning Cycle	Course Section A (university-based)	Course Section B (MFE)
Cycle 1	**Number Talks**	**One-on-One Interview**
Introduce	● Number talks were modeled and facilitated by the course instructor four times. ● The decomposition of eliciting and interpreting student thinking (TeachingWorks, 2020).	● Strategies for eliciting and interpreting student thinking were modeled and discussion about them facilitated by the course instructor during the prior five weeks. ● TCs engaged in readings focused on strategies for solving addition, subtraction, and multiplication facts.
Prepare	● TCs planned number talks and collaborated to brainstorm questions that they would ask. ● TCs rehearsed them using simultaneous rehearsals during class.	● TCs prepare for one-on-one interviews in a simulated interaction with peers. ● TCs plan using the support of a planning tool
Enact	● TCs taught number talks to students in their clinical experience. Nearly all TCs did this in a small group setting, but a few opted to facilitate a whole class number talk.	● TCs conduct a one-on-one interview with a student focused on eliciting the students' thinking about how to solve addition, subtraction, and/or multiplication facts. ● TCs listened carefully, recorded student thinking, and responded to student ideas.
Analyze	● TCs shared during class meetings how the experience went. ● TCs reflected on questions that they asked to elicit thinking and the extent to which students' responses influenced either follow-up questions or the modification of the next part of the number talk.	● TCs shared in the following class meeting about the questions they asked to elicit student thinking and how that influenced their follow-up questions. ● TCs collaboratively interpreted the information gathered from the assessment and discussed next steps for the students.

Vignettes from Both Course Sections

Vignette from University-based Mathematics Methods Course

It was week 8 of the course and there were three 50-minute class meetings left until the TCs were going to begin teaching their problem-solving small group lessons in our partner schools. Intentionally, the course instructor had focused on three goals for the week to focus on maximizing the likelihood that TCs would positively impact students' learning when they taught their lessons: (1) revisiting aspects of equity-based teaching, (2) Providing opportunities to interpret student thinking and make decisions about future tasks, and (3) rehearsing the lesson with a focus on eliciting and interpreting student thinking.

Revisiting Aspects of Equity-based Teaching

Gutiérrez' framework for equity (Gutiérrez, 2009) is front and center in this section of the course. From the first meeting, we unpack the dimensions of access and power as priority aspects, and also address the other dimensions achievement and identity. From a problem-solving perspective during weeks 5 through 7 we spent time discussing how commercial curricula often do not give students access to high quality learning opportunities and that we need to be intentional on how we introduce and teach word problems in a way that gives students agency and power to make sense of the mathematics in their own way.

During Week 8 we evaluated problems from a commercial curriculum and discussed ways to modify the problems to increase access and power. We also spent time reading an article and discussing ways that we can pose questions to students who are starting problems, working on problems, or have finished a problem, in order to elicit their thinking and start to interpret students' understanding and performance (Jacobs & Ambrose, 2008).

Providing Opportunities to Interpret Student Thinking

During Weeks 6 and 7 TCs spent time writing or modifying word problems from the course instructor's problem-solving website. For each lesson they worked with other TCs during class to discuss ways to increase access or increase rigor of tasks word problems on student thinking and/or their work on the first word problem in a lesson. TCs observed and practiced strategies such as adjusting the size of the numbers in the problems, providing access to more hands-on manipulatives or encouraging students to solve a problem using both manipulatives and paper-pencil strategies, and modifying the complexity of language in the word problems.

The focus on eliciting and interpreting student thinking had been central in the course all semester. Previously in clinical practice experiences TCs spent time observing the extent to which their clinical educators elicited student thinking and modified problems or how they taught based on students' thinking and/or performance. Further, during course activities TCs looked at student work and discussed what subsequent problems and teaching strategies should be used. While this work had been done before, TCs had not been in a position where they needed to do this immediately in the moment of teaching until the rehearsal in Week 8.

Rehearsing the Lessons with a Focus on Eliciting and Interpreting

In Week 8 when TCs were rehearsing lesson plans, this was the second formal rehearsal where everyone in the class was rehearsing, but it was the third time where candidates had

rehearsed posing and teaching word problems using a launch-explore-discuss format. In each of the previous times, I, as the course instructor, had posed a word problem using a fish bowl format where a half-dozen TCs were at my small group table role playing elementary school students and the rest of the class was around us. During these fish bowl rehearsals, I would pause and ask everyone to talk to each other about what teacher moves I had just done and why. I also would ask them what I should likely do next. After those conversations I would "tag out" and "tag in" a TC to take over my small group. We would continue this for two-word problems which would last approximately 10 to 15 minutes.

In Week 8, though, TCs were simultaneously rehearsing so that all TCs were able to practice during the 50-minute class period. TCs came with one of the word problems that they had written along with questions to ask. At each table were counters, base ten (place value) blocks, and paper if they were needed. This rehearsal was different from previous ones where one TC at each table role playing as a student would make an error or demonstrate a misconception related to doing the wrong operation or incorrectly counting. Through the fish bowl modeling and rehearsals previously TCs had seen, practiced, and talked about ways to support students through their misconceptions. During Week 8 all TCs had the opportunity to practice this work with one of the word problems that they were posing to their students.

Take-Aways from Clinical Practice Experiences

In their project reflections, TCs mentioned a few common take-aways from the number talk enactment as they prepare to think about their enactment of their number talks with elementary school students.

First, students made comments about the strengths of their students. One TC, who worked with Kindergarteners mentioned, "I was so impressed that my group, which has misconceptions during whole class lessons, really did well making sense of the visuals and making connections to addition." Other comments focused on the strengths of students being able to explain what they were seeing, talk about both visuals and equations, and "make connections between the different pictures."

Thinking about future experiences, TCs reported the need to plan for a wider range of difficulty. Some TCs that reported that the number talk activity was too easy for students and it did not last long at all since it was not challenging. A TC who worked with second grade students commented,

> I had 3 pictures of dots to focus on addition. They finished so quickly. I had to come up with questions on the spot where they compared the pictures. I am glad that we had at least talked about that in class.

Others reported that the number talk activity was too challenging and they had to help their students a lot or modify the activity in the middle of teaching. One candidate who worked with first grade learners wrote, "Even though I used the questions that we had practiced they just stared at me and I had to ask questions multiple times and provide a lot of help."

Additionally, TCs mentioned the benefit of rehearsing and practicing the number talk. No one reported that they were nervous or uncomfortable teaching their number talk, but a few mentioned the uncertainty of not knowing how to respond to students' answers and thinking. This take-away supports the idea and need for more explicit course activities about the possible

range of student responses and possible responses that will increase the likelihood of student learning.

Vignette from a Field Mediated Mathematics Methods Course

Prior to the start of the MFE Mathematics Methods course the course instructor collaborated with the second- and third-grade teachers to identify the concepts of fluency with addition/subtraction and multiplication/division facts as two areas where a majority of their students needed extra support. We also identified second and third graders who could benefit from one-on-one instruction and paired them with a TC to be their math buddy. To help the TCs understand where to begin instruction with their math buddy, they first administered a one-on-one assessment to help them identify the facts that the TCs should focus on during their small group instruction. Importantly, the assessment provided the TCs an opportunity to apply the skills needed to elicit and interpret student thinking.

The two weeks prior to the one-on-one assessment, the course instructor structured the course activities around three goals to introduce and prepare the TCs. The goals included: (1) develop a positive relationship and recognize student strengths; (2) build an understanding of fact fluency and grade level expectations; (3) rehearse the interview using strategies for eliciting and interpreting student thinking. The goals were identified to maximize the effectiveness the TCs would have when assessing their students and in interpreting their student's thinking. During Week 6 of the course, the TCs administered the one-on-one assessment and then interpreted the results.

Prepare the TCs for the Assessment

To build rapport prior to the assessment, the TCs worked one-on-one for two weeks with their assigned second- or third- grade math buddy. During this time the TCs supported their math buddy with their regularly planned mathematics activities. The emphasis during the first few weeks of the experience was to build a positive relationship with the student and understand how the student learned best. The TCs recorded insights they learned about the student in a weekly log. TCs were also encouraged to reach out to the classroom teachers who worked with their assigned student to learn more about the strategies that were most successful for helping the student learn. One TC recognized during the first two weeks of working with her student, that her student was more successful when he knew a strategy to solve and had ownership in the activity. She used this insight during her one-on-one assessment. Instead of asking the student the facts, she provided all of the facts and had the student choose which ones to work on first. After having the opportunity to select several facts and successfully solving them, the student readily worked through the more challenging facts they had yet to answer with their TC.

In addition to building a positive relationship with the students, it was also important for the TCs to develop a strong understanding of computational fluency. The TCs understanding of computational fluency would help inform the kinds of questions they could ask their students and to interpret their students' thinking. In the two weeks prior to the assessment, the TCs read two articles, "Developing Computational Fluency with Whole Numbers" (Russell, 2000) and "Enriching Addition and Fact Mastery Through Games" (Bay-Williams & Russell, 2014). The first article provided the TCs with a background on what it meant to fluently compute and the second article was to help TCs understand the phases of learning basic facts. Next, the TCs

unpacked grade-level standards and created short videos explaining different strategies for solving the basic facts and why they might use that particular strategy.

Rehearsing and Enacting the Assessment with a Focus on Eliciting and Interpreting

To support the TCs with eliciting student thinking during the assessment, the TCs were introduced to the talk moves (Chapin, O'Connor, & Anderson, 2013). The talk moves were shared with the TCs to support them in facilitating a productive discussion. The TCs were also given instructions to ask their math buddy questions such as: "How did you figure that out?". The TCs were provided with the facts for the assessment and were responsible for modifying the order and which facts they asked their math buddy depending on how their students responded.

The TCs simultaneously rehearsed the fact fluency assessment with one of their peers. The TCs worked in groups of three to rehearse the assessment. This was the first formal rehearsal for the TCs. One peer was tasked with being the "student", the other the "teacher", and the third peer was asked to observe the interaction and then offer feedback. After about ten minutes, the peers switched roles. The "student" solved the facts they were given using strategies that they had read about and seen their math buddy using. The "teacher" asked the "student" how they solved and asked follow-up questions as needed. While the TCs were rehearsing, the course instructor monitored the groups, listened to the ways the TCs were eliciting student thinking, and provided coached feedback. After the TCs rehearsed, the course instructor shared several aspects she noticed related to eliciting and interpreting student thinking.

After the TCs rehearsed the fact fluency assessment, we went to the second and third grade classrooms and the TCs administered their assessment. The course instructor and the classroom teachers were able to observe the TCs engaging their students in the assessment. We provided in-the-moment feedback to help support the TCs in eliciting student thinking. The TCs recorded the strategies the student used to solve and made any additional notes on the record sheet.

Analyzing Student Thinking

During the following class, the TCs met in small groups of their peers to collectively analyze and interpret the information on their record sheets. The goal of each group was to identify a mathematics fact that they would select for their math buddies if they were to lead a number talk. The purpose of having the TCs think about the fact they would select was to help them closely analyze which facts their student answered correctly or incorrectly and what strategies their students used. One group of TCs chose the equation 5 x 7 for their number talk because many of the students that they interviewed had struggled with the five facts and the group knew that counting by fives was important for solving other facts. One of the TCs in this group mentioned that her student knew this fact but recognized that the student did not yet see the relationship between 5 x 7 and 7 x 5. The class was then able to discuss why it would be helpful for the number talk to have 7 x 5 as the follow-up equation.

The TCs were then involved in a second rehearsal focused on leading a number talk using the fact they identified. The purpose of this rehearsal was to help the TCs work through some of the challenges they encountered when eliciting their student's thinking during the assessment. The TCs worked with their peers to identify several strategies their students would use to solve the equation. TCs also had to anticipate at least one developing idea or misconception. Two of

the groups were then selected to rehearse in front of the class. One of the group members was the teacher and the other members of the group acted as the students using the strategies they had discussed. The TCs not in the presenting groups were able to participate, observe, and/or ask questions.

Throughout the rehearsal, the TCs were very engaged. Notably, when the developing idea was shared, we paused for several minutes to discuss how to help a student work through a developing idea. The TCs had questions such as, "How could you encourage the student to try another strategy?" and ideas about how to respond like, "You could ask someone who solved in a different way to share". The rehearsal of the number talk differed from the rehearsal of the one-on-one assessment because the TCs were able to use the recent experiences they had with their students to help them think about how students might respond and interact and also encouraged them to ask authentic questions that reflected their own experiences. As we concluded the rehearsal, the TCs noted that they felt more prepared to work with their students in small groups.

Take-Aways from Clinical Practice Experiences

The TCs shared how much they enjoyed administering the one-on-one assessment. For example, one TC shared that this helped them learn a lot about their second-grade math buddy and their thought process. Further, the TC explained that it gave them a strong idea about the content needed to be addressed to help develop their student's mathematical understanding. Another TC shared that they wanted to continue working with their third-grade math buddy one-on-one so that they would be able to provide lessons specific to their students' needs. They also shared, based on the assessment results, that they needed to regularly incorporate fact fluency games because that was something their students shared that they enjoyed and helped them to want to participate in the activity.

Several TCs described how they learned a lot about their student's strategies for solving. One TC shared that to multiply their student used a representation to model the multiplication expression. For example, the student represented 4 x 6 by drawing four circles and then drawing six dots in each circle. The student then counted each dot to find a product of 24. While the TC recognized that the student was successful in solving, the TC shared that they wanted their student to use more efficient strategies such as derived facts.

Because I was able to observe several of the TCs administering their assessment, I also had the opportunity to provide in-the-moment coaching such as suggesting follow-up questions for the TCs to ask and reminding TCs to use the talk moves (Chapin, O'Connor, & Anderson, 2013). I specifically reminded the TCs of the talk moves wait time and re-voice to encourage the TCs to give enough time for their student to respond and help the TCs accurately document the information they were gathering.

One difference I noticed between the MFE and a traditional methods course was the rehearsal after the one-on-one interview. The rehearsal was much more closely related to what actually happens in the classroom. The TCs were able to use what they had seen their students doing to accurately portray them during the rehearsal so that we had an opportunity as a class to talk through different ways elicit the student's thinking, interpret the student response and identify different ways to respond.

Implications and Considerations for Future Partnership Work

In the context of School-University Partnerships both of these vignettes bring to light multiple implications and considerations for future partnership work as well as future research. We have focused this section on preparing TCs for clinical practice experiences, the benefit of intentional and purposeful rehearsals, and opportunities for future research.

Preparing TCs for Clinical Practice

One of the key takeaways that we have noticed in the last few years was the need for partnership schools for clinical practice that give TCs freedom to learn by teaching mathematics in ways that align to the practices taught in education courses. Even in classrooms in which clinical educators were using scripted mathematics textbooks that did not support equity-based teaching, the process of teaching lessons to only a small group of students led to opportunities for TCs to enact lessons using the launch-explore-discuss model and gain opportunities to elicit and interpret students' thinking (Polly, 2021; Polly & Holshouser, 2021). Teacher education programs need partner schools with clinical educators that will allow their TCs to enact pedagogies that align with what they are learning in their education courses (Winitzky & Arends, 1991; Polly, 2021).

In addition to partner schools that give TCs freedom to teach in specific ways, there is a need to also structure course activities in ways that get TCs as prepared as possible for what they will experience in their clinical practice. For example, if there is a likelihood that TCs will be working with students who are developing their mathematical thinking and reasoning skills there is a need for preparation to include time to learn about strategies to support that population of students. This preparation includes equipping TCs with content- and concept-specific strategies and common misconceptions so that they can notice them and readily adapt their lesson as needed (Polly, 2021). The strength of strong school-university partnerships is that teacher educators should have a clear idea on the types of environments that TCs will be enacting lessons and can prepare them to be successful (Putman et al., 2021).

Further, identifying the concepts and skills where the students in the clinical setting need extra support can provide a space for TCs to contribute to student learning. In the MFE, the classroom teachers and mathematics teacher educator were able to identify computational fluency as an area where the students needed additional support. The mathematics teacher educator could then create experiences for the TCs that would address computational fluency. In both vignettes, student needs are placed at the center of the partnership. Students should be the primary beneficiaries in the school-university partnership (Walsh & Backe, 2013).

Intentional and Purposeful Rehearsals

While the ideas of practice-based teacher education have been discussed now for over a decade (Ball & Forzani, 2009; Kazemi et al., 2016) there is growing empirical evidence about the need for these experiences to be intentional and purposeful (Colonnese et al., 2022; Shaughnessy & Boerst, 2018). The intentionality and specific purposes of these experiences in methods courses increases the likelihood that TCs will enact specific practices and pedagogies in desired ways and positively influence student learning (Colonnese et al., 2022). During the first vignette in the university-based methods course the course instructor intentionally had TCs rehearse one of the word problems that they would be posing and had the other TCs role play

both correct students and students demonstrating misconceptions. This idea of addressing misconceptions during rehearsal, in past semesters has anecdotally provided TCs with at least an idea of what to do during clinical practice experiences when they are teaching elementary school students and a misconception is brought to light. Meanwhile, in the MFE in the second vignette the course instructor had the TCs engage in a rehearsal after their assessment to help think through some of the challenges the TCs experienced and to prepare them for their first lesson. In past semesters, TCs have anecdotally shared that it is difficult for them to authentically identify what students might say during the lesson. Other mathematics teacher educators have noted similar findings (e.g., Spangler & Thrasher-Hallman, 2014; Kim, 2011). Because the TCs had been able to access various students' thinking first, this enabled them to accurately represent student responses and grapple with different ways to respond.

As teacher educators continue to think through the implementation of aspects of practice-based teacher education, including the stages of the learning cycles, and the use of rehearsals, there is a need to consider what the goal of the rehearsals are. Further, there is a need to consider how to structure the planning of instructional activities and associated preparation before the rehearsals in ways that best support TCs developing of skills and knowledge related to specific instructional practices (Colonnese et al., 2022). In the case of both vignettes there was an intentional decision to focus solely on the high-leverage teaching practice of eliciting and interpreting student thinking. By focusing only on one practice for multiple rounds of the practice-based teacher education learning cycle TCs have multiple opportunities in courses and during clinical practice experiences to hone their ability to enact this.

Opportunities for Future Research

From our current work with PBTE described in this article, we envision several opportunities for future research. First, since we implemented PBTE practices in both a university-based setting and as part of a MFE, it seems worthwhile to understand how the different contexts for teacher education influenced TC development of knowledge and skills related to the emphasized instructional practice of eliciting and interpreting students' thinking. These findings can advance the field related to the structure of teacher education programs and related clinical practice experiences. Further, since MFEs are not always feasible, it is necessary to better understand what aspects from this experience are impactful for TC development so those aspects may be able to be translated to a university-based course.

Subsequent areas of research include identifying the different course activities and their influence on TC's development. The two vignettes provided varied ways to develop TCs skills and knowledge related to eliciting and interpreting student thinking in various ways. Since these assignments all focused on that high-leverage teaching practice (or core practice) it would be helpful to understand how each activity contributes to the overall development of TCs knowledge and skills. Ultimately, the clinical experience of the TCs should benefit the students that they are working with, so it is necessary to create both university- and clinical-based experiences that will maximize the effectiveness of the TCs.

Within that goal the quality of the school-university partnerships is a critical variable. In the case of the MFE the course instructor had worked with the principal and university department leadership to have the course and the clinical practice experience all take place in the elementary school. In the case of the university-based methods course, TCs completed their

clinical practice experiences in partnership schools who were committed to allowing TCs to complete the courses' assignments. Further research should also consider how the clinical educator (i.e., mentor teacher) influences TCs perceptions and development of their knowledge and skills.

Author Bios

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Section II: School-University Partnerships in the Context of COVID-19

Teaching Through a Pandemic: Possibilities for Student Engagement Created by University-School-Community Partnership

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Abstract: In this article, the authors examine their collaboration on a joint ELA-art-mindfulness project before and during the Covid-19 pandemic. The following chronicles the impact of the pandemic on the project and on student engagement, key takeaways from teaching and collaborating during a virtual school year, and the implementation of said takeaways as school returned to in-person instruction. The authors also reflect on their university-school-community partnership and plans for future collaboration.

Keywords: school-university partnerships, community-based partnerships, Professional Development Schools, PDSs, service-learning

NAPDS Revised 9 Essentials Addressed:
Essential 1: A professional development school (PDS) is a learning community guided by a comprehensive, articulated mission that is broader than the goals of any single partner, and that aims to advance equity, antiracism, and social justice within and among schools, colleges/universities, and their respective community and professional partners.

Essential 3: A PDS is a context for continuous professional learning and leading for all participants, guided by need and a spirit and practice of inquiry.

Essential 4: A PDS makes a shared commitment to reflective practice, responsive innovation, and generative knowledge.

Essential 9: A PDS provides dedicated and shared resources and establishes traditions to recognize, enhance, celebrate, and sustain the work of partners and the partnership.

Introduction

When reflecting on the Covid-19 pandemic and its impact on students, some may think of the "learning loss" incurred or the negative effects on students' health and wellbeing. Some may remember the early days of the pandemic and the drastic switch to remote learning, which revealed great disparities in students' access to technology and their education. Some may reflect on how students' lives were affected by personal and financial loss during the pandemic, and how that impacted their attendance and engagement in school.

We - the three authors of this article - are still addressing the many challenges imposed by the pandemic and its impact on our students. However, when thinking back on the "pandemic years," we also reflect on the strength of our university-school-community partnership (Miller & Hafner, 2008) and the possibilities that emerged because of it, which helped to engage our students during and after that challenging period. This is the story of our partnership and the collaborative work we shared in order to get our students (and ourselves) through the pandemic and beyond it.

As an English teacher (Dan), community artist and activist (Lynn), and PhD candidate researcher/mindfulness instructor (Patricia) collaborating on a project before and during the pandemic, we initially were interested in engaging students in a social activist art project that would transform a communal school space. We focused on student agency and empowerment, alongside academic rigor and the structure of Project-Based Learning (PBL). However, Covid-19 greatly shifted our collaboration and project in multiple ways: like millions of other teachers, we had to abruptly shift to remote learning, and we had to continually respond to new challenges that virtual schooling and living in a pandemic presented to us and our students. Though we initially tried to hold onto our project because we thought it would be a good way to engage students remotely, we finally allowed ourselves to let go of it in order to better respond to students' ever-changing needs.

Ultimately, our main question driving our collaboration became, "how do we engage students in meaningful learning during (and after) a pandemic and attend to their well-being?" Below we discuss our partnership and outline five key takeaways from our collaboration during the virtual 2020-2021 school year. We also discuss how we are implementing these takeaways to address the academic and social emotional learning challenges that students are currently facing as we have returned to in-person learning. Lastly, we briefly reflect on our university-school-community partnership and future directions.

Background of the Partnership and Project

The three of us came together through a service-learning program within the department of Education Studies at our local university, which places undergraduate students at schools in the area as tutors and mentors. Patricia was a PhD student researcher who was an instructor with the service-learning program. Dan had been a supervising teacher for the program for numerous years, hosting many undergraduates as they tutored his alternative high school students in his English classroom; he had also invited Patricia to teach yoga and mindfulness to his students. Lynn had been a long-time collaborator with the program, establishing many joint art-inspired projects between the Education department and her art studio/community center.

Before the pandemic, Patricia applied for a small grant that funded arts and humanities projects that encouraged university partnerships with the local community. Knowing his passion for social justice and mindfulness, she asked Dan to be a partner on this project, and they

considered having students in his English classes create social justice and mindfulness-based artwork, which would decorate a communal school space. Lynn was approached for her expertise in designing and teaching arts-based lessons that focused on community activism. Acknowledging that many university-school-community partnerships can often be grounded in asymmetrical power relationships, we purposefully took an egalitarian approach to our collaboration, keeping in mind mutuality, reciprocity, and respect for one another (Strier, 2011). Together, we discussed integrating English, art, and mindfulness, each of us putting forth ideas based on what we were willing to contribute. We made plans for the following school year, which included the use of undergraduate tutors, several field trips to community art spaces, and hosting a school-wide event at the project's culmination. Our university-school-community relationship formed and solidified through the process.

Though we were able to put some of our initial plans into effect, the pandemic stopped our grand project in its tracks. We took some time to reassess what students' needs were, what was possible on the school's virtual platform, and made multiple pivots to better attend to students holistically. By allowing ourselves to be flexible and responsive to what the context of the pandemic demanded, the relationships we formed deepened between ourselves and our students and we were able to form a virtual learning community.

The grant as well as the university service-learning program afforded us opportunities for interactions which Bringle and colleagues (2009) state, "involve complex and dynamic relationships that are necessarily subject to re-negotiation over time and that hold the potential to catalyze significant growth for the participants as well as substantial new work and new knowledge production" (p. 2). The nature of our relationship evolved from three professionals who admired one another's work and were excited to plan and implement a project together, to true collegiality and friendship built on our collective struggles and experiences. The evolution of our relationship grounded us during the uncertainty of the pandemic, provided consistent human interaction and connection at a time when we were feeling increasingly isolated, and reshaped our project and how we thought about teaching, learning, and collaborating. We formed a true partnership embedded with closeness, equity, and integrity (Bringle et al., 2009). It is within this partnership that we formed new knowledge about teaching during a pandemic, and what follows are the lessons we learned from it.

Five Key Takeaways from Teaching and Collaborating During the Pandemic

The following section details what we learned from teaching and collaborating during the pandemic and remote learning. Five key takeaways are explained, along with Dan describing how he has been implementing them after school resumed in-person.

Re-thinking Engagement and How to Assess It

The integration of mindfulness and art activities into the English curriculum served not only to engage students academically, but also to attend to their well-being and social-emotional needs (Henriksen & Shack, 2020), which proved to be equally, if not more, important to address during the pandemic. Eventually we moved our virtual classroom towards a more process-based way of engaging and assessing our students. Instead of pushing ourselves to accomplish our original culminating project and measuring students on completion, we treated each day as its own entity, teaching shorter lessons with smaller milestones and multiple forms of expression. For

example, if we were reading our primary text, *The Four Agreements*, we may *only* have proceeded with a discussion of a quote or two that we had selected in our dialectical journals, as well as designed art and mindfulness activities around those specific quotes. With these smaller milestones, we sought to emphasize how we could engage with each other, and the text, in a way that had immediate applicability.

"Engagement" for us meant providing many different ways to simply learn and to be in the classroom. It meant providing students multiple opportunities and means to contribute, such as unmuting their microphones to speak, writing in the chat, adding pictures or text to the daily Nearpod, or using other Google Classroom and Google Meet features. We encouraged creative ways to bring in our whole selves with embodied forms of learning (Grogan et al., 2014; Wisner, 2013) through various art and mindfulness activities (we provided physical "kits" to students that included all the materials we would use over the year), which brought together our mental, emotional, physical, and spiritual selves into the classroom. Also, taking a trauma-informed approach (Wiest-Stevenson & Lee, 2016) to our expectations of students allowed us to be generous in our approach with them and with our own pedagogy, as we considered student engagement. We understood when students couldn't turn on their laptop or phone cameras in class and celebrated them through their profile pictures and the emojis they shared.

Dan: Back in the Classroom

The students and I are in the midst of a transition. I hesitate to call it a transition to "normalcy" because "normal" for me no longer exists. We are transitioning back into a collective, taking things one day at a time. We no longer have the constraints of the virtual classroom, but being together - on the heels of isolation - has its own challenges. We all need to relearn how to coexist and function together. A lot of the so-called "soft skills," like being on-time, working with peers, and academic organization, are lacking. Given these challenges, I am still very much on board with a more "generous" brand of engagement and assessment.

Initially it was almost like "going through the motions." We were physically together but mentally we were in different places. We didn't seem to remember how school was supposed to work. I knew that some of this should be expected, but the pernicious hangover from isolation was well-entrenched. Art and mindfulness would once again become our anchors to the here and now.

I went back to what worked when we were in our virtual classroom. There was comfort in routines. For example, as we did in the virtual classroom, we would start the class with a "thought of the day" or a question directed to the young people. It could be as simple as, "how are you doing today?" Then we would record our responses in a Nearpod, Flipgrid, or as a response to a Google Classroom Question; that way we could check-in relatively quickly with each other. These activities were designed to set a positive tone, fostering a sense of optmism that was based on the notion that "we are in this together." We were all well aware of the fear, anxiety, and dysfunction that the pandemic brought, but we tried to draw our attention to that which we could control, and to the conscious and collective choices we could make.

When we were virtual we did a digital daily journal comprised of 4 sections: "On my mind," "Today", "Feeling Grateful For," and "My Day in a Meme" (courtesy of shelleygrayteaching.com), which gave us another avenue for conversation. Really, I was desperate for any opportunity to get the young people to share how they were feeling, what they were looking forward to, or any other kernel of information we could build upon. Coming back into the

classroom, we continued this ritual, which would help us connect with one another, as well as delve into our key text for the day and ensuing activities. Though I have yet to return to "The Four Agreements," which was a great anchor during the pandemic and virtual learning, we have continued using the same basic plan: journal, read, discuss.

What worked particularly well during the pandemic was coupling an opportunity to express ourselves through art with a text. There was comfort in the opportunity to express ourselves individually. We also made space for our daily mindfulness practice which, too, created a feeling of comfort. This is how I engaged and assessed the students: creating art provided the opportunity for engagement and completion of activities was the assessment.

Adults Modeling Process Over Product

Learning is the process, rather than product, which is something we strove to model in our co-teaching. What do students learn when they see adults learning something new? One of the things we loved about combining our expertise to teach English, art, and mindfulness is that it allowed students to see us adults as learners, and allowed us adults to experience the vulnerabilities that can come up when learning something new. We were more interested in the skills students would be using in developing their agency (Lindgren & McDaniel, 2012), rather than measuring "mastery" of academic content through a single test, paper, or project; this was especially important during the pandemic, when so many factors were out of our (and our students') control. During class, Patricia would set the tone with a mindfulness activity, which would help us stay present and let go of judgements of ourselves and others in the learning process. Dan would engage the students with a reading or writing activity that would build upon our collective intention for the day. Then Lynn would complement mindfulness and literature by encouraging student expression through art. More important than the activities themselves was the collective impact of three adults working together and maintaining our focus on the development and nurturing of agency.

Dan: Back in the Classroom

In the beginning of in-class learning, we (I) missed out on the modeling piece. We were not allowed to have too many "outsiders" in the classroom post-Covid. I knew the value of our partnerships, but we were hamstrung by the necessary safety protocols. Now it would be just a singular adult modeling the process.

Even without our university partners with us in the classroom, I still went forward with an emphasis on process over product. We have tried to stay in the moment with our learning and our attentiveness to each other. For example, we start every day with a "morning meeting" (an idea from Homeboy Industries*) where we check in with each other and get ourselves oriented to the day. We will do journaling, yoga, meditation, or all of the above. We are constantly reminding ourselves that we matter to each other and that we need one another. Every day is its own "mini unit," if you will. I still do long-range planning. I still design units of study that seek to engage and explore issues of consequence, but I am mindful of the pitfalls of "sticking to the plan at all costs." I try to remain flexible so that I can attend to whatever the most pressing needs of the students are at any given time. For example, earlier in the school year, when we were still reacquainting ourselves with in-person learning, I pivoted from district-mandated curriculum to a lesson based on our notions of "hope." At the time there was a palpable sense of hopelessness*

among the young people. I did not want to offer any false or "hokey hope" (Duncan-Andrade, 2009) that things would get better. Rather, I wanted to guide the young people towards an understanding that we are in this pandemic together and that we can rely on each other as material sources of hope (Duncan-Andrade, 2009). It was necessary and important work, and it was what the moment called for.

Learning is a process for us that takes place every day. I am less concerned with a product that is to be met at all costs. Most importantly, we are present *for each other. We make mistakes together, support each other, and listen to one another.*

Education as Holistic and Interconnected

When we first conceived of our project, we planned English, art, and mindfulness as three separate disciplines that were being housed in one classroom. But after some time, our separate domains became much more integrated and we took a more holistic approach (Hare, 2006) to better support student learning and motivation. For example, Dan was having the students read *The Four Agreements* (Ruiz, 1997), highlighting the theme of "not taking anything personally." Knowing the theme, Patricia led class with a mindfulness activity focusing on being present and not forming judgments, and Lynn led a blind contouring activity, encouraging students to not be concerned with others' opinions of their artwork and to silence self-judgment. There was not much planning of the lesson beforehand, but rather a reliance on our abilities to make connections in real time, trusting each others' expertise in our domains. Being flexible and open to content connections and interrelated experiences ended up being more useful than copious amounts of pre-planning, and allowed for natural interdisciplinary connections to occur.

Dan: Back in the Classroom

At this time I am unable to collaborate in the classroom with my university partners in the pursuit of holistic education, due to new safety protocols as well as time and available resources. But nevertheless, this approach still informs all that we do here, from the different embodied learning activities I embed in my English lessons, to supporting the development of the skills of present awareness and being non-judgmental. The most effective lessons have been those that emphasize all aspects of the self - the mental, emotional, physical, and spiritual. We are all rediscovering who we are as individuals and as learners. An example of such a lesson is the "One Pager." For a One Pager, we will have a shared reading of a text (I use poetry quite often for this activity), and then we will react to the text in the following way: cite two excerpts from the text, draft an "I Believe" statement (based on how the text "speaks to us), and create an original piece of art that shows some symbolic significance. In this way, I can have the students interact quickly and efficiently with a given text, yet all the while incorporating different aspects of their whole selves as learners.

Relationships Matter

We all knew that we wanted to create and nurture a space where we all felt like we (ourselves and the students) were part of something greater than our individual selves. We never wanted to lose sight of the fact that we needed each other now more than ever, since the pandemic caused us to feel so remote and isolated from one another. All three of us emphasized relationship-building (Hare, 2006), forming secure attachments with students, so that they would feel safer

taking risks in the classroom - with art, with mindfulness, with English, and with themselves. Dan created a compassionate and supportive environment, allowing time for students to check in about their emotional wellbeing, for moments of joy and lightness, for important discussions about the current political and social unrest in the nation, and also for personal connections to happen with each other and to the ideas we were discussing. All ideas and concerns were acknowledged and valued and us adults were equal participants in the activities. Sometimes difficult subjects were discussed, but humor was always woven into the conversations. We connected to each other and built relationships through our similar human experiences and stories.

Dan: Back in the Classroom

In the wake - or more aptly the midst - of the pandemic, the young people we serve were struck with multiple tragedies. One young lady, a student, was shot and killed by a fellow student. Four other students were arrested for murder in a separate incident. It goes without saying that anything we could say or do in the aftermath seemed inadequate at best. But our school is small, and we have developed and nurtured a culture of caring for our students. Hence we were able to respond quickly and compassionately.

Relationships matter. They matter for reasons that, at times, we cannot fathom. It is not only in the face of tragedy that relationships come to the fore. Relationships matter every day. Our school year has been marked by extreme episodes of sadness and grief. But sandwiched in between are many lesser examples of struggle. Students and adults are only just coming out of isolation, and we are having to re-establish lines of communication and trust that are the real precursors to learning taking place. This has been difficult. The novelty of simply being together has worn off. We must be together with a renewed sense of purpose.

Now that things are relatively calm, I have started reaching out to our university and community partners to dream up new ideas, and that feels good. It feels good to get back to the "unfinished business" of collaboration and collegiality. It feels good to share these goals with the students. It feels good to share the opportunities and projects that are just around the corner.

Strength in Community (and How to Collaborate with Others)

During the pandemic, we were isolated, but we did not have to work in isolation. It was important for us to leverage our pre-pandemic relationship to help guide us through the pandemic together. Developing meaningful partnerships takes time and consistent effort, and we three have developed a strong working relationship over these past few years. Over time, we created and nurtured a community of learners (Hare, 2006), which helped bring us and our students through some tough times. By working in community, it was easier to practice the joy and play in learning, which was much needed during the pandemic. Incorporating daily art and mindfulness through spirited collaborative activities was a way to value and encourage the exploration of moments of joy, as well as personal agency. Connecting with students and connecting with each other was not only for the benefit of our students' wellbeing, but for our own as well. Our collaboration has been reciprocally beneficial and truly joyful, and we hope it is something that we can continue and deepen, for the benefit of the students we serve.

Dan: Back in the Classroom

We were not together every day during the pandemic, but the days where Patricia, Lynn, and I all worked together were by far my favorite days. The students enjoyed those days, too. One

of my educational mantras is "less of me, more of them." In the online world though, this was difficult. It seemed to consistently be "more of me, and even more of me." With Lynn and Patricia, there was an entirely different vibe to the virtual classroom. It was "more of us," and it was easier to facilitate a sense of community between us and the students. Though Patricia and Lynn are not able to continue back in-person, our partnership still affords opportunities for collaboration and community-building.

One thing the students worked on a lot during the pandemic was their dialectical journals. After we read a chapter together we would go into breakout rooms - with the assistance of tutors from the university service-learning program - and we would discuss excerpts from the text. Here we could work in small groups - 2 or 3 students - with a college mentor. This yielded positive results, nurturing both accountability and an opportunity for the university and high school students to engage in dialogue, enriching the dialectical experience. Back in person, we still have those same opportunities to work with our college mentors and to share with each other in small groups and with partners. Dialectical journaling is also still a mainstay, and I am grateful that we can do this in-person and be present for each other, and that our university partnership allows us to have a more personalized learning space where each student is heard.

The need and desire to collaborate with our university and community partners, post virtual learning, has a renewed sense of importance. In fact, these relationships are no longer ancillary (if they ever were): they are absolutely essential. The ideal school that I imagined being a part of, pre-pandemic, was a place that offered much more than common core courses and a handful of electives. In my "radical imagination" (Ginwright, 2016), we are a place that offers wraparound services. We are a place where students can find legal services, health care, and virtually everything they and their families would need to live safely and productively. "Post" pandemic, in the absence of this "dream" (a dream I have not given up!) I am working to reinstitute the sense of community we all enjoyed. I am also looking to institute aspects of my "radical imagination" that no longer seem so radical. For example, I am currently working with a neighboring community college to secure grant funding for a public art project and for an artist in residence. These opportunities were made possible via my relationship with Lynn. Having a dedicated wellness center is also within our grasp. All I need to do is to keep leveraging the relationships we have with our university and community partners.

Radical Imagining: What Next?

Times of radical change provide an opportunity for us to rethink the existing structures within the education system and radically change our practices to better meet students' holistic needs. The pandemic was certainly a time of radical change - from instant school closures to the immediate switch to remote learning and getting technology into the hands of all students. Grading systems were rethought, and other measures of student and school accountability were put on hold. As we continue through the post-pandemic phase, we should continue to rethink radical changes in education instead of automatically adopting our pre-pandemic practices and relationships.

Though these recommendations on student engagement in learning were born out of the pandemic, we should all reflect on what we learned from our experiences and hold onto the positive things that came out of this challenging time. For us three, in addition to these takeaways on student learning, what we gained from this experience is our strengthened university-school-community partnership and what it affords us: deeper professional and personal relationships to help us sustain

our work, and a shared space to reflect on our values and to radically imagine (Ginwright, 2016) possibilities for teaching and learning. The experiences we shared before and during the pandemic forged this transformational relationship (Clayton et al., 2009), and we are committed to furthering the process of relationship (and partnership) development past this single project.

We still meet to reflect on our experiences as well as to dream up new collaborations; during our last meeting it was suggested we give our original project of creating an art piece for a communal school space a second chance. We are discussing funding opportunities to keep Lynn involved in the project, and to bring additional professional artists into the classroom to collaborate with community college teachers and students on public art projects at the school site. She has offered many of her personal connections to local cultural art institutions which has already yielded fruitful results. Patricia has rejoined Dan's classroom to lead mindfulness-based activities, and she is also looking for post-doctoral opportunities to continue her professional career locally so that the collaborations can continue. Dan extends an open invitation to his classroom, always ready to receive visitors, resources, and ideas for projects. After this unstable year teaching back in the classroom, we are starting to regroup so that we can come back together for something new next year. Additionally, to create more sustained cultural change, we also want to, "develop individual partnerships into social networks that achieve a critical mass and develop the capacity to assist many individuals" (Bringle et al., 2009, p. 15). To do so, we hope to involve more teachers and students from Dan's school, community cultural institutions, and undergraduate student tutors in future iterations.

We offer our story to serve as just one example of how to form a university-school-community partnership for the benefit of partners and students. We know that we have taken much away from our partnership, both professionally and personally, and we hope that others will consider forming partnerships along with the possibilities that can come from them.

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A School-University Partnership for Integrated STEM Learning: Curriculum Modifications and Considerations for Emergency Remote Teaching

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Abstract: Emergency remote and hybrid instructional approaches during the COVID-19 pandemic presented new challenges to science teachers, including how to incorporate authentic, hands-on, and collaborative learning experiences via Zoom™ instruction. Through a school-university partnership, a first-year middle school science teacher, an assistant professor, and two doctoral students collaborated to support student learning despite the constraints imposed by COVID-19. The partners worked together to develop and adapt a six-lesson, integrated science, technology, engineering, and mathematics (STEM) unit for use in a hybrid learning environment. In this article, we describe the unit, which focused on science concepts of force and motion through an engineering context related to helmet design. We highlight the key adaptations that were made to transition this unit to a hybrid format, including the assets brought by each partner. Finally, we discuss lessons learned and implications for teachers.

KEYWORDS: integrated STEM education, research-practice partnership, emergency remote teaching, COVID-19, teacher professional learning

NAPDS NINE ESSENTIALS ADDRESSED:
Essential 3: A PDS is a context for continuous professional learning and leading for all participants, guided by need and a spirit and practice of inquiry.

Essential 4: A PDS makes a shared commitment to reflective practice, responsive innovation, and generative knowledge.

Essential 5: A PDS is a community that engages in collaborative research and participates in the public sharing of results in a variety of outlets.

Essential 8: A PDS creates space for, advocates for, and supports college/university and P–12 faculty to operate in well-defined, boundary-spanning roles that transcend institutional settings.

Essential 9: A PDS provides dedicated and shared resources and establishes traditions to recognize, enhance, celebrate, and sustain the work of partners and the partnership.

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Introduction

The COVID-19 pandemic brought about unprecedented challenges for K-12 teachers, who suddenly were required to teach remotely and in hybrid (some students remote and some in person) formats, often lacking clear guidance and support. Emergency remote teaching (ERT) is distinct from online and distance learning, which often require months of advance planning; ERT includes a rapid and temporary shift in instructional delivery mode in order to provide short-term access to instruction that would otherwise be unavailable (Hodges et al., 2020). With the shift to ERT, questions about instructional quality and student engagement arose (e.g., Bassok et al., 2021; Phillips et al., 2021). In particular, integrated science, technology, engineering, and mathematics (STEM) instruction often requires access to physical materials for inquiry-based learning and engineering design activities. Challenges associated with providing students STEM learning materials were exacerbated with ERT instruction associated with COVID-19. In order to implement an integrated STEM unit, teachers had to ensure that all students had access to the required materials regardless of whether they were learning at home or in school.

Through a school-university partnership, we sought to provide authentic, hands-on, and collaborative STEM learning experiences to middle school students via ERT, including fully remote and hybrid modalities. We developed an integrated STEM curriculum unit for implementation in a hybrid ERT context, utilizing continuous improvement approaches (Bryk et al., 2015) during the development and implementation of the integrated STEM unit to address the unique challenges associated with teaching during COVID-19. We addressed the following research questions:

1. How, if at all, do the teaching practices of a first-year teacher shift when coaching and integrated STEM curriculum materials are provided during ERT?
2. What unique assets do a first-year teacher and three university partners draw upon in developing and implementing an integrated STEM unit using ERT?
3. What challenges and successes do a first-year teacher face when providing integrated STEM instruction using ERT?

In this article, we will first briefly describe some of the relevant research on reform-based science teaching and research-practice partnerships. We will then describe the research design we utilized and share our findings related to the research questions. In particular, we will unpack the challenges and successes (Research Question 3) to include implications for teachers beyond the context of this study. Finally, we will share a broader discussion of the study, describe some of its limitations, and suggest areas for future research.

Literature Review

Reform-Based Science Teaching

Reform efforts in science instruction have called for student-centered, inquiry-based, hands-on learning experiences that allow students to learn science concepts through the use of science and engineering practices (e.g., National Research Council [NRC], 2012; NGSS Lead States, 2013). Reform-based teaching is grounded in constructivist learning theories; in science, this includes starting with questions about nature, collecting and using evidence, and integrating "knowing" with the process of finding out (NRC, 1996, p. 30). It also includes student collaboration, student discourse, and reflection (Piburn & Sawada, 2000).

However, adopting new instructional practices can create a range of tensions for teachers (Braaten & Sheth, 2017; Radloff & Capobianco, 2021; Windschitl, 2002). They must learn to execute new pedagogical approaches to science instruction, and they must also navigate matters related to teacher accountability measures. In particular, past research has shown that teachers perceive the integration of STEM disciplines to conflict with standardized tests, which often emphasize vocabulary knowledge over conceptual understanding (e.g., Hutner et al., 2022; Marshall et al., 2021). Even beyond integrated STEM instruction, high-stakes accountability testing often leads to a narrowing of the curriculum, with tested topics receiving the most focus (Byrd-Blake et al., 2010; Pinder, 2013). Thus, teachers adopting reform-based science teaching practices are faced with the dual challenges of learning and implementing pedagogical strategies within a system that may not prioritize reform-based approaches.

Research-Practice Partnerships

Research-practice partnerships (RPPs) represent an intentional collaboration among researchers and teachers to support improved instructional practices and educational outcomes. RPPs are a key strategy in providing improved and more equitable STEM education (National Academies of Sciences, Engineering, and Medicine [NASEM], 2021). Coburn and Penuel's (2016) review of studies on RPPs found largely positive student learning outcomes associated with interventions developed by RPPs. In addition, other studies have found that instructional practices improve in connection with RPP interventions (Yarnall et al., 2006). Thus, RPPs provide a rich context for supporting teachers in developing quality STEM instructional approaches, potentially improving student learning opportunities.

Research Design

Context

This project built upon an existing RPP among a mid-sized private university, a large urban school district, a Fortune 100 company, and local community partners in the Southwestern United States. The partners intend to develop a hybrid "third space" that links the K-12 and university settings (Zeichner, 2010). Following three years of co-planning among the four partners, the STEM School opened in August of 2021. Currently serving students in grades 7-8, the school will expand its reach until it serves grades PreK through 8. The school is composed primarily of Latinx (71%) and Black (26%) students. Schools in this area have been characterized by low rates of student achievement compared to other schools in the district, and the community has been fraught with distrust due to school closures and environmental injustices associated with a nearby superfund hazardous waste site. Hundreds of students leave the neighborhood to attend private and charter schools with better records of academic success. With an overarching goal of equity, the

STEM School aims to provide a high-quality education to students in the community while also supporting students' families by providing wraparound services.

Innovation at the STEM School includes teaching approaches and curriculum materials being utilized in the classroom. While schools and teachers in this urban school district have often relied on direct instruction of facts and vocabulary in an effort to prepare students for multiple choice standardized tests, research-based best practices call for deep, conceptual learning by doing (NASEM, 2021; NGSS Lead States, 2013). The STEM School is therefore developing and utilizing science curriculum materials that engage students in inquiry through the use of science and engineering practices. With a marked shift from lecture and memorization, both teachers and students require additional support as they begin to experience open-ended learning activities, such as engineering design challenges.

Participants

The project activities represented in this article included four key individuals. Nick (pseudonym), a first-year middle school science teacher, sought the opportunity to serve as a school-based partner because he wanted to give his students hands-on STEM learning experiences in his science instruction. A university assistant professor and two doctoral students served as the university-based partners, refining integrated STEM unit activities based on Nick's feedback and supporting his planning and reflection throughout the unit implementation. As the only science instructor of this particular subject at his school, Nick expressed a desire for this collaborative planning process.

Curriculum Context

The teacher first taught a district-prescribed chemistry unit. It addressed chemical equations, formulas, and bonds over five 90-minute class periods (see Table 1). The teacher then shifted to the integrated STEM unit, which was developed based on Moore et al.'s (2014) framework for integrated STEM instruction, which includes six key tenets: 1) a motivating and engaging context; 2) an engineering design challenge; 3) opportunities to learn from failure through redesign; 4) inclusion of science and/or mathematics content; 5) student-centered pedagogies; and 6) an emphasis on teamwork and communication. The integrated STEM unit was comprised of six lessons focused on concepts of force and motion and aligned with the state science standards (see Table 2). After agreeing on the topic and engineering design challenge that centered on student design of helmets to meet the needs associated with a specific activity of students' choosing, the university partners drafted initial lessons. The lessons were designed with Nick's particular students and context in mind, so each lesson was designed to be taught in a 90-minute class period. When the initial lesson drafts were completed, they were shared with Nick for his feedback, and additional revisions were made to the plans in the days immediately preceding Nick's implementation of the lesson. Nick was also encouraged to make in-the-moment adjustments he deemed necessary to meet his students' needs.

Table 1
Comparison Unit Lessons

Lesson	Learning Objective	Lesson Details and Activities
1	Students will interpret the periodic table, including groups and periods, to explain how properties are used to classify elements.	Practice standardized test questions Article about covalent bonds Teacher slide presentation on elements and valence electrons Practice questions identifying number of valence electrons
2	Students will recognize the types of elements that are on the periodic table.	Practice questions identifying number of valence electrons Article about metals Teacher slide presentation on periodic table groups and families
3	Students will recognize what the numbers in a chemical formula mean.	Practice questions locating elements on periodic table Article about amino acids and identifying differences between compounds Teacher slide presentation on subscripts and coefficients in chemical equations Practice questions to interpret subscripts and coefficients PhET simulation about chemical equations
4	Students will recognize what the numbers in a chemical formula mean.	Practice questions to interpret subscripts and coefficients Article about hydrogen peroxide and its uses Elephant toothpaste video Teacher slide presentation on numbers in chemical formulas Worksheet with practice counting elements in chemical equations.
5	Students will distinguish between physical and chemical changes and properties of matter.	Video about different elements' reactions to water Teacher slide presentation about physical and chemical changes

In Lesson 1, students were introduced to basic concepts of force, motion, and energy through a melon drop and a bouncy ball lab. They also interacted with guest speakers from the Fortune 100 industry partner to learn about the engineering design process, continuous improvement approaches, and collaboration. Lesson 2 focused on deepening students' understanding of force and motion, including Newton's laws of motion and associated calculations. Students participated in a Google Jamboard™ activity to define key vocabulary terms in everyday language and completed station activities to explore a PhET simulation, practice force and distance calculations, and learn about helmets in the National Football League. Lesson 3 included a discussion and drawing of forces that were present during the melon drop from Lesson 1. The focus then shifted to the helmet design challenge, including an introduction, discussion of criteria and constraints, small group design work, and peer feedback on initial design ideas. Lesson 4 and Lesson 5 were designated for ongoing work on the helmet design project. As part of the design process, students were required to develop a presentation that included a description of their helmet prototype, video footage of the prototype being tested, and relevant force and speed calculations. Lesson 6 provided students with the opportunity to present their designs to a panel of experts, including industry engineering partners, and ask and respond to questions about their designs.

Table 2
Integrated STEM Unit Lessons

Lesson	Learning Objective	Lesson Details and Activities
1	Students will describe the relationship between force, motion, and energy.	Melon drop Guest speakers from Fortune 100 company discuss engineering design process and collaboration Bouncy ball lab Exit ticket about helmets
2	Students will calculate force and distance based on given quantities. Students will explain Newton's laws of motion.	Coin drop activity Introduction to Newton's laws of motion Google Jamboard™ vocabulary activity – students define force and motion terms in everyday language Station rotations: PhET simulation; force and distance calculations; reading about helmets in the NFL Written summary of effective helmets using force and motion vocabulary
3	Students will investigate and describe applications of Newton's laws of motion.	Article about real-world physics Force drawings in relation to melon drop Introduction to helmet engineering design challenge Small group helmet design brainstorming and sketching Google Jamboard™ gallery walk and peer feedback Helmet design development Exit ticket with speed and force calculations
4	Students will design an effective helmet and justify its design based on their knowledge of	Speed and force calculations Article about how physics informs the design of Olympic athletes' clothing Review of helmet design criteria

	Newton's laws of motion.	Small group helmet design Exit ticket with speed and force calculations
5	Students will design an effective helmet and justify its design based on their knowledge of Newton's laws of motion.	Speed and force calculations Article about the importance of communication skills and active listening Review helmet design and presentation criteria Small group helmet design Preparation for presentation
6	Students will present their helmet designs and the rationale for their designs to a panel of experts.	Final preparation for presentation Small group presentations in Zoom™ breakout rooms (each room with panel of experts) Panelist questions for students Peer evaluation of presentations and participation Google Form™ reflection

Instructional Adaptations

Of the 24 students enrolled in the seventh-grade science class, approximately half consistently attended in person, while the other half attended remotely. Throughout this article, this method of simultaneous, synchronous instruction of in-person and remote students will be referred to as a hybrid approach. In order to ensure access to all of the curriculum materials, individual kits were prepared and delivered to the homes of students participating remotely. In addition, adaptations to the curriculum were required to facilitate participation and communication across students in the classroom and those at their homes. These adaptations will be discussed in more detail in the Technology Integration section below.

Following a classroom COVID-19 exposure, the unit shifted from hybrid to entirely remote starting with Lesson 3. The final lesson was further shifted to entirely asynchronous given a weather-related school closure. Rather than presenting their final designs to the class and a panel of industry engineers in real time, students created recordings of their presentations. They then watched other groups' presentations and provided feedback to one another.

Research Methods and Data Collection

This convergent mixed-methods study included simultaneous collection of quantitative and qualitative data. As part of the broader RPP, we utilized design-based implementation research (DBIR) methodologies, which include collaborative design, testing, and iterative improvement of classroom innovations (Penuel et al., 2011). By making improvements and adaptations to the planned curriculum materials and instructional strategies, this DBIR approach helped ensure that the integrated STEM unit could meet the unique needs of the classroom context (Cobb et al., 2003).

Prior to the start of the unit, the university partners completed a series of training sessions using the Reformed Teaching Observation Protocol (RTOP; Piburn & Sawada, 2000) to ensure inter-rater reliability. The RTOP includes 25 items organized into five sub-scales: lesson design and implementation, propositional pedagogical knowledge, procedural pedagogical knowledge, communicative interactions, and student-teacher relationships. Each item is scored from 0 (never

occurred) to 4 (very descriptive of the lesson). Each day of hybrid and remote instruction, the university partners observed via Zoom™ and took observation field notes. Following the observation, they debriefed the observation and discussed each item of the RTOP until they reached consensus on the score, continuing to iteratively refine the RTOP scoring guide to provide clear criteria and examples.

In addition to the RTOP data and observation field notes for both the comparison unit and the STEM unit, data collection for the STEM unit included recordings of planning conversations that took place with the teacher prior to each lesson and ranged from ten minutes to one hour and forty minutes. These conversations focused on reviewing the lesson plans, finalizing any remaining details, and anticipating potential challenges associated with the instructional modality. Following each STEM lesson observation, the four partners met again for a debrief conversation in which they reflected on the day's activities, identified additional needs or adjustments to the upcoming plans, and continued to consider the teaching context. These conversations ranged from 13-23 minutes in length. The university partners utilized the protocol shown in Table 3 to guide the debrief conversations, progressing from general reflection to questions specific to the day's lesson implementation, and closing with identifying steps to ensure success moving forward. Finally, a teacher interview of 37 minutes at the conclusion of the unit focused on the teacher's overall experience and reflections.

Table 3
Debrief Conversation Reflection Protocol

General Reflection	Questions Specific to Lesson Implementation	Looking Ahead
• How did you feel about today's lesson? • What did you think went well today? Why? • What would you do differently if you taught this lesson again? Why would you make those changes? • Where did your students struggle? What support do you think they needed?	• I noticed… [observer describes observation without judgment]. What did you think about that? What prompted you to make that decision? • What do you think would have happened if you… [observer makes suggestion]?	• What would you like to do to prepare for the next lesson? • What can we do to help you prepare for the next lesson?

Data Analysis

Quantitative RTOP data were analyzed using RStudio by running a repeated-measures ANOVA using the anova_test function in the rstatix package (Kassambara, 2021). Qualitative data, including the transcribed planning and debrief discussions and observation field notes, were analyzed using inductive coding methods (Saldaña, 2016). Through iterative codebook development and multiple rounds of coding, the partner assets, challenges, and successes that are

described in the following sections were identified. Qualitative and quantitative analyses were compared to conclude whether the results were similar or dissimilar (Creswell & Guetterman, 2018).

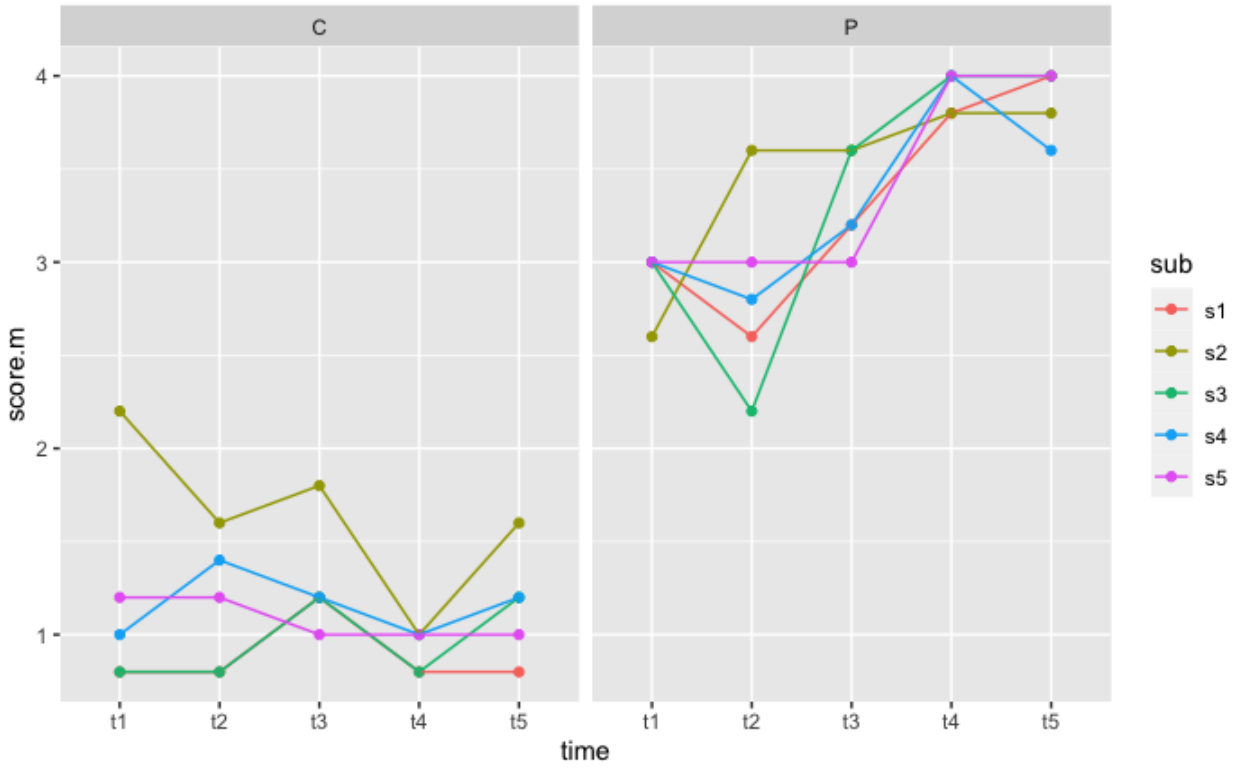
Findings

In this section, we share the key findings related to the three research questions. First, we share the results of our quantitative analysis to capture the shift in teaching practices evident based on RTOP data. Second, we share the unique assets of each partner that became central in partner conversations. Finally, we highlight three challenges and successes the teacher encountered throughout the project. For each challenge or success, we include a sub-section that includes a discussion of the relevant research literature as well as recommendations that extend beyond the context of this study.

Shifts in Teaching Practices

Using a repeated-measures ANOVA, the difference in RTOP scores between the comparison unit and the STEM unit was statistically significant [$F(1, 20) = 727.486$, $p<.05$], with a large effect size of 0.822 (Fox & Weisberg, 2019). In addition to the statistically significant difference on the overall RTOP scores, the teacher showed higher RTOP scores on all five sub-scales of the instrument (see Figure 1) as well as every individual RTOP item. Thus, the teacher demonstrated greater use of student-centered, reform-based instructional practices during the STEM unit versus the comparison unit. These instructional practices included small group collaboration, hands-on exploration, and student voice in the activities.

Figure 1
Average RTOP Scores for Comparison Unit (C) and STEM Pilot Unit (P)



Note. The time axis indicates the lesson number (t1 = Lesson 1, t2 = Lesson 2, etc.). The score.m axis is the mean RTOP score for each sub-scale. The sub-scales are grouped items within the RTOP (s1 = lesson design and implementation; s2 = content: propositional knowledge; s3 = content: procedural knowledge; s4 = classroom culture: communicative interactions; s5 = classroom culture: student/teacher relationships).

Partner Assets

Each of the four individuals brought unique assets to the partnership. The recurring planning and debrief meetings provided many opportunities to draw upon these assets to improve the quality of the curriculum materials and instructional practices. Nick had established strong relationships with his students, developing a knowledge of their interests and lived experiences. He had recently completed his undergraduate degree in biology, with minors in chemistry and science, technology, and society. This educational background contributed to Nick's deep science content knowledge, and with medical school remaining a possibility in his future, he was also passionate about science. As a first-year teacher, these assets allowed him to connect with students and excite them about science.

The three university partners, who are the authors of this article, also had distinct assets. The first author was an assistant professor at the university and had been involved in the STEM School project for several years. Her leadership and collaboration within the broader RPP led to a deep understanding of stakeholder needs, constraints, and desired outcomes. She also had expertise in integrated STEM curriculum development and instructional practices, as well as instructional coaching. As a former elementary STEM teacher, she possessed pedagogical

content knowledge (PCK), considering the best instructional approach for each STEM topic (Shulman, 1986). The second author was a Ph.D. student at the university and had extensive experience with technology integration. With this experience, he was able to suggest specific technological tools that would support teaching and learning within ERT contexts. As a former agricultural science teacher, he also brought PCK to the partnership, co-leading the design of the instructional materials and pedagogical supports. The third author was also a Ph.D. student at the university and had taught middle school science in the same state as Nick. With her extensive knowledge of state science standards, policies, assessments, and accountability systems, she connected deeply with Nick's context. She also had extensive PCK and co-led the curriculum development.

Challenges, Successes, and Implications

Throughout the integrated STEM unit implementation period, a variety of challenges and successes emerged. In this section, we will discuss the challenges and successes related to technology integration, student discourse, and curriculum development. We will frame the findings from this partnership in relation to what has been learned in other teaching contexts and highlight the implications for teachers in Discussion and Implications sub-sections for each of the three key challenges and successes.

Technology Integration

As the integrated STEM unit was taught in ERT hybrid and fully remote modalities, technology played a central role. With at least some students requiring remote instruction each day, Nick conducted all classes via Zoom™ and made use of his Google Classroom™ to manage assignments. There were challenges with student attendance and Zoom™ participation throughout the unit, and despite the technology affordances, Nick generally saw higher levels of engagement among the students who attended class in person. He also selected technology tools to allow for greater efficiency, to promote collaboration among students, to support students in deepening their understanding of the science content, and to engage students in engineering design activities.

Nick relied heavily on Pear Deck™ to share informational slides and key links with students. This was an efficient means of distributing information, but Nick maintained a high level of control over the activities. He included opportunities for students to respond to prompts within Pear Deck™, enabling in-the-moment formative assessment, but there were few opportunities for students to interact with one another.

Classkick™ was a new technology that Nick had not used prior to the integrated STEM unit, but he found it beneficial for student collaboration. For example, students completed a bouncy ball lab and were able to work on individual devices but also see and provide feedback on each other's work. With social distancing guidelines in place even for in-person students, this allowed for more meaningful small group interactions. Like Pear Deck™, Classkick™ allowed Nick to simultaneously monitor each student's progress and responses.

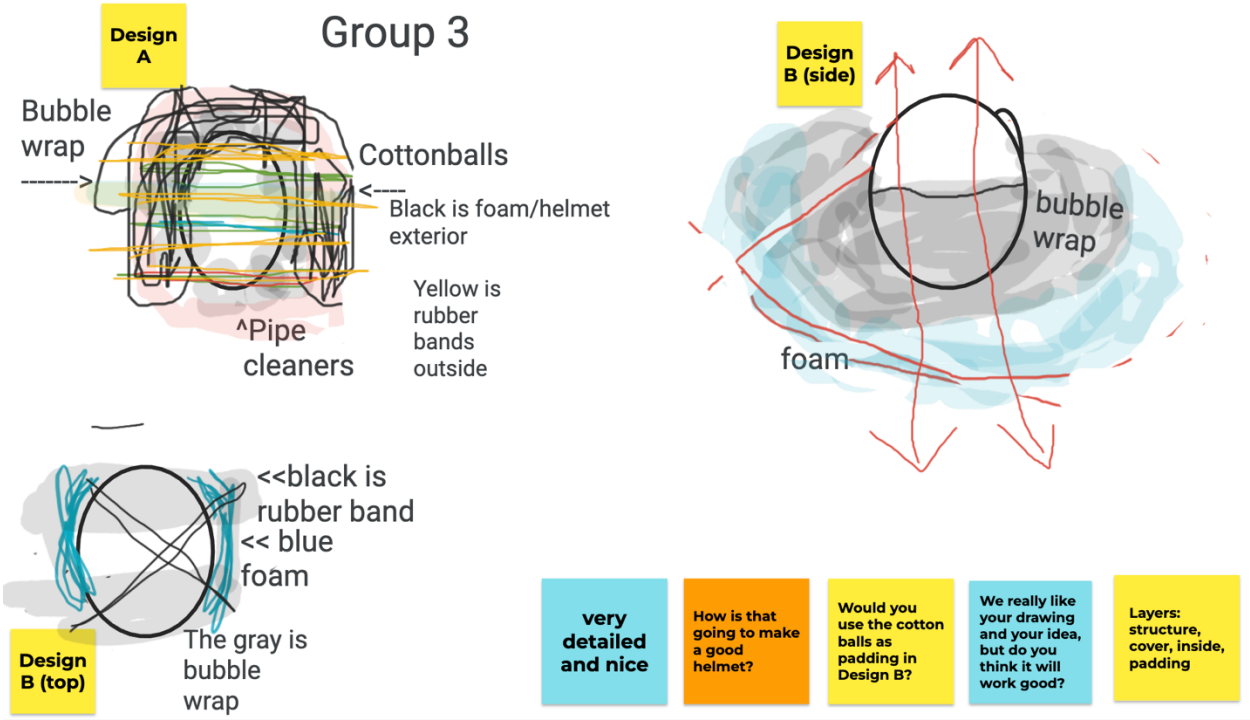
Nick was hesitant to use technology tools that released control to the students because he was concerned about how students would use this freedom. Indeed, there were some challenges that arose. For example, the first time that students used Google Jamboard™, they did not use the tool effectively. The Jamboard™ activity was intended to activate prior knowledge and have students begin co-constructing definitions of key vocabulary terms. Each Jamboard™ had a

different term (e.g., force, speed, acceleration), and students added words, images, or drawings to reflect what the term meant to them or made them think. Students independently added to the shared workspace with no opportunities for conversation with each other. Few students contributed, and one student added an inappropriate comment, resulting in Nick's early termination of the activity.

However, despite some stress and anxiety following the initial experience with Google Jamboard™, Nick recognized its potential value and persisted in using it. The subsequent instances in which Google Jamboard™ was used were more productive, and students were able to use the platform for effective collaboration among both in-person and remote students. For example, small groups used Google Jamboard™ as a shared space for brainstorming and planning their helmet designs. Groups brainstormed for 10 minutes, simultaneously adding ideas to the Jamboard™ despite not being in the same physical space. They then provided feedback on other groups' designs and revisited their own to address the questions and suggestions they had received. In Figure 2, one group developed two design ideas (Design A and Design B), labeling which materials they intended to use for each. They drew one of their ideas from multiple angles to show how the pieces would be positioned. Comments from other groups are shown in the colored boxes on the lower right; for example, one of the comments focused on their use of cotton balls in one design but not the other, asking whether they would use them for padding. This approach allowed for a collaborative space and a virtual gallery walk in which students saw other groups' ideas and offered feedback to strengthen their designs or help them consider other possibilities.

Figure 2

Google Jamboard™ Small Group Brainstorming and Feedback



Discussion and Implications for Technology Integration. The integrated STEM unit prompted Nick to use new technology tools to meet the need for student collaboration. While the tools were valuable, the process would have been smoother if the students were already familiar with the tools, their capabilities, and expectations related to their use prior to the integrated STEM unit. Rather than using the tools for the first time in a complex activity, we recommend introducing new technology tools in a low-stakes environment. For example, teachers could introduce Google Jamboard™ through a simple polling activity, allowing students to respond to a poll question and cast their "vote" by adding their name to the relevant section of the board. A See-Think-Wonder activity could allow students to use additional Jamboard™ tools, like drawing or adding images, scaffolding their development of Jamboard™ skills before they use them in more complex activities.

For Nick, different technology tools were useful for distinct purposes. Pear Deck™ provided an efficient means for distributing information, whereas Classkick™ and Google Jamboard™ allowed for greater collaboration among students. Both Pear Deck™ and Classkick™ allowed Nick to monitor students' individual contributions very carefully, whereas Google Jamboard™ did not produce a lasting record of which student contributed each element. While each tool is useful, we recommend carefully considering the instructional goals, level of collaboration that is needed, and extent to which individual students will be assessed before selecting a specific tool for a given activity.

When Google Jamboard™ was used without a collaborative element, Nick found it to be less effective. Students often experience decreases in science confidence, or self-efficacy, as they move through the middle school grades (Lofgran et al., 2015), so perhaps they were hesitant to display their individual ideas to the whole class before receiving some level of peer affirmation. As Nick saw when students used Jamboard™ for small group design activities, the open-ended, collaborative use of the technology promoted deeper discussion and engagement. We therefore recommend utilizing Google Jamboard™ when there are multiple "correct" answers or solution pathways. Further, allowing for small group collaboration and shared contributions to Jamboard™ can support deeper student engagement with the content and each other.

Nick identified as a digital native and was familiar and comfortable with technology; however, after teaching for approximately five months, he had selected a few key technologies for use in his classroom and did not consider adding new technologies to his instructional repertoire until prompted to do so by the university partners. Teachers adopt (or do not adopt) technologies for a range of reasons, including the technology's ease of use, its perceived usefulness, its cost, and teacher attitudes toward technology (Aldunate & Nussbaum, 2013; Granić & Marangunić, 2019; Hu et al., 2003). Through the partnership, Nick learned about and utilized new technologies (e.g., Google Jamboard™, Classkick™) that he found to meet unique needs in his classroom, and he planned to continue using them beyond the integrated STEM unit. We recommend creating an intentional space for teachers to share their use of various technology tools with one another, including discussions of the tools' affordances and limitations. For example, schools could have dedicated professional learning time during which teachers discuss shared problems of practice (including technology-related), plan inquiries into possible solutions, and then share the results of their inquiries, both positive and negative. Discussion of implementation strategies, challenges, and successes can help teachers feel more comfortable experimenting with new technology tools and persisting in their use despite setbacks. With ongoing sharing and exposure to new technologies, teachers can more carefully consider their

instructional needs and select technologies accordingly rather than defaulting to what is already familiar to them.

Student Discourse

Throughout the year of implementing ERT in both fully remote and hybrid modalities, Nick struggled to incorporate opportunities for students to engage in meaningful student-teacher and student-student discourse. Because he relied heavily on teacher-centered, lecture-based instruction as an efficient and manageable approach to ERT, most opportunities for student discourse were in the form of responding to teacher questions, which often had a single correct answer. These questions often resulted in a typical classroom pattern of initiate-respond-evaluate (IRE), maintaining Nick's central position in receiving and legitimizing student responses. While Nick desired deeper forms of student discourse, the challenges with teaching both remote and in-person students simultaneously and low participation rates among students were significant barriers.

When implementing the integrated STEM unit, Nick was pushed beyond his comfort zone in facilitating student discourse when a single correct answer was not expected. Because the unit included an open-ended design challenge with multiple possible solutions, students shared a variety of ideas in both small group and whole class settings. The path of classroom discussions was therefore less predictable to Nick, requiring more immediate decisions about whether and how to pursue student ideas versus when to redirect the conversation. Although this was challenging, he also recognized that new student voices were being heard in the classroom and that students were developing skills in having productive conversations among themselves.

These opportunities for student discourse required advance planning of discussion prompts that would evoke meaningful conversation. They also required advance attention to logistics, such as how in-person and remote students would connect with each other. The importance of this clear planning became evident when Nick made in-the-moment modifications to the lesson plans. These spontaneous adjustments often resulted in him defaulting to direct instruction, resulting in IRE discourse patterns. For example, during the melon drop activity, Nick became uncertain about whether students understood the forces acting upon the melon. He shifted from a discourse pattern in which students were co-constructing understanding of the phenomenon together, to a lecture about forces with few opportunities for student input.

Discussion and Implications for Student Discourse. Student discourse in science has long been accepted as central to learning (e.g., Lemke, 1990), but research indicates that opportunities for scientific discourse are often limited, particularly in school settings with a high proportion of students from racial and ethnic minorities (e.g., Bae, DeBusk-Lane, et al., 2021; Manz, 2015). Serving predominantly Latinx and Black students, Nick's tendency toward direct instruction of groups historically underrepresented in science was observed in the present context as well.

Facilitating productive science discussions includes moving beyond a basic elicitation of student ideas to uncover students' science ideas (both accurate and inaccurate), build on these ideas, challenge students to provide evidence and reasoning, and move the group toward a deeper understanding of the subject matter (Carpenter et al., 2020; Roth et al., 2017). With an increasing focus on the use of science and engineering practices within K-12 classrooms (NGSS Lead States, 2013; NRC, 2012), the range of instructional goals for student discourse is broad. Within

the integrated STEM unit, students engaged in a number of science and engineering practices, including defining the engineering problem, carrying out investigations, analyzing data, designing solutions, constructing arguments based on evidence, and communicating information. The discourse demands of these tasks were high, particularly given the shift from largely lecture-based instruction prior to the integrated STEM unit.

It is therefore important to consider how to scaffold student discourse. Previous studies related to supporting student science discourse have found that a range of scaffolds, including templates, diagrams, and discussion prompts, promote deeper discourse and learning (Bae, Mills, et al., 2021; McFadden & Roehrig, 2019; Lombardi et al., 2018). The integrated STEM unit included multiple scaffolds for student discourse. For example, after students developed design ideas within their small groups, a virtual gallery walk and peer feedback process was used to encourage students to provide constructive feedback to other groups. To support the provision of specific and useful feedback, sentence stems were provided: "We really like…," "What if you…," and "How are you going to…?" Additional templates for products could have further scaffolded student work. For example, a Google Jamboard™ template with designated areas for drawing a design, explaining it in words, connecting to science ideas, and thinking about potential problems or challenges with the design could have promoted deeper thinking about the design process.

In addition, providing general scaffolds may not be enough to ensure equitable participation, particularly within small group settings. Open-ended STEM activities present unique challenges to students within small groups, resulting in an inequitable distribution of power and responsibility, often differing based on gender and race/ethnicity (Wieselmann et al., 2020; Wieselmann, Dare, et al., 2021; Wieselmann, Keratithamkul, et al., 2021). Additional scaffolds should therefore be included with the goal of supporting equitable participation in small group activities. For example, discussion protocols in which each group member has a designated amount of time to share their ideas can help ensure that conversations are not dominated by certain individuals.

While student discourse is central to effective integrated STEM teaching, it does require careful consideration. Discussion prompts, scaffolds, and procedures to support equitable participation in discourse activities must be thoughtfully planned. In addition, teachers should consider their role in discourse and identify a clear approach for disrupting patterns of inequity they observe.

Curriculum Development and Professional Learning

In this partnership, the integrated STEM curriculum unit served as both a culminating product and as a pedagogical tool to support effective teaching practices. Within the partnership, the curriculum materials were iteratively developed over time, with each day's planning and debrief meetings shaping the lessons. Each partner leveraged their own assets to strengthen the unit. For example, Nick was well equipped to bring student interests and lived experiences into the lessons, so in areas where the original examples were deemed irrelevant (e.g., a skiing example when few students had ever been skiing), Nick improved the lesson with more personally meaningful connections. He also recognized an opportunity to connect helmet design to a previous unit on animal adaptations, considering how woodpecker and ram adaptations help prevent the animals from head injuries. When the third author recognized opportunities to reinforce concepts and vocabulary that were often heavily weighted in district and state

assessments, the lessons were adjusted accordingly. Further, her experience teaching English Learners revealed the importance of clearly distinguishing between speed and velocity, given the term "velocidad" means speed in the Spanish language. In this way, the partners worked together to develop a final curriculum product that was appropriate for the local context and population of students.

While these lesson modifications were a valuable aspect of the partnership, the curriculum also served as a tool for promoting Nick's use of student-centered instructional strategies. Nick was free to modify lesson activities in the planning phase or in the moment during instruction, but the rationale provided for the activities within the curriculum pushed him to move beyond his comfort zone and utilize new approaches. The curriculum detailed specific approaches to engaging students in student-centered learning; for example, it called for collaborative lab activities, open-ended design, and communication among students, positioning Nick as the facilitator and reflecting a shift from his typical lecture-based instruction. The expertise and firsthand teaching experience of the authors supported Nick in making these shifts, anticipating challenges and ways to overcome them. Nick found collaborative planning and debrief discussions to be incredibly valuable. Given the many demands on teachers' time, he did not typically experience this type of co-planning activity. By discussing the lessons both before and after teaching them, he felt he was able to refine his teaching strategies and recognize additional areas for growth as a teacher.

Discussion and Implications for Curriculum Development and Professional Learning. The focus on real-world problems within the integrated STEM unit offered a number of opportunities to support student learning and to promote Nick's growth as a teacher. Davis and Krajcik (2005) emphasized that curriculum materials can be used to support both teacher and student learning. They highlight several curriculum aspects that can promote teacher learning, including helping teachers anticipate what students will think and do in relation to the lesson activities, drawing connections across instructional units, justifying pedagogical decisions, and promoting the teacher's own ability to develop and adapt curriculum materials (Davis & Krajcik, 2005). Each of these elements played out in the present context; however, the curriculum materials worked in concert with the corresponding planning and debrief conversations for educative purposes. The opportunity for Nick to contribute ideas, ask questions, and troubleshoot potential challenges with the university partners supported deeper growth than may have been prompted by static curriculum materials alone. When Nick made connections between helmet design and animal adaptations, the first author recognized an opportunity to connect to the broader crosscutting concept of structure and function (NGSS Lead States, 2013; NRC, 2012). Both Nick and the university-based partners brought unique knowledge to the partnership, and it was the rich discussions of lesson activities that allowed for deep connections across units to be made. Collaborative curriculum development and co-planning opportunities grounded in school-university partnerships can lead to more effective, context-appropriate curriculum materials.

In addition to allowing for connections across units, the daily planning and debrief discussions served to deprivatize teaching, both for Nick and for the university-based partners. Nick's instructional practices were on display throughout each day of lesson implementation, providing a shared understanding of the classroom context and his instructional decisions. In planning for and reflecting upon instruction, these concrete examples allowed for deeper discussion. In addition, throughout the planning and debrief sessions, all of the university-based partners also described their own teaching practices, including things that worked well and those

that did not. In this way, Nick was able to learn from the "mistakes" the others had made, avoiding some potential pitfalls in the process. This was particularly significant given the drastic shift from teacher-centered to student-centered instruction and the many logistical challenges associated both with hybrid instruction and with integrated STEM instruction in general. While classroom observations are part of many districts' formal teacher evaluation and accountability plans, the extended nature of the classroom observations, as well as their non-evaluative nature, allowed for ongoing and thoughtful reflection on teaching practices. University partners may be able to support these efforts to inquire into teaching practices by observing classroom instruction, modeling classroom instruction, supporting lesson study or instructional rounds, or facilitating video-based lesson analysis. Teachers have few opportunities to observe others, and these additional opportunities to discuss, view, and reflect upon different approaches to teaching can be rich learning experiences for both school-based and university-based partners.

Discussion

Implementing an integrated STEM unit in ERT circumstances presented a number of challenges for the school and university partners. Planning and carrying out the unit required additional planning time and ongoing flexibility as the COVID-19 context shifted. Despite these challenges, the opportunity for collaboration was viewed positively by both Nick and the university partners. Nick reflected on his instructional practices and recognized that he grew in his technology integration and his ability to engage students in authentic learning. He saw increased student discourse and higher levels of engagement among students, and in describing the experience, Nick remarked, "This is the most fun I've had teaching." Nick was particularly appreciative of the opportunity to discuss teaching with former teachers, unconstrained by typical professional learning community structures. These conversations addressed everything from logistical considerations to pedagogical content knowledge for how best to teach certain topics. Indeed, research has indicated that teachers learn while working alongside other teachers in collaborative efforts that make instructional practices public, and this learning can support teacher leadership as well (Lieberman & Friedrich, 2010).

While the school-university collaboration was positive for all of the partners, two key tensions became apparent. First, Nick was conflicted about how much control to release to his students throughout the unit. He struggled to balance student agency and teacher control of the learning environment, particularly because he was accustomed to maintaining a highly controlled classroom. The integrated STEM unit prompted him to utilize new technologies for collaboration among students, promote student discourse, make connections to student lives and experiences, and provide design activities with multiple solutions and multiple solution pathways. All of these elements shifted power from Nick to the students and created a more complex learning environment in which different groups of students progressed at different paces. Although there were some challenges around setting expectations for how students would make use of this agency, both Nick and his students ultimately embraced the opportunities. This tension between student agency and teacher authority during inquiry-based instruction has been well-established in the research literature (e.g., Buzzelli & Johnston, 2001; García-Moya et al., 2019; Tan & Wong, 2012). However, there is a growing recognition that classroom authority can be shared among the teacher and students (Brubaker, 2012; Kim, 2021; Oyler, 1996). Future work should include intentional efforts to support teachers in developing a shared classroom authority.

Second, tension between authentic learning opportunities and accountability testing was apparent throughout the partnership. Previous studies have demonstrated that teachers perceive the integration of engineering within science instruction as conflicting with mandated tests (Hutner et al., 2022). While integrated STEM units often focus on conceptual development and the co-construction of knowledge, this can be at odds with student accountability and preparation for vocabulary-heavy standardized tests (Marshall et al., 2021). Nick repeatedly expressed feeling this tension between engaging his students in integrated STEM activities and preparing them for standardized testing. Because this was Nick's reality, the university-based partners sought to identify strategic opportunities to incorporate test preparation activities. For example, rather than dedicating an entire lesson to lecture and practice test questions, select questions were used as "bell-ringer" or exit ticket activities at the start and end of the lessons to demonstrate what had been learned without compromising the key lesson activities. The university partners emphasized using these practice questions as a means of formatively assessing student learning. The third author's deep understanding of the state assessment also allowed for the recognition of key opportunities to reinforce vocabulary and concepts within the integrated STEM activities.

Limitations

While this study provides helpful information about the challenges and successes an early-career teacher faced while implementing integrated STEM instruction for the first time, two key limitations must be considered. First, the teacher utilized ERT to implement the integrated STEM unit during the COVID-19 pandemic. While this contextual factor was a central element of the project and motivation for the study, it is likely that different challenges and successes would emerge with either fully in-person or established online/distance learning instructional models. Second, the findings represent the experiences of one teacher. Although some of the lessons learned likely transfer to other teachers, caution must be taken in generalizing specific findings to the broader population of early-career teachers.

Conclusion

The school-university partnership described in this article was unique in many ways. The broader partnership between a mid-sized private university, a large urban school district, a Fortune 100 company, and local community partners seeks to develop an innovative and collaborative approach to education. Aiming to bridge K-12 education and the university setting, the partner roles spanned boundaries between these two distinct entities. Both the school and university partners took up roles that are not typical in their positions, creating a third space to link the settings (Zeichner, 2010). Further, the COVID-19 pandemic, ERT, and weather-related school closures further underscored the unique aspects of the partnership. Despite these distinctive elements, the learning from this partnership can extend beyond the immediate context.

The integrated STEM unit was implemented within the ERT context and required a significant amount of planning and resources. Notably, the resource structures surpassed the typical scope of the school and university. STEM kits were assembled by the university partners and distributed to the students by Nick. Daily meetings to reflect upon previous lessons (see Table 3) and strategize for upcoming lessons required an investment of time from all partners. These dedicated resources enabled the success of the partnership, and those who desire to develop and sustain partnerships in new contexts should develop a clear shared plan for ensuring access to needed resources and structures, such as discussion protocols, for using time effectively.

The partnership described in this article was characterized by ongoing commitment to professional learning by all partners. Nick viewed the opportunity to improve his teaching practice as a valuable affordance of the partnership, and the university-based partners saw rich opportunities for learning how to support early-career teachers in implementing integrated STEM instruction in ERT modalities. The individual goals coalesced into a meaningful partnership that was mutually beneficial. When developing partnership plans, it is critical to consider the assets, needs, and constraints of each partner or institution. We recommend having an explicit discussion of these elements early in the planning phase, but it is also necessary to revisit the conversation throughout the partnership. By articulating these expectations up front and recognizing when they shift, partnerships can work toward positive outcomes for all stakeholders.

Author Bios

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Supporting and recovering science learning loss with a game-based learning approach leveraging a school-university partnership

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Abstract: This study describes the process of forming a school-university partnership to support the professional growth of our pre-service teachers and the in-service teachers at one partner school district and improving middle school students' science learning amid the pandemic.

KEYWORDS: science education, game-based learning, school-university partnership, teacher professional development, clinical experience

NAPDS Revised Nine Essentials Addressed:

Essential 2: A PDS embraces the preparation of educators through clinical practice.

Essential 3: A PDS is a context for continuous professional learning and leading for all participants, guided by need and a spirit and practice of inquiry.

Essential 4: A PDS makes a shared commitment to reflective practice, responsive innovation, and generative knowledge.

Essential 7: A PDS is built upon shared, sustainable governance structures that promote collaboration, foster reflection, and honor and value all participants' voices.

Essential 9: A PDS provides dedicated and shared resources and establishes traditions to recognize, enhance, celebrate, and sustain the work of partners and the partnership.

Introduction

COVID-19 has made a tremendous impact on student learning around the globe (Van Lancker & Parolin, 2020). In Indiana, and throughout the United States, the pandemic resulted in significant learning deficits among K-12 students (Indiana Department of Education, 2021). The data released by the Indiana Department of Education (IDOE) in 2021 shows that only 37.5% of the 3rd to 8th grade students in Indiana meet the grade level proficiency in science. Minority students, students with low socioeconomic status, and English language learners all suffered a significant academic impact that will require learning recovery time of more than one year. To address Indiana students' deficits in learning, the IDOE offered the Student Learning Recovery Grant Program and Fund, calling for the partnership of public and non-profit organizations to provide learning recovery and remediation services for K-12 students who demonstrate a deficit in learning as a result of disruptions to in-person learning caused by the pandemic.

In response to the IDOE's call, our university formed partnerships with the area's school district and non-profit organizations, using a community-based approach to accelerate student learning in math, literacy, and science. The authors of this paper, and one of the teams in this larger grant project, are responsible for supporting students' science learning through the formation of a partnership with middle school science teachers at the traditional public schools in the community and a charter school with close ties to the university. Through this school-university partnership, we leveraged a game-based learning (GBL) approach (Gee, 2006) to provide ongoing support for in-service science teachers to revise their curricula and enhance both learner motivation and instructional effectiveness. We also created opportunities for university teacher candidates to partner with participating schools and offer remedial tutoring services for struggling learners. An added benefit to pre-service teachers in our secondary practicum sequence whose placement for field experiences occurs in the classrooms of teachers participating in this initiative is the opportunity to observe in-service teachers as they integrate GBL into their teaching.

This study describes the process of forming the school-university partnership to support the professional growth of our teacher candidates and the in-service teachers at one of our partner school districts, Muncie Community Schools (MCS), while improving middle school students' science learning in the midst of the pandemic. First, we will describe the roles and contributions of different stakeholders that led to the formation of this collaboration. Next, we will discuss the successes and ongoing challenges of supporting students' science learning with the GBL approach through the school-university partnership.

Relevant Concepts and Literature

In this section, we provide an overview of the challenges in STEM education and offer research-based rationales for using game-based learning and school-university partnerships as the collaboration model for addressing issues in STEM education.

The Challenges in Science Education and Game-Based Learning

Many middle school students struggle in science classrooms due to the abstractness and complexity of science concepts. These challenges often exist when reading science texts that typically contain unfamiliar terms and complex sentences that create barriers for comprehension (Dori et al., 2018; Johnstone, 1991). Furthermore, as studies have shown, motivation to learn plays an important role in conceptual learning tasks such as learning scientific concepts (Hsieh, 2014; Wentzel & Miele, 2016). Students with low motivation to learn need further support to remove the

challenges inherent in learning science concepts and skills. Without such support, these students may be less motivated to learn science, and thereby their learning performance will be negatively impacted (De Loof et.al., 2021)

The game-based learning (GBL) approach has the potential for alleviating learning challenges in science education (e.g., Al-Tarawneh, 2016; Law & Chen, 2016). Studies indicate the use of GBL learning increases student motivation and science learning (e.g., Al-Tarawneh, 2016; Hussein, et al., 2019). However, to successfully implement GBL in K-12 classrooms, teachers need to learn about GBL in general and extend their understanding of content, teaching methods, and technology tools and resources used for games (Foster & Shah, 2015; Tzuo et al., 2012). Without support and training, it is unlikely that teachers or schools will adopt and sustain the use of GBL effectively (Tzuo et al., 2012). Our school-university partnership helps address this gap. We are able to offer the training, resources, and support the 5teachers need for implementing GBL. In return, the teacher participants and their students have shared valuable insights into the applications of GBL and have provided teacher candidates at our university the opportunity to gain critical field experience and observe GBL in action.

Shortage of Quality STEM Teachers. Over the last two decades, the U.S. has continued to experience a shortage of qualified STEM educators in math and science despite policies to increase the overall STEM workforce (Feder, 2022). An increase in K-12 STEM teachers is also necessary to prepare the next generation of STEM professionals to fuel the economy and expand STEM-related development. The U.S. lags behind in granting undergraduate science and math degrees (National Science Board, 2016). This has contributed largely to a shortage of teacher candidates and in-service teachers in math and science fields. Over 40 states have identified teacher shortages in the fields of math and science (U.S. Department of Education, 2022). Feder (2022) also mentioned that "in science, technology, engineering, and math (STEM) fields more broadly, the shortages in teachers in 2017–18 were about 100000 in high schools and 150000 in middle schools" in the United States.

In the case of science, even when schools can fill these openings in middle and high positions, teachers are often not certified in their current job (Sutcher, et al., 2019) or received significantly less preparation in pedagogies compared to teachers in other fields. Science teachers (40%) were twice as likely as math teachers (21%) to have completed no student teaching practicum or experience before their first year (Ingersoll et. al., 2014); thereby lacking pedagogical and/or content knowledge essential to positively impact student learning. These teachers often struggle to connect content knowledge to pedagogical approaches that best encourage the knowledge building needed to effectively teach the students in their classrooms. A lack of clinical practice also impacts attrition as they often struggle with class discipline and lack of administrative support (McConnell, 2017).

To address the shortage of certified science teachers in middle and secondary schools, both in-service teachers and teacher candidates need professional learning and instructional support. The increased support to in-service teachers could also potentially stymie attrition (Ingersoll et. al., 2014). To that end, our project aims to leverage a school-university partnership to help impact science students' learning through increasing teacher pedagogical knowledge. We address both teacher candidates' and in-service teachers' professional learning needs and assist both teachers and students to feel supported in science education.

Leveraging School-University Partnerships

In 1998, MCS teachers and administrators across grade levels and schools were invited by the Dean of the Teachers College to investigate the Professional Development School model (Holmes, 1990; National Association of Professional Development Schools, 2008; 2021) to decide whether investing in a formal PDS relationship with Teachers College was something they were interested in pursuing. This "bottom-up" approach in which "buy-in" by teachers is fundamental and reflects a recognition of P-12 teachers' expertise and agency in identifying both individual and school-wide efforts necessary to improve student achievement is a defining characteristic of PDSs (Holmes Group, 1990; Johnson, 1990). Based on overwhelming support on the part of district teachers and administrators, the Muncie Community Schools and the Ball State University's teacher preparation programs entered into a formal partnership in 1999. Characterized by both school-specific foci and concerns relevant to all schools in the corporation, collaborative efforts were teacher-driven and facilitated by the assignment of university-based liaisons. Over the next eighteen years, this school-university partnership resulted in numerous initiatives designed to improve student success, build schools' capacity to host teacher candidates for transformative field experiences, and support the initiation of and participation in a variety of research projects. The teachers' central and pivotal role in first choosing to participate in such a partnership and then in defining the focus of much of the professional development and research activities cannot be over-emphasized.

The relationship between the Muncie Community Schools and Ball State University fundamentally changed; however, in 2017 when the district was labeled as "distressed" by the IDOE. The designation was a result of decreasing enrollments caused by economic flight, financial misappropriation by previous school managers, low performance on standardized tests, and high rates of poverty within the community, thus leading the state DOE to initiate a school takeover process. In 2018, a resolution by the state's General Assembly opened the way for Ball State University to assume the management of the school district. Over the last three years, the relationship between the university and district has addressed financial issues, increased human capital, and supported innovative pedagogies to improve student learning. However, the relationship between the school corporation and university has shifted away from a Professional Development School model as framed by the Holmes Group (1990) and the National Association of Professional Development Schools (2008; 2021) to a more "top-down" model with many decisions arrived at between school and university administrators (Collins, 2014). While this newer partnership between the university and the community it serves continues to evolve, it is important to point out that the project described in this article was implemented in a spirit more aligned with the tenets of Professional Development Schools as defined by the Holmes Group (1990) and the National Association of Professional Development Schools (2008; 2021). Although Ai-Chu Ding (the first author and the GBL project coordinator), was designated as the sole communicator with the district's Associate Superintendent, the team met with teachers to better understand their professional development needs and their perceived struggle in the classroom in meeting student's learning needs. The university personnel's approach in working with participating middle school teachers was more aligned with the collaborative way in which the school district teachers were used to working under the Professional Development School model. Predicated on building mutually respectful relationships that facilitated the goals of both school and university professionals, the GBL initiative leveraged classroom teachers' knowledge of student and classroom contexts while increasing teachers' knowledge and use of GBL to increase

student learning in science. This mutualistic aspect was ideal as several university personnel with expertise in different fields worked with different areas of instructional practice in MCS.

Context and Project Description

Context

Muncie Community Schools (MCS) is a mid-sized urban school district situated in the Midwest. In the mid-1970s to '90s, the city was served by industrial and manufacturing companies that employed many in the community (Delaware County, IN, n.d.). After an economic downturn that shuttered many of the city's manufacturers and employers during the first decade of the 2000s, the city has bounced back but shifted to healthcare and education sectors for employment which represent the city's main employers.

MCS is a diverse district with approximately 5,000 students educated within a single high school, two middle schools, six elementary schools, and a youth opportunity center (i.e., alternative school program). The two middle schools, Northside (NMS) and Southside (SMS), serve approximately 550 and 580 students. Students at these schools share demographic features of the overall district, where 57.4% of students identify as white, 21.5% of students identify as African-American, 15% of students identify as multi-racial, and 5.3% of students identify as Hispanic. Just over half (58.4%) of the district's students receive free or reduced-price meals representing a decrease from 75.8% two years ago.

Approximately 20% fewer students in grades 3-8 scored at proficiency or higher in English language arts (ELA) and math on state standardized tests compared to the statewide percentage of students who scored at the same level. NMS students scored approximately 12 percentage points higher in science and ELA than SMS students and approximately five percentage points higher in math (see Table 1).

Table 1
Percentage of students scoring proficient or higher on state standardized tests (SDOE)

School	ELA (%)	Math (%)	Science (%)
Northside MS	33.9	24.2	35.2
Southside MS	20.8	19.8	25.3
MCS (Grades 3-8 only)	27.6	28.3	29.9
State Average (Grades 3-8)	47.9	47.8	47.4

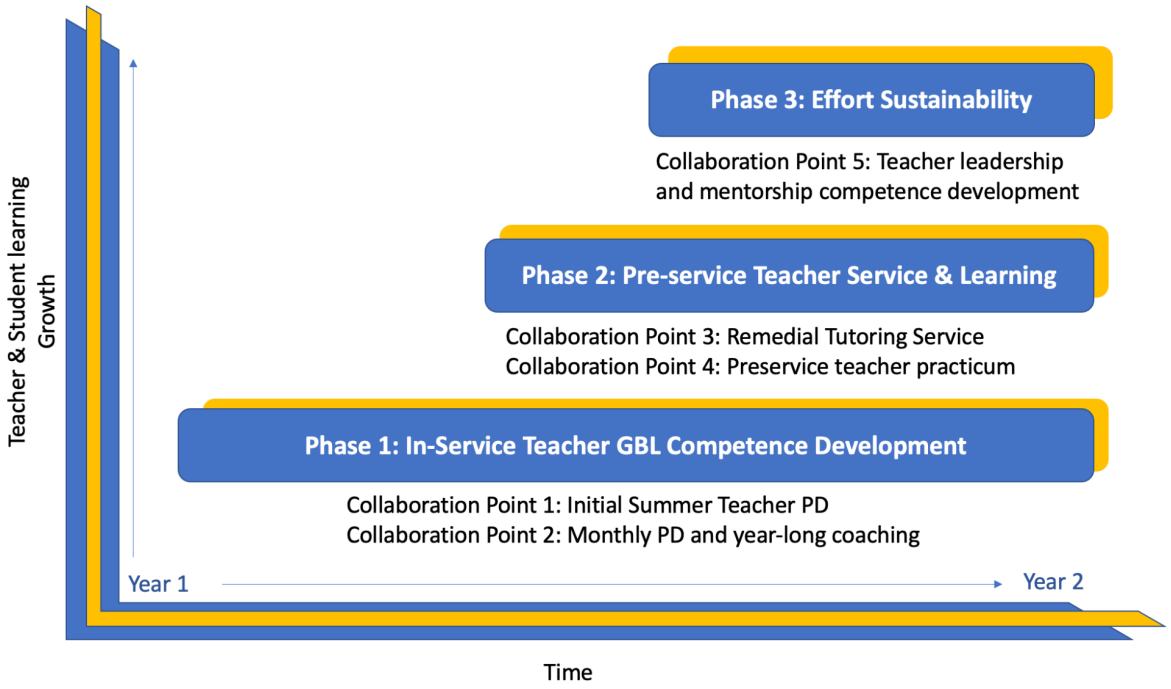
Almost 400 teachers work in the district; all teachers were rated as effective or highly effective in the previous year. Most teachers in the school district have sixteen or more years of teaching experience (40%), while 35% of teachers are in their first five years of teaching, and 25% have between five and fifteen years of experience.

Project Description

This project aims to leverage a school-university partnership to increase both in-service teachers and pre-service teacher candidates' competence in incorporating GBL middle grade

science classrooms. As this approach is a relatively new concept to both our school teachers and our teacher candidates, we created a three-phased model (Figure 1) where five major collaboration points are carried out throughout the period of two years.

Figure 1
Our School-University Partnership Model



During Phase 1, the goal was to increase science teachers' GBL competence and ensure they have the infrastructure (e.g., allotted time for professional development and lesson development, program licenses and hardware) and resources (e.g., curricula mapping, games that align with learning objectives, Breakout.edu kits, and pedagogical support) they needed to implement GBL in their classes. This will be an ongoing effort across both years of the project. But we also anticipate that many in-service teachers and teacher candidates will develop the competence and confidence to model GBL practices for their peers during year one. Therefore, the summer before the first year, we provided initial GBL professional development for five teachers who expressed the most interest in early implementation. Throughout the 2021-2022 academic year, we visited the schools to provide in-classroom support, and offered monthly workshops for all science teachers in the MCS middle schools. We continued to visit our participating teachers' classrooms and provide coaching on their curriculum and instructional practices throughout the year. While the first year has concluded, Phase 1 runs throughout both years.

At the start of the 2022 school year, the goal of Phase 2 is to begin placing teacher candidate with GBL-participating in-service teachers. Pre-service teachers will observe our participating teachers' practices and interact with students for their own professional growth. In addition teacher candidates will offer tutoring services for struggling learners.

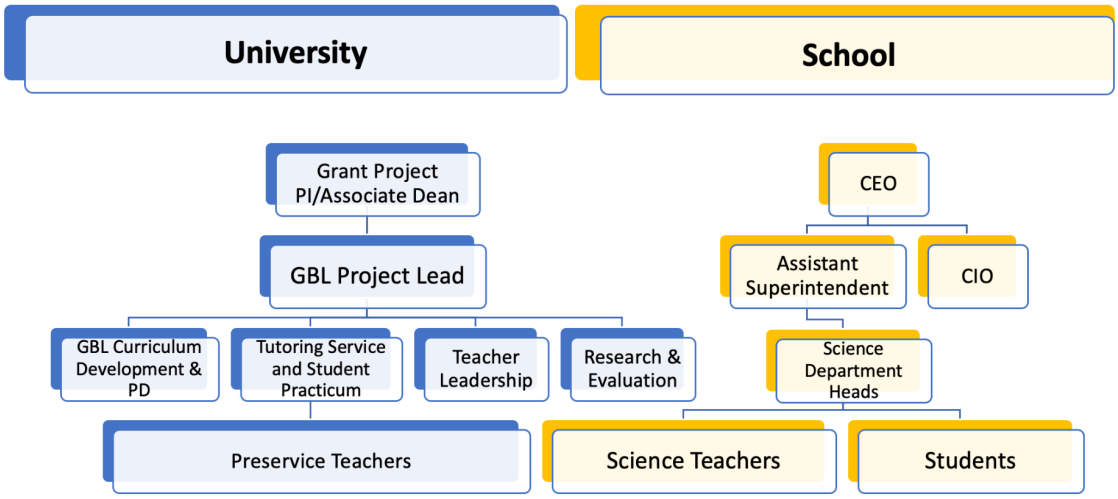
Finally, in Phase 3, the goal is to sustain teacher instructional practice and to support the reciprocal relationship with our partner schools after the grant is concluded. In order to sustain

pedagogical or technological innovation within a community, teachers need to own and lead the effort themselves (Bradley-Levine et.al., 2010, 2017). Therefore, we are inviting teachers who participated in Year One implementation to serve as project leaders. We will provide ongoing leadership development and continue to support them as they enhance their GBL competence. We anticipate this will increase teacher capacity within the district and will sustain the adoption of GBL across both middle schools beyond the life of the project. To ensure that both teacher candidates and in-service teachers benefit from the partnership, we will also develop our participating teachers' mentoring competence, ensuring that they can offer our teacher candidates adequate guidance during their clinical practice experiences. Phase 3 will start in the summer of 2022 (see Figure 1).

The Stakeholders

The grant program we received uses a community-based approach to accelerate student learning. As part of this larger grant project, we worked with various levels of leaders and stakeholders to form the school-university partnership. As such, the formation of the partnership required extensive and constant communication and coordination among various stakeholders. This section will briefly introduce the key stakeholders involved for making this partnership possible (see Figure 2).

Figure 2
Different Stakeholders Involved in the Formation of School-University Partnership



At the first level, our Associate Dean for Equity and Engagement, Dr. Kendra Lowery, serves as the Principal Investigator of the grant project and coordinates all endeavors and communications among the various community partners and university faculty. Meanwhile, Dr. Lee Ann Kwiatkowski, the CEO for Muncie Community Schools, oversees and helps connect university faculty with district leaders.

At the second level, the first author (Ding) serves as the Co-PI of the grant project and oversees and coordinates all the endeavors in the GBL project. With the second (DuBois) and fourth (Bradley-Levine) authors, she is also in charge of delivering ongoing GBL coaching support

and PD for teachers. On the MCS side, Dr. Charles Reynolds, the Associate Superintendent, supports our collaboration by serving as liaison between our team and the science teachers. In addition, Dr. Tony Harvey, the Chief Information Officer, ensures that teachers, students and the project team have access to necessary GBL technological resources.

At the third level, the third (Shaver) and fifth (Siebert) authors are coordinating the tutoring program and teacher candidate clinical practice experiences. Bradley-Levine oversees teacher leadership development and supports program evaluation in collaboration with the sixth author (Giraldo-Garcia). All members of the project team work with the science department heads at the two MCS middle schools to coordinate details about the monthly professional development and research activities. With all of these different levels of leadership, each share an over-arching goal of supporting the middle school science teachers and their students, and our own teacher candidates.

Findings

Our project began in June 2021 and will end in June 2023. Thus far, we have successfully completed *Collaboration Point 1*and are continuing to implement *Collaboration Point 2 (See Table 2).* In February 2022, we also began implementing *Collaboration Points 3 and 4.*

Table 2
Timeline for Collaboration Points

		Start Date	Status
Collaboration Point 1	Summer Teacher Professional Development	July 2021 July 2022	Completed Planned
Collaboration Point 2	Monthly Professional Development and Year-long Coaching	August 2021 August 2022	Completed Planned
Collaboration Point 3	Bringing Teacher Candidates as Tutors for Struggling Students	February 2022	On-Going
Collaboration Point 4	Pairing Teacher Candidates with Participating Teachers for Professional Growth	February 2022	On-Going
Collaboration Point 5	Teacher Leadership and Mentorship Competence Development	Fall 2021	On-Going

In this school-university partnership, each collaboration point involves different opportunities, successes and challenges. They also require coordination, communications, and strategic planning among different stakeholders. As our model reflects a rather top-down collaboration approach, listening to teachers' voices and constantly modifying professional development to address teachers' learning needs is highly important to us. In this following section, we will share the opportunities, successes and challenges for each collaboration point and how we worked with different stakeholders to overcome the obstacles.

Collaboration 1: Initial Summer Teacher GBL PD

Organizing the professional development and recruiting teachers to participate in the project was a crucial but challenging first step. When we knew we had received the grant and would partner with MCS, there was only one month of summer break remaining to plan and host the professional development. As explained earlier, this grant project consists of various components and involves stakeholders at different levels. One of the initial challenges for us was to streamline the communication channels and confirm the contacts at both the university and the district and schools for the various components of the project. To address this, the grant project P.I., Dr. Kendra Lowery, convened a whole-group meeting to provide an overview of the grant program and allowed us to introduce our part of the project (GBL) to our school and community partners. During the meeting, we confirmed that we would collaborate with MCS and focus on supporting science education. From there, the CEO of MCS connected Dr. Ai-Chu Ding (first author/ GBL project coordinator) with the MCS Associate Superintendent, Dr. Chuck Reynold, and they became the two main contacts for planning the summer professional development.

Dr. Reynold shared with Dr. Ding the science department's current professional development needs, the curricular package the district had adopted, and the school schedule. They discussed how the project team could help address the needs of the school and the science teachers, as well as how they could introduce science teachers to the GBL approach to support integration of GBL within their existing curricular resources. Pleased with the plan, Dr. Reynold permitted the project team to design the learning activities for a three-day summer professional development that was already planned and intended for curriculum mapping. He also facilitated the team's utilization of the monthly early-release days (two hours) that were already planned for science teachers at both middle schools. Drs. Reynold and Ding agreed that the project team would facilitate teachers' curriculum mapping and recruit teachers to participate in the project during the 3-day summer professional development and then offer the participating teachers an additional two-day professional development focusing on GBL. Our relationship and collaborative planning with Dr. Reynold, the Associate Superintendent, was a critical point leading to the success of the initial phase of this project.

However, knowing that teachers may resist top-down professional development or pedagogical innovations, Dr. Ding made sure that on the first day of the summer professional development she asked for input from teachers about their challenges and professional development needs. She also explained the benefits of GBL and how it aligned with their existing curricula. She assured the teachers that their participation was completely voluntary; but she believed the use of GBL would help address some of the instructional problems they had been experiencing with their students. Intrigued by the new approach and its potential benefits, all six teachers who participated in the initial three-day summer professional development registered for the additional two days of GBL summer professional development, as well as for the year-long coaching focused on designing and implementing GBL units in their classrooms.

The initial three-day summer professional development focused on teachers creating new curricular maps to reflect the adoption of new science kits for student use. This workshop also allowed the university team to assist teachers in finding game resources which reflected the learning objectives in each beginning science units. The second GBL professional development presented GBL theory. This workshop also provided different formats of GBL and explored teachers interest in using Scratch in their science units.

Collaboration 2: Monthly GBL PD and Year-Long Coaching

Another key piece of the collaboration with MCS is providing monthly professional development sessions with the science teachers of both middle schools. The professional development sessions take place one to two times per month, depending on the MCS schedule. GBL has different models and levels of integration depending on teachers' familiarity, technology competence, and pedagogical orientations. During the summer professional development, the project team realized that our coaching must be attuned to the teachers' comfort level instead of forcing a particular GBL model on teachers. Therefore, during the initial professional development sessions in September, we introduced the benefits of GBL and possible implementation approaches to MCS teachers, but we allowed teachers to freely determine the best ways to adopt GBL depending on teachers' interest and competence in using technological resources, as well as the content they were currently teaching. This allowed teachers' ownership over the timeline, curricular content, and mode in which GBL would be integrated in their classroom.

Doing so allowed MCS teachers to plan lesson units with GBL approaches and try them in their individual classrooms, especially teachers who participated in the summer professional development. However, teachers who did not participate in the summer professional development were still skeptical and hesitant about integrating GBL into their classroom after the initial professional development sessions in September due to limited understanding and planning time for GBL. After the first month of school, the project team decided to transition the professional development to a modeling approach, which focused on two goals: first, introducing modes of technology for GBL learning and gaming, and second, previewing resources that connected to teachers' curricula and learning objectives.

Teachers examined different modes of technology to facilitate GBL including: Oculus virtual reality headsets, games and programming with Scratch, Legends of Learning, BreakOut.edu activities, and other online simulations (e.g., PhET). Each mode was presented in different professional development sessions and the project team modeled the technology with teachers acting as if they were the students. Modeling allowed the project team to ensure the discussion and reflective components of the GBL activity were integrated within the activity. Discussion followed the activity, with the project team assessing the interest of each teacher in the technology presented and possible adaptations or additional support (via training or in-class during implementation) needed for use. Additional discussion through email occurred for further integration follow-up and support for specific needs, including the design of a Breakout.edu unit for a particular science topic.

During the first professional development in January, the project team modeled the BreakOut.edu game on the periodic table, which had been created the previous semester by the project team. Following the professional development, teachers who had been skeptical about integrating GBL became excited about trying GBL with their students. One sixth grade teacher immediately looked through previously created BreakOut.edu games to identify those that she could use to meet the learning objectives for an upcoming unit. She also started coordinating with Ding on student grouping plans, including the number of kits she would need, and the dates for game play. In another example, another sixth grade teacher initially felt overwhelmed by the idea of implementing a new and unfamiliar approach. However, after the modeling during one of the professional development sessions, he immediately logged into a BreakOut.edu account (provided by the project team for the workshop) and searched for games he could use when teaching an upcoming unit. A third teacher, who was two weeks away from starting a GBL unit on genetics,

discussed the creation of a BreakOut.edu game focusing on the learning objectives for this unit with Dubois (second author). The teacher discussed tailoring the BreakOut game to focus specifically on using probability and the integration of additional math practices with the Punnett Squares topic as puzzles in the game. The decision to use modeling as the format of our monthly professional development became a critical moment that led to our success in maintaining this collaboration.

Furthermore, because teachers identified time as a constraint and the necessity to address the standards, the project team decided that it was important that we provide contextualized GBL resources and curriculum planning support. We used the content of the MCS curricular maps to locate GBL resources that corresponded with learning objectives identified by teachers for successive units of study in each grade (i.e., six, seven, and eight). During each professional development session, the project team shared with teachers a spreadsheet with GBL games and activities that were aligned to learning objectives from the curricular maps. Teachers then collaboratively explored the games with their colleagues who teach the same grade to brainstorm how they might be used for upcoming science units. Teachers discussed connections to content and possible pedagogical uses while the project team answered questions or located additional resources. The team continued to correspond with teachers through email to share even more games or activities connected to specific science topics or lesson objectives brought up during these discussions. MCS teachers reported that the curation of games that aligned with their learning objectives was one of the most beneficial outcomes of the professional development sessions.

Collaboration 3: Remedial Tutoring Service for Struggling Learners

The third collaboration activity was the creation of during- and after-school tutoring opportunities for middle school students primarily in the area of science. This was a logical extension of the GBL programming, which was instituted in these schools within science classrooms. Additionally, MCS students have demonstrated difficulty with science as reflected both in grades and on standardized exams. Therefore, science was selected as the first subject for tutoring, with the eventual goal of expanding tutoring to all subjects once the grant established capacity for the tutoring program.

As such, discussions were held with administrators at three school sites within the community. The main conduit with which planning occurred was with Dr. Chuck Reynold, the Associate Superintendent of Muncie Community Schools. The three building-level administrators were, in theory, able to voice their ideas and concerns for the tutoring program via Dr. Reynold and he, in turn, would serve as a sounding board and line of communication between the university and said building administrators. Dr. Reynold was able to announce plans for the tutoring, both the idea for its inception and timeline for implementation at weekly leadership meetings with building administrators. This meeting was a part of MCS' planning and administrative communication. Discussions with Dr. Reynold were held both over the phone, via email, and in-person if he happened to be in the building when the researchers visited one of the tutoring sites.

The three sites had different preferences for when they wanted tutoring to occur. MCS requested that tutoring be available during the school day, asking for tutors to arrive at set times so that students could be scheduled for one-on-one tutoring while they were already at school. This avoided the need for students to arrange rides to or from school and allowed them to utilize transportation provided by the district. Discussions were also had with administrators to offer tutoring on campus during the weekends, further giving students access to qualified tutors. With

this blueprint in mind, the project team planned the tutoring program, recruited tutors, and trained them (which will be discussed in more detail in the next section, Collaboration 4). However, due to various factors (e.g., multiple leadership changes at school locations throughout the fall semester, the pandemic-related issues with staff and student absences, and issues with the IRB), the tutoring program occurred for only a few weeks before the fall semester ended.

There were different issues with the program from its inception. It was discussed that the first round of tutoring would serve as a pilot to determine what aspects of the tutoring program should be implemented, what training we should give to tutors, how best to recruit future tutors from university pre-service teaching programs, and how our pre-service teachers would integrate into the various MCS spaces as tutors of science students. This pilot would span the gap between Phase I and Phase II until the tutoring program was fully established.

However, challenges arose emerging from a multitude of issues throughout the semester. Foremost, there was a breakdown in communication between Dr. Reynold and building-level administrators. At times, sites were unaware of the tutoring program with the university and turned away tutors. This most likely was a result of one of the tutoring sites having four different principals during the Fall 2021 semester. It is understandable, with that level of turn-over, that communication could be an issue between the new principals and the university attempting to establish the tutoring program. Additionally, COVID-19 continued to be a massive complication, leading to a large number of staff and students at all three locations missing time, further exacerbating the communication problems. Finally, issues arose with finalizing the IRB for the tutoring program, delaying the start of tutor recruitment and training until early November. As a result of these multifarious issues, we decided to continue with attempting to establish the pilot for the few remaining weeks in the semester until we were better able to meet the goals of Phase II with a fully operational tutoring program. While tutors were ready for the final few weeks, the MCS sites did not have any tutoring due to administrators not fully knowing when tutoring was to start and no locations for the tutoring to occur established in the schools.

Between the end of fall semester and the first few weeks of spring semester, we worked to find ways to overcome these obstacles. After discussing these issues and realizing some of the pitfalls and how they could be avoided in the future, we approached Dr. Reynold and discussed our idea for the future of the tutoring program. Moving forward into the spring semester, communication began with Dr. Reynold but then building-level administrators were contacted directly by the faculty member spearheading the tutoring component of the GBL initiative. This added layer of communication helped mitigate the aforementioned miscommunication issues. Additionally, tutor recruitment began before the start of the semester, giving pre-service teachers a chance to join the tutoring program before finding other employment at the university or in the community. Finally, as tutor numbers waned, we expanded tutoring positions from only pre-service science teachers to students majoring in science sooner, allowing for a faster training and orientation period and facilitating preparing tutors for the field faster. As a result, the partnership agreed to follow the same blueprint when the university and schools returned from summer break to establish a true pilot tutoring program, fully moving the partnership into Phase II in this regard.

Collaboration 4: Pre-service Teachers and the Practicum Experience

The tutoring program connected closely to one of the university's teacher education goals, which is to provide pre-service teachers continual, authentic teaching experiences during their four years of teacher training. As per Ball State University Teachers College's mission statement, this

would continue to "prepare tomorrow's teachers and enhance the skills of current educators" under our instruction and care (Ball State University, 2022). Until Fall 2021, most secondary pre-service teachers only had one opportunity to work with students in the field for eight weeks during their middle school/high school practicum courses. As a result, graduates of the secondary teacher education program reported in exit surveys that they felt unprepared for student teaching and expressed a need to have more time teaching and working with students in the field before the pivotal and high-stakes student teaching semester. This assumed even greater significance since the aforementioned eight-week practicum did not typically occur until the semester before student teaching.

The GBL tutoring project represents one approach to achieve a "clinically-rich" teacher preparation program (American Association of Colleges for Teacher Education, 2018; Association of Teacher Educators, 2016; National Council of Accreditation to Teacher Education, 2010), allowing them to interact with middle and high school students in strategically-focused and developmentally-appropriate activities at the early stage of teacher preparation. The tutoring program drew from teacher education candidates in good standing enrolled in the middle school or high school practicum courses or multicultural education course. Tutoring positions were offered first to students who were preparing to become science teachers. After the first round of recruiting, the positions were opened to all secondary preservice teachers in good standing.

Tutors were offered a paid tutoring position and underwent a one-week orientation in which they completed an online tutoring module adapted from the Ball State University Learning Center's Peer Tutoring program for university students employed to provide tutoring services to other university students. The Learning Center's Peer Tutoring training drew on material from a number of well-established and highly-respected tutoring programs at other institutions as well as integrating videos, material, and activities created by Learning Center staff and experienced tutors. As the Learning Center provides assistance in all content taught at Ball State, the training focuses more holistically on providing tutors with pedagogical strategies and skills rather than content knowledge. Since the preservice teachers employed as tutors within this project came with content knowledge, but were fairly early in their professional education sequence, utilizing this comprehensive training model provided a solid introduction into the ways in which the knowledge, skills and dispositions of a tutor did (and did not) align with those of a classroom teacher. Once their training was complete, the tutors were assigned to one of the middle schools based on their availability.

Our efforts to support pre-service teacher education is ongoing and constantly evolving depending on the opportunities and needs we observe. Our Year One experience has taught us a great deal about the nature of this collaboration and helped us refine our plan to address the various aspects of tutoring programs, such as recruiting and placement. As we gradually iron out the administrative details of the program, we continue to revise our model of collaboration with our pre-service and in-service teachers to provide quality and in-demand professional learning opportunities for them. In terms of pre-service teacher practicum, our experience tells us that the field experience piece of the pre-service teacher education sequence is unique for expanding this program. Ball State University and MCS have had an extended partnership going back decades in terms of placements for both these field experiences and student teaching; in fact, current teachers participating in the GBL training have had students for these experiences in the past. Both Shaver (third author) and Siebert (fifth author) are in charge of placing students for their field experiences for practicum. We will continue to refine our recruitment and placement plan and foster

relationships with GLB participating teachers to send more students to these classrooms, allowing our pre-service teachers to refine their GBL and STEM skills.

Collaboration 5: Teacher Leadership and Mentorship Competence Development

The project team invited teachers to opt in to the initial summer professional development opportunity, which allowed the team to support these teachers to develop curriculum and instructional skills related to an existing interest. Although teachers began professional development with varying levels of comfort and expertise, the ongoing support provided by the team allowed them to integrate learning at their own pace. During implementation, the team arranged support structures at the individual and group levels to provide just-in-time personalized assistance and establish a community of learners. The support structures provided by the project team fostered confidence among the teachers to try new instructional strategies, learn from mistakes, and make their practice transparent to their colleagues. The continuous and ongoing relationship between the project team and the teachers allowed us to form a relationship of trust and a collaborative learning community. The positive relationship thus established was a critical factor leading to the successful recruitment of teacher leaders.

Several teachers emerged early as leaders within the initial implementation group. These teacher leaders took the initiative to integrate GBL into their lesson plans shortly after the summer professional development. In addition, they supported others in the group by sharing their successes and challenges. The project team interviewed these teachers at the end of the fall semester. During the interviews, we asked them to reflect on how they had already shared their GBL work with their colleagues. We also probed their willingness to take on a leadership role in scaling up the project and joining in the work of encouraging and supporting other teachers in the middle schools to integrate GBL into their instruction. We then invited the teachers who described an interest in taking more responsibility to engage as co-designers and presenters for the next professional development. to be offered in Summer 2022. These teachers expressed enthusiasm and self-assurance, as well as a willingness to develop their leadership capacity with the project team.

As we prepare for the next professional development event, the project team will provide the teacher leaders with leader development opportunities so that they may replace the project team in providing necessary supports to their colleagues and our pre-service teachers in the coming year. For example, the project team will guide teacher leaders through a process designed in the United Kingdom and used by teachers participating in a national teacher leadership network. This process, called Teacher-Led Development Work (Frost & Durrant, 2003), provides a framework for teacher leaders to reflect on their values and concerns related to taking initiative to implement change across a school, identify their leadership capacity, and plan strategies to extend existing capacity. Teacher leaders then collaborate to create an action plan for implementing a specific change. In our case, the action plan will define the strategies and steps involved in scaling up the implementation of GBL across the two middle schools. During the second year of the project, our teacher leaders will carry out the action plan through ongoing collaboration with their colleagues and administrators. Some strategies they will use to manage the change include leading staff professional development experiences, modeling and sharing their own use of GBL with other teachers (including pre-service teachers), and mentoring and coaching their colleagues and our pre-service teachers during implementation. The teacher leaders will also gather and use data in order to evaluate and adjust the action plan. In addition, as these teacher leaders will serve as

mentor teachers to our pre-service teachers, we will embed professional development focusing on mentoring strategies to foster their mentoring competence. As the program expands and more teachers join us to serve as mentors to our pre-service teachers, the teacher leaders will serve as mentoring coaches to support their colleagues' mentoring work, ensuring quality professional learning for both in-service teachers and pre-service teachers.

Participating Teachers Share Their Experience with the School-University Partnership

As our project is moving toward Phase 2, participating teachers have shared positive feedback about their experience within this partnership. They have also noted how the use of GBL has improved students' content learning and motivation. One teacher, the science department chair at one of the middle schools, wrote an email to her colleagues and to the MCS leadership team to share her experience trying one of the GBL resources we introduced:

> I just want to brag about my students and their continued hard work. . . . They have persevered through virtual reality, posters, greenhouse work, flipgrid videos, in-class games and now for my latest brag: BREAKOUT EDU! I have students emailing me asking [me] to help them solve the first lock. It's not even an assignment! I had 100% engagement in class and the students are excited to have a competition to see who will win. . . . Finally I have found a program that holds their attention and they WANT to solve the puzzles. I wanted to give a huge shout out to Ai-Chu and to Chuck for supporting our Science department. Thank you so much!

This teacher's enthusiasm is linked directly to her students' interest in learning science concepts because they are learning them through an engaging GBL activity. Another teacher, who teaches 8th grade, shared during an interview about the exciting improvement of her students' science performance:

> I kind of looked at the data on the pre- and post-test, and I saw there is like [a] 22% increase on knowing the different elements and things like that. . . . The biggest one I saw and was surprised to see was their short-answer responses. . . . I thought they would have done better with the multiple choice ones, but they actually did better with the short-answer responses than they did with the multiple choice. They had like anywhere from [an] 18 to 40% increase on writing information in on those short-answer responses. . . . I was kind of really surprised. . . . and I was impressed by that.

This teacher noticed that her students had more to write about the content they were learning than in the past. This seems to indicate that students attained a deeper level of learning and may have remembered more of what they learned as a result of GBL learning activities.

As shown through early data collection, the middle school science teachers who participated in the GBL project during Phase One have noticed an improvement in both students' engagement and learning outcomes during the GBL units they implemented. Data collection will continue through the next phases as the project team collects and analyzes learner data. However, these preliminary findings provide encouraging evidence that the project team was able to leverage the school-university partnership to facilitate learning recovery within middle school science classrooms. As teachers witnessed improved engagement and learning outcomes among their students, they also gradually changed their attitudes and perceptions about using GBL as an instructional approach. This is the type of change we wish to see.

Concluding Thoughts

This study has described an ongoing school-university partnership that aims to support middle school science learning recovery through the provision of teacher professional development and leadership, remedial tutoring services, and teacher candidate education. Our project is a two-year program where we have only completed the first phase of our model and are continuously planning and implementing the various collaborative components in this project. Through describing the various stakeholders and our decision-making process throughout the collaboration points, we have shown the complex and intricate nature of such a partnership (NAPDS Essential 7 and 9). We have also foregrounded a key aspect of forming school-university partnership that is less explored and discussed in the literature. For practitioners who plan to form school-university partnership to support student learning, our model and experiences will provide some insights into the challenges they may face and the potential strategies they may use to cope with the challenges. Specifically, we delineated how we modified and negotiated our collaboration with teachers in a spirit more aligned with the tenets of Professional Development Schools as defined by the Holmes Group (1990) and the National Association of Professional Development Schools (2008, 2021) in a "top-down" model of collaboration (NAPDS Essential 3 and 7). Our model embraced a commitment to reflection through innovative pedagogies to engage in a continuous professional learning with all participants (NAPDS Essential 4).

One recurring theme across the various collaboration points is the importance to gradually shift and empower teachers. In our unique context, and in many cases of school-university collaborations, the project would unavoidably start with a rather "top-down" model where the administrative teams make decisions for teachers and students. In such circumstances, listening to teachers early on in the project allowed us to understand teacher needs, pedagogical philosophies and constraints, and we were therefore able to make further modifications to our professional development and collaboration model for increased teacher buy-in (NAPDS Essential 3, 4 and 9). By noticing the barriers and needs specific to each teacher's required level of support and classroom barriers, the project team immediately revised the content and mode of professional development, adding more modeling elements to facilitate teachers' reflection and discussion with peers. In a top-down collaboration model, teachers particularly need to feel that they have control of the process. Thus, constant reflection and open dialogue facilitate the collaboration with partners (teachers, university team, school community) in identifying specific curriculum topics, planning the class activities with appropriate games, and implementing the game-based interventions (NAPDS Essential 4). In addition, as shown by our model timeline (Figure 1), we envision a model where teachers gradually gain control over their learning. Starting with engaging in GBL PD provided by us, they then serve as role models for other colleagues and our pre-service teachers (NAPDS Essential 9). Then through empowering the teacher leaders, teachers will take full control over their own learning by co-designing the future professional development sessions with us and even leading those sessions (NAPDS Essential 9). To that end, our model and experience could be helpful for practitioners in similar contexts. The study has shed a light on how we could realize school-university partnership in a relatively traditional school-university collaboration through the use of various strategies and components.

In terms of teacher candidates' professional education, we have embraced the need for clinical practice through tutoring which allows pre-service teachers to increase their ability in guiding students in the learning process in a GBL context (NAPDS Essential 2). This skill set underscores the importance of understanding student motivation and connection to science

concepts. This highlights the connection of teacher GBL competency to tutoring skills (Nousiainen et.al., 2018). It also provides pre-service teachers the ability to observe practices of formal and informal assessment using digital games and provide evidence of GBL and related activities to student mastery of learning objectives. Furthermore, as it pertains to GBL, teacher candidates rarely have any chance to observe this type of practice in the field. It is therefore challenging for them to adopt and design such an approach for their own students as well. With this school-university partnership, we see the potential for creating a rare professional growth opportunity for pre-service teachers to observe GBL practices by trained in-service teachers (NAPDS Essential 2). Due to the progress of our project, we currently do not have enough data to share findings about teacher candidates' professional growth within this model. Findings and conclusions of the study currently focus on our endeavors toward supporting our partner schools which reflects five tenets of the NAPDS Revised Nine Essentials. Through intentional communication with both MCS administration and middle grade science teachers, we were able to build capacity through GBL pedagogy to impact student learning. As we move forward to the next stage of our project, we will shift our focus to monitor the professional growth of our teacher candidates and continue to explore how we could leverage the school-university partnership to support their professional growth and continue to engage in collaborative research.

Author Bios

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Section III:

School-University Partnerships in Mathematics and STEM Education

Teaching Responsively: Learning from the Pedagogical Reasoning of Experienced Elementary Mathematics Teachers

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Abstract: The participants in this study belonged to a professional development school that embraced the responsibility and challenge of improving students' mathematical thinking. In this study, experienced teachers' pedagogical reasoning was made visible as they analyzed pieces of student written mathematical work in an approximation of practice designed to support professional noticing. Researchers then worked to characterize participants' professional noticing using the lens of responsive teaching. Results indicate that experienced teachers' decisions about how to respond to students' mathematical thinking fall on a continuum and often shift in responsiveness across pieces of student written work. The findings of this study provide guidance for teacher educators who work to develop K-12 educators' responsive teaching practices and have practical implications for the use of approximations of practice to develop responsive teaching practices.

KEYWORDS: Professional noticing, Responsive teaching, Approximations of practice

NAPDS NINE ESSENTIALS ADDRESSED:
Essential 2: A PDS embraces the preparation of educators through clinical practice.

Essential 3: A PDS is a context for continuous professional learning and leading for all participants, guided by need and a spirit and practice of inquiry.

Essential 4: Reflection and Innovation—A PDS makes a shared commitment to reflective practice, responsive innovation, and generative knowledge.

Introduction

Teachers who value teaching practices that use the substance of student thinking as the basis for mathematics instruction tend to enact responsive instruction (Ball, 1993; Dyer & Sherin, 2016; Franke & Kazemi, 2001; Jacobs & Spangler, 2017). Educational scholars have developed many constructs to describe how teachers work to make sense of student thinking and use that thinking to support student learning. These teaching constructs include professional noticing of children's mathematical thinking (Jacobs et al., 2010), cognitively guided instruction (Fennema et al., 1996), formative assessment (Coffey et al., 2011) and teaching responsively (Dyer & Sherin, 2016). While each of these teaching constructs are nuanced in their approach, they all emphasize the belief that teachers should elicit, attend to, and make sense of student thinking to respond in ways that develop mathematical ideas (Kavanagh et al., 2020). Further, each of these teaching constructs involve both observable classroom practices and unobservable teacher reasoning. In this study, we draw on the teaching constructs of professional noticing of children's mathematical thinking and responsive teaching to focus on how experienced teachers engage in pedagogically reasoning as they draw on student thinking to inform their instruction.

To make a teacher's pedagogical reasoning visible, teacher educators are exploring the affordances of practice-based teacher education in which mediated clinical experiences are used to prepare teachers to enact high quality instruction (Ball & Forzani, 2009; Grossman & McDonald, 2008; Kavanagh et al., 2020). One type of practice-based teacher education involves approximations of practice that are designed to simulate components of teaching in a context of reduced complexity (Kavanaugh et al., 2020). The approximation of practice in this study involved teachers bringing pieces of student mathematical written work to participate in a semi-structured interview. The interview was designed to prompt the participants to notice student thinking in each piece of written work, and then share their decisions about how to respond to student thinking, referred hereafter as teacher actions. We also asked the participants to share their pedagogical reason for each teacher action, to help us to determine the purpose for a given action. We then examine each teacher action and related purpose using a responsive teaching lens.

The three participants in this study belonged to a professional development school (PDS) partnership that included twenty-eight public schools and a five-year teacher education program in a College of Education at a research one university. These teachers embraced the responsibility and challenge of PDS essential element three, professional learning and leading (NAPDS, 2021) in which partnerships are formed with an intentional goal of improving student learning in a content or subject area as evidenced by their agreeing to participate in this study. To situate the current study, we review the literature on pedagogical reasoning, responsive teaching, practice-based teacher education with a specific focus on the use of approximations of practice, and professional noticing of children's mathematical thinking.

Literature and Theoretical Framework

Pedagogical Reasoning

Effective mathematics teaching and learning occurs when teachers elicit and makes sense of children's mathematical thinking to make instructional decisions that develop student ideas (Ball, 1993; Dyer & Sherin, 2016; Franke & Kazemi, 2001; Jacobs & Spangler, 2017). This work includes both visible teaching practices, such as how a teacher responds to student thinking, and the invisible cognitive work that involves how a teacher makes sense of student thinking prior to making an instructional decision. This invisible cognitive work is often referred to as

pedagogical reasoning. Loughran (2019) described pedagogical reasoning as "the thinking that underpins informed professional practice" (p. 4). According to Loughran et al. (2019) understanding how pedagogical reasoning develops and the way it influences practice is critical for teacher development. In this study, we use the term pedagogical reasoning broadly to describe all the ways our participants reasoned about student thinking. We then characterize how their pedagogical reasoning worked to support responsive teaching.

Characterizing Responsive Teaching

Responsive teaching is both a teaching stance and a practice that emphasizes the importance of using the substance of student mathematical thinking to guide instructional decisions (Dyer & Sherin, 2016; Hammer et al., 2012; Richards & Robertson, 2015). Importantly, responsive teaching involves instructional moves that work to take-up and pursue student thinking rather attempting to "fix" or "correct" student thinking (Dyer & Sherin, 2016; Richards & Robertson, 2015). Research on responsive teaching include studies that theoretically conceptualize this teaching stance (see Hammer et al., 2012) and studies that identify teacher moves or actions that facilitate responsive teaching (Dyer & Sherin, 2016, Jacobs & Empson, 2016, Lineback, 2015). For example, Dyer and Sherin (2016) identified three teaching actions that result in responsive teaching during classroom discussions that involve: 1) a substantive probe of student ideas; 2) an invitation for student comment; and 3) a teacher uptake of student ideas. In this study, we worked to first determine if teachers understood their students' mathematical thinking, as this is an important precursor to teaching responsively (Richards & Robertson, 2015). Then, if a teacher demonstrated an understanding of the student mathematical thinking, we asked participants to share how they would respond to this thinking which included both a teacher action and their purpose for that action. We then determine if our participants' pedagogical reasoning was responsive. For example, consider a teacher deciding to respond to student thinking by asking an open question. This teacher action appears responsive as it could work to pursue student thinking. However, if the teacher explains that the "reason" they asked an open question is for the student to fix a calculation error, the pedagogical reasoning becomes not responsive as it does not pursue or take-up student thinking. According to Yang et al. (2021) even experienced teachers need more deliberate practice to achieve a certain level of proficiency to respond to student thinking in ways that are responsive. To provide spaces that allow teachers to model and discuss their teaching, teacher educators are exploring the affordances of practice-based teacher education.

Practice-Based Teacher Education

Practice-based teacher education is a form of teacher education that uses mediated clinical experiences to prepare teachers to enact high quality instruction (Ball & Forzani, 2009; Grossman & McDonald, 2008; Kavanagh et al., 2020). Although practice-based teacher education was initially developed to be used with prospective and novice teachers, Sztajn et al. (2019) recommend that practice-based teacher education opportunities are beneficial for all teachers regardless of their level of experience or expertise. Practice based teacher education is emerging as an innovative approach to teacher education in that it emphasizes teachers rehearsing (practicing) rather than learning through lecture and discussion (Kavanaugh et al., 2020). One approach to enacting and studying practice-based teacher education involves examining teachers' engagement in approximations of practice designed to simulate components

of teaching in a context of reduced complexity (Kavanaugh et al., 2020).

Approximations of Practice. According to Kavanaugh et al. (2020) approximations of practice should be authentic and involve activities such as video of an actual classroom interaction and/or original artifacts of student work. They should also allow participants the time and space to examine learner thinking and make spontaneous responses (Kavanaugh et al., 2020). According to these researchers, teachers benefit from opportunities to practice their teaching as they engage in repeated cycles of observing, analyzing, and planning in increasingly complex approximations of practice (Grossman et al., 2009; Kavanagh et al., 2020). These characteristics of effective approximations of practice were used to conceptualize the approximation of practice designed for this study. The approximation of practice in this study involved teachers bringing pieces of students' mathematical written work to participate in a semi-structured interview designed to prompt professional noticing (Jacobs et al., 2010). This approximation of practice replicates a space where a teacher, after school is dismissed, sits down with pieces of student written work, to notice students' thinking in those pieces of written work.

Professional Noticing of Children's Mathematical Thinking

Sherin et al. (2011) describes the construct of teacher noticing as involving two main skills: (1) attending to children's strategies and (2) interpreting children's understandings. Jacobs et al. (2010) extended this framework to include a third element, deciding how to respond based on a teacher's understanding of student mathematical thinking. While there are many aspects that a teacher could notice in a classroom, the most critical is to actively notice student thinking (Jacobs et al., 2010). Emphasizing the importance of attending and interpreting student thinking prior to deciding how to respond Jacobs et al. (2010) introduced the construct of professional noticing of children's mathematical thinking, hereafter referred to as professional noticing.

Research on the interrelated nature of professional noticing skills often consider attending and interpreting together and explore the relationship of these two skills with the deciding how to respond skill (Fisher et al., 2018; Jacobs et al., 2010; Monson et al., 2018). This research demonstrates that expertise in attending to and interpreting students' mathematical thinking serve as important pre-cursors to deciding how to respond in ways that are considered responsive (Jacobs & Empson, 2016; Richards & Robertson, 2015). Researchers have examined teachers' decisions about how to respond in relation to what teachers have attended to and interpreted about student thinking (see Luna & Selmer, 2021) and identified observable teacher moves that work to take-up and pursue student thinking (Dini et al., 2020; Jacobs & Empson, 2016; Luna & Selmer, 2021). In this study, we also asked the participants to share their pedagogical reasoning so that we could identify their purposes for a teacher action. Therefore, we asked the following question: What teacher actions and purposes for those actions support responsive teaching practices?

Methodology

Study Context

The approximation of practice used in this study (see Figure 1) involves participants examining pieces of student written work created during a mathematics lesson from their own classrooms. Prior to engagement in the approximation of practice, participants (A) teach a typical mathematics lesson, and (B) choose pieces of written work from that teaching event to examine

in the practice space. Next, participants engage in a semi-structured interview that included the questions: 1) How would you describe the student work? 2) What does that tell you about student thinking? 3) How would you respond? 4) Why did you make that decision? These questions prompted the participants to (C) engage in professional noticing as they examined their students' work, and then decide how to respond (D-F). Each participant engaged in the approximation of practice four times over a two-month period, hereafter referred to as cycle one, two, three, and four**.**

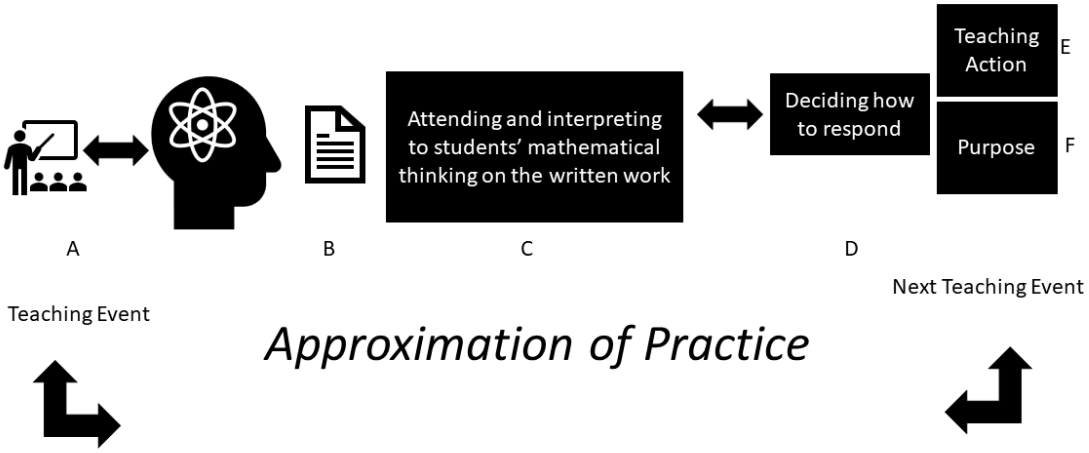

Figure 1. Approximation of Practice

The three participants in this study all worked at Hill Elementary (pseudonym), a public school located in a suburban, ethnically diverse neighborhood in a medium sized city in the Southern Appalachian region of the United States. Over 650 students attend the school. Forty-three percent of students qualify for free or reduced lunch, and 33% of students identified as a minority. At Hill Elementary school, 65% of the students scored at or above the proficient level for mathematics, well above the state and county average. The three participants were active partners in an established PDS partnership with the researchers' university. This study attempts to illuminate essential element four that calls for PDS's to be, "…living laboratories for creating, implementing, refining, and sharing innovative approaches to teaching and learning in efforts to better understand teaching and learning" (NAPDS, 2021, p. 15). Teachers and teacher educators in this PDS partnership engaged in on-going workshops, research projects, and co-teaching, that resulted in multiple collaborative state and national presentations and publications in high quality journals. All partnership projects had an explicit focus on student thinking in the content areas of mathematics and science.

Participants

Recall that even experienced teachers need more deliberate practice to achieve a certain level of proficiency to respond to student thinking in ways that are responsive (Yang, 2021). Therefore, we sought teachers with previous professional noticing experience for participation in the current project to increase the opportunity to observe and capture responsive teaching practices.

The first participant, Ingrid, taught for five years in a fifth-grade classroom. She earned National Board Certification and an Elementary Mathematics Specialist Certification. She was asked to participate in the current study because of her previous involvement in a professional development project that involved teachers videotaping themselves during mathematics instruction and attending bi-weekly meetings during which university researchers and participating teachers analyzed their professional noticing in the video clips.

The second participant, Kendall, had seven years of teaching experience in a fourth-grade classroom. She also obtained National Board Certification and an Elementary Mathematics Specialist Certification. Kendall was asked to participate because she had been part of a long standing PDS collaboration that involved teaching mathematics and science through a garden-based learning program.

The third participant, Hannah, had eight years of teaching experience in fourth and fifth grade classrooms. Hannah was asked to participate because she led the fourth-grade teachers in implementing the PDS mathematics and science integrated garden-based curriculum. Hannah had then approached university faculty with an idea for a mathematics and science integrated garden-based unit focused on developing student conceptual understandings of area and perimeter. Hannah and university faculty collaboratively developed this unit.

Research Design

We used a single case study design (Yin, 2014) to provide a rich description of the responsiveness of experienced teachers professional noticing while engaged in the approximation of practice. The final data set included 12 interview transcripts and 37 pieces of student written work brought by the participants. We coded the transcripts by identifying and separating out evidence of each professional noticing skill identified as attend, interpret, and decide. We also analyzed each piece of written work to identify the important mathematical elements and created a checklist for each piece of student work. We began our analysis by focusing on the attend and interpret transcript segments.

Data Analysis

Because teachers cannot be responsive to mathematical thinking that they do not understand (Richards & Robertson, 2015), participants had to attend to at least 70% of the mathematical elements identified by the researchers and contained in a checklist created for each piece of written work. To illustrate this coding process, consider a piece of student work brought by Ingrid during her first cycle in the approximation of practice (see Figure 2). The task requires a student to think relationally about the value of a variable that would make the equation true.

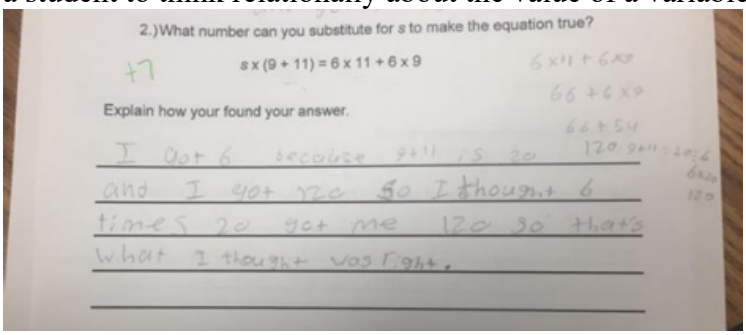

Figure 2. Ingrid's Shared Piece of Student Written Work

Ingrid noticed five out of the five (100%) identified mathematical elements (see Table 1).

Table 1
Mathematical Elements

Mathematical Element	Illustrative Quote
The student calculated 6x11 and 6x9 resulting in answers of 66 and 54	"I can see that he was able to solve the order of operations correctly to come up with the answer of 120"
The student added 66 and 54 together resulting in an answer of 120	"I can see that he was able to solve the order of operations correctly to come up with the answer of 120"
The student added 9+11 resulting in an answer of 20	"He ends up going 6 times 20"
The student multiplied 6x20 resulting in an answer of 120.	"He had 120 on this side and 20 on the other side and So I don't know if he could put together the like he knew 6 would be the right thing"
The student does not share any reasoning	
The student wrote 6 as the answer because 9+11 is 20 and he got 120 (6x20= 120)	"I mean he really shows no work he just said, I thought 6 times 20 would get me 120 and that's what I did and it was right"

This analytical process was implemented for the other 36 remaining pieces written work. Next, we analyzed the transcript sections marked as "decide" to identify the teacher actions and purposes for those actions. These sections contained the participants' responses to the interview questions: How would you respond to this student? Why did you make that decision? Participants often shared more than one decision about how to respond to student thinking noticed in a piece of written work resulting in 59 decide segments.

Teacher Actions and Purposes

To identify teacher actions and purposes we conducted a qualitative content analysis using "theme" as the unit of analysis (Miles & Huberman, 1994). We identified prior studies that examined teachers' actions during mathematics instruction (Herbel-Eisenmann & Breyfogle, 2005; Luna & Selmer, 2021). This analytical process resulted in eight codes for teacher actions (see Table 2). The next step in the analytical process was to identify each teacher action as responsive or not. Teacher actions were considered responsive if they worked to take-up and pursue student thinking rather than fixing student thinking (Dyer & Sherin, 2016; Richards & Robertson, 2015).

Table 2
Teacher Actions

Teacher Action (The teacher…)	Illustrative Quote	Responsive
…asks the student to elaborate on and/or clarify their thinking	"I would ask him to explain why you would use meters."	Y

… prompts the student to reread the problem situation and consider their related strategy	"I would tell him to re-read it and see what he does."	Y
…asks the student to use a different strategy	"I would encourage her to solve the problem a second way."	Y
…asks the student to work on a new task	"I would give her another one (task)."	Y
…tells, instructs, and/or explains a strategy or concept to a student	"I would go through the procedural steps of how we break this number down."	N
…asks the student a funneling question(s)	"I would ask her, what is the formula for finding volume and ask her, did you follow that formula?"	N
…asks the student to rewrite/recheck their work	"I would tell the student to just slow down and double check the math."	N
…provides the student with test scores	"I would like to show them their test score progression from the beginning of the year until now."	N

This process resulted in four of the eight teacher actions considered responsive to student thinking and included the teacher: 1) asks the student to elaborate on and/or clarify their thinking; 2) prompts the student to reread the problem situation and consider their related strategy; 3) asks the student to use a different strategy; or 4) asks the student to work on a new task. The teacher actions considered not responsive included the teacher: 1) tells, instructs, and/or explains a strategy or concept to a student; 2) asks the student a funneling question; 3) asks the student to rewrite/recheck their work; or 4) provides the student with test scores.

We identified seven purposes for the teacher actions. The first four purpose codes (see Table 3) were identified as responsive as they all worked to take up and pursue student thinking (Dyer & Sherin, 2016; Richards & Robertson, 2015) and included the teacher wants: 1) to test student understanding; 2) to understand additional student thinking; 3) the student to make mathematical connections; and 4) the student to understand a conceptual error. The next three purpose coded were identified as not responsive and included the teacher wants: 1) the student to not have a procedural error, 2) to understand student thinking that is confusing to the teacher; and 3) for students to recognize the importance of persevering in mathematical work. The purpose that involved the teacher wanting to understand student thinking that is confusing was considered not responsive because a teacher cannot be responsive to what they do not understand (Richards & Robertson, 2015). The purpose that involved a teacher wanting a student to not have a procedural error, is clearly focused on fixing student work and is therefore not considered responsive. Finally, while the purpose of the teacher wanting a student to recognize the importance of persevering in mathematical work is important in the creation of a vibrant, mathematical learning environment, it does not involve eliciting and understanding student thinking and was therefore considered not responsive.

Table 3
Purposes for Teacher Actions

Purpose (The teacher wants….)	Illustrative Quote	Responsive
...to test student understanding	"…to make sure she grasped this concept of exactly what kind of division we're doing here."	Y
…to understand additional student thinking	"I would ask him to explain how he figure out the six, because I want to know what he was thinking."	Y
… for the student to make mathematical connections	"I want him to think about the actual relationship of the numbers."	Y
... for the student to understand a conceptual error	"I want to make him look at the bigger picture (the problem context) of how it all fits together."	Y
…to understand student thinking that is confusing to the teacher	"I would do that so I would have a better understanding of what she meant."	N
...for the student to not have a procedural error	"It looks like the reason that these questions were missed was from computation errors to just making sure that he doesn't miss the easy part"	N
...for the student to recognize the importance of persevering in mathematical work	"I just want them to see that their hard work mattered."	N

Decide Sequences

We refer to a teacher action and its related purposes as a decide sequence. There were 59 decide sequences across the 37 pieces of written work. Recall that noticing the important mathematical elements in a piece of written work is an important precursor to teaching responsively (Richards & Robertson, 2015). Therefore a decide sequence would only be considered responsive if the participant had noticed the identified mathematical elements in the piece of student written work. If the participant had noticed the identified mathematical elements and both the teacher action and purpose were considered responsive, the decide sequence was designated as responsive. If either the teacher action or the decide purpose were identified as not responsive, the overall decide sequence was considered as approaching responsiveness. If both the teacher action and purpose were considered not responsive so was the decide sequence. Once the final codes were developed, the researchers coded the remaining data independently then met and discussed differences and modified the codes until 100% consensus across all data points was achieved.

Results

In all, participants brought 37 pieces of written work to examine across the four cycles in the approximation of practice. All three participants noticed all the important mathematical elements in each piece of written work except Kendall who did not notice all the mathematical elements in one piece of student written work. Across the four cycles of professional noticing in the approximation of practice participants posed 59 decide sequences related to the 37 pieces of

written work (i.e., teacher action and purpose). Ingrid had the most decide sequences (29) across 19 pieces of written work. Kendall had the second most decide sequences (20) across 10 pieces of written work. Hannah had the least decide sequences (10) across 8 pieces of written work. Next, we present the results for individual participants across the four cycles in the approximation of practice.

Ingrid

Across four cycles Ingrid shared a total of 19 pieces of written work and had the most decide sequences (29) out of the three participants. Most of her decide sequences (21/29) were considered responsive (72%). Her go-to teacher action involved asking a student to elaborate on and/or clarify their thinking (14 instances) most often for the purpose of testing student understanding (8 instances) followed by the purpose for the student to make mathematical connections (3 instances) and the purpose for the student to understand a conceptual error (3 instances).

Ingrid had 7 out of 29 instances of her decide sequences designated as approaching responsive (25%). Recall that a decide sequence was considered approaching responsive if the either the teacher action or purpose was designated as responsive. Overall, two (of the seven) approaching responsive decide sequences occurred when Ingrid posed teacher actions considered to be not responsive which included asking a student to rewrite/recheck work (1 instance) and the teacher telling, instructing, and/or explaining a strategy or concept to a student (1 instance). Both not responsive teacher actions were for the responsive decide purpose of the teacher wanting the student to make mathematical connections. Ingrid's remaining approaching responsive decide sequences included the responsive teacher actions of asking the student to elaborate on and/or clarify their thinking (4 instances) and asking the student to use a different strategy (1 instance) all paired with not responsive purposes that included the teacher wants the student to not have a procedural error (3 instances) and to understand student thinking that is confusing to the teacher (2 instances). Ingrid had only one not responsive decide sequence that involved asking the student a funneling question for the purpose of the teacher wanting the student to not have a procedural error.

Kendall

Kendall was our only participant to not notice all the mathematical elements in one out of ten of pieces of student written work. This resulted in three decide sequences for that piece of written work being identified as not responsive. Despite this, like Ingrid, most of Kendall's decide sequences (14 out of 20) were considered responsive (70%). For her responsive decide sequences Kendall's most prevalent teacher action was asking a student to work on a new task (10 instances) followed by asking a student to elaborate on and/or clarify their thinking (4 instances). Kendall's most common decide purpose was wanting a student to understand a conceptual error (7 instances) followed by wanting a student to make mathematical connections (3 instances).

Kendall had one approaching responsive decide sequence during her second cycle of professional noticing which involved a not responsive teacher action of asking a student a funneling question for the responsive purpose of the student making mathematical connections. Kendall had five not responsive decide sequences including three decide sequences for which Kendall did not notice the important mathematical elements in the piece of student written work.

The remaining two not responsive decide sequences involved providing a student with past test scores for the purpose of a student recognizing the importance of persevering in the learning of mathematics.

Hannah

Hannah shared the fewest pieces of student work (eight) and had the fewest decide sequences (10) and only two of them (20%) were identified as responsive. Both of Hannah's responsive decide sequences involved the same teacher action of asking a student to elaborate on and/or clarify their thinking but for two different responsive purposes; the teacher wanting to test student understanding and wanting the student to make mathematical connections.

Hannah's had six approaching responsive decide sequences. Five involved the not responsive teacher action of telling, instructing, and/or explaining a strategy or concept to a student for the responsive purpose of wanting to test student understanding. The last approaching responsive decide sequence involved the responsive teacher action of asking the student to use a different strategy for the not responsive purpose of wanting the student to recognize the importance of persevering in mathematical work. Hannah had two not responsive decide sequences. One involved the teacher action of asking the student to rewrite/recheck their work and the other involved asking the student a funneling question; both for the not responsive purpose of wanting the student to not have a procedural error.

Discussion

In this discussion, we identify patterns and changes in patterns for each participant's pedagogical reasoning across the four cycles in the approximation of practice. Our discussion includes the importance of teachers identifying mathematical elements in student work and how teacher actions and purposes inform our understanding of responsive teaching.

Pieces of Student Written Work

Our data indicates that our participants noticed the mathematical elements in self-selected pieces of student written work in all but one instance. This finding is not surprising, as our participants are experienced teachers. However, the one instance in which Kendall did not notice all the mathematical elements reveals something we feel is important. Kendall brought a piece of student work that involved a word problem about building a tower out of different colored blocks (see Figure 3).

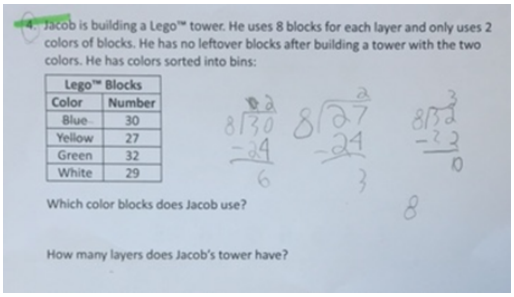

Figure 3. Kendall's Piece of Student Written Work

In the problem, a student named Jacob builds a tower using eight blocks for each layer and only uses two colors of blocks. He has no leftover blocks after building a tower with the two colors. One solution is for a student to add up the number of two-block color combinations and then determine which combination(s) is divisible by eight. A second solution, and the one that the student seems to be utilizing (see Figure 3), is for a student to figure out the number of layers a single color makes, add the remainders for two-color combinations and then determine if any of these sums are divisible by eight.

However, Kendall appears to lack the knowledge needed to recognize the viability of the student's strategy and instead focuses on her preferred strategy; She states, "he should have seen that you have to use two colors, so you are going to have to add the colors together and then divide to see if it is divisible by eight." She then posed three decide sequences. The first of which was, "I would have him really pick apart what the problem is asking because he has forgotten that he needs to be looking at two numbers instead of the one." Imagine this teacher action playing out in a classroom setting. It is highly likely that the student might incorrectly assume that their original strategy was not viable resulting in frustration and confusion. This scenario supports the idea that a teacher's ability to identify the important mathematical elements in each piece of student written work is not just an important but also a necessary precursor to teaching responsively (Richards & Roberts, 2015).

Teacher Actions and Purposes

Our findings suggest that our participants each had a go-to repertoire of teacher actions and related purposes in the 59 decide sequences. All three participants, tended to make similar teacher actions across the four cycles in the approximation of practice, with Ingrid asking a student to elaborate on and/or clarify their thinking (14 out of 29 instances), Kendall asking a student to work on a new task (10 out of 20 instances), and Hannah telling, instructing, and/or explaining a strategy or concept to a student (5 out of 10 instances). While participants did not individually favor a particular decide purpose, as a group they tended to favor the decide purpose of wanting a student to make mathematical connections (23 out of 59 instances) and to test student understanding (14 out of 59 instances), both responsive. Additionally, there was not a one-to-one correspondence between teacher actions and related purposes. These results confirm that participants engagement in the approximation of practice is at times predictable but also allowed the participants to be instructional decision makers in an unscripted space. Teacher educators need to continue to create, facilitate, and study approximations of practice that work to capture and develop teacher professional noticing and responsive teaching to improve mathematics education in various educational settings. These findings also demonstrate the importance of not just eliciting teacher actions but also the often-hidden pedagogical reasoning involving a teacher's purpose for a teacher action.

Responsive Decide Sequences

We used the lens of responsive teaching to identify each decide sequence as responsive, approaching responsive, or not responsive. As participants engaged in the approximation of practice, they posed several decide sequences for each piece of work. Examining these decide sequences for each piece of written work revealed that responsive teaching fell on a continuum as participants would often shift from approaching to responsive for a given piece of student written work. These shifts often occurred through a change in the responsiveness of a teacher

action. At other times, these shifts occurred through a change in the responsiveness of a decide purpose. These findings align with other findings that suggest there are various pathways towards teaching responsively and that teaching responsively is not an all or nothing endeavor (Richardson & Robertson, 2015). Our work demonstrates that these shifts can occur through visible teacher actions and/or teacher's often hidden, purpose for a teacher action. We illustrate this phenomenon with an example from Hannah in her first cycle in which she brought a task that involved finding the area and perimeter of two rectilinear shapes (see Figure 4). Hannah expertly analyzed the student thinking as she explained:

> He took it and made it into a full rectangle and used that full rectangle to figure out the missing sides, so this was three and he wrote three over here and then he had five down here because the three and the five equals the eight and then three and four is seven.

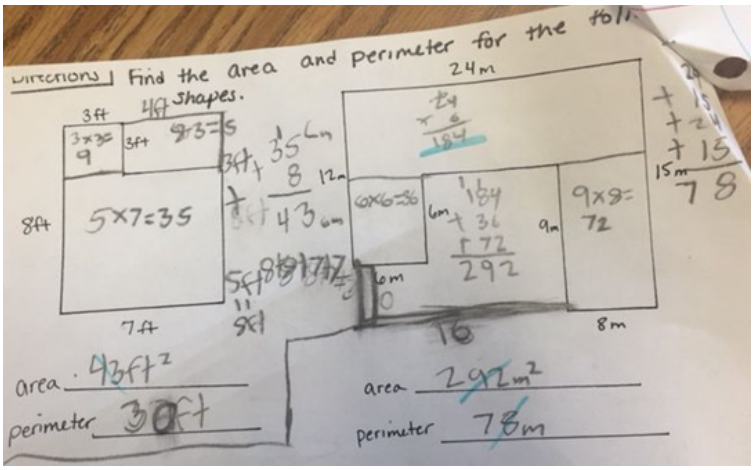

Figure 4. Hannah's Piece of Student Written Work

Hannah noticed that although her student had composed the rectilinear shape into a large rectangle, he didn't use this composition to find an answer. She also noticed that while he did his calculations (e.g., five times seven and three times nine) correctly; he, "incorrectly wrote 35 and eight (instead of nine)." She then states, "It is just a computation error or writing the wrong number and I would ask him to slow down and double check his math he did to find an answer." This decision about how to respond was coded as the teacher asks the student to rewrite/recheck their work for the purpose of the student fixing a procedural error. This decide sequence was identified as not responsive. She then shifted her noticing to the student's work determining the perimeter of the first shape stating:

> The student added up all the sides to get the perimeter. This worked for the first shape to find the right answer…. I can almost imagine he is pushing the sides out to find the perimeter, but it doesn't show if he understands they are adding up each side of the rectilinear figure and not the perimeter of a big rectangle.

Hannah then applies what she noticed about how the student found the perimeter in the first shape to his work on the second shape,

> …he does the same thing for the second figure by taking 24, 15, 24, 15 because it works for the first figure, but he is not taking into account that these are not the

> same on both sides and that this is a whole different shape (interpreting why the student did not find the correct perimeter of the second shape).

Hannah then shares a second teacher action:

> I would tell him it works here (finding the perimeter for the first figure) because this side is really up here so there are no extra sides that I am counting…but when I am looking here this face and this face together equal your bottom, but nothing equals this section there is nothing to pull over and then you're not accounting for these spaces on the inside.

She went on to state, "I want the student to connect how their method worked for the first shape and how that relates to the second shape." This decision about how to respond was coded as the teacher tells, instructs, and/or explains a strategy or concept to a student so the student makes mathematical connections. This decide sequence was identified as approaching responsive.

We find this example interesting for several reasons. First, Hannah engaged in noticing complex student thinking. She recognized that the student understood the conceptual idea of finding area and was merely making computational errors. Yet, pedagogically, she first focused on the student fixing these procedural errors. One could argue that fixing these errors is important, or not, but using the lens of responsiveness, a teacher action and/or related purpose focused on fixing, rather than pursuing student thinking are considered not responsive. Hannah then connected the student's strategy for finding the perimeter of the first figure to his work in finding the perimeter for the second figure and posed a not responsive teacher action coded as tells, instructs, and/or explains a strategy or concept to a student for the responsive purpose of the wanting the student to make mathematical connections.

In this example, Hannah shifts from a not responsive (i.e. fixing a procedural error) to a responsive (i.e. making mathematical connections) decide purpose. Imagine if Hanna made one more shift, from a not responsive (i.e. tell, instruct, explain) to a responsive (e.g. ask student to elaborate on and/or clarify thinking) teacher action. We suspect that all teaching professionals often experience shifts in responsiveness. In this example, a teacher educator might simply ask Hannah, or any teacher engaged in the practice space, to consider a shift in her teacher actions towards an action that creates a space for the student to make, rather than being told, these mathematical connections. In this slight shift, a teacher might become responsive to student thinking.

Conclusion

In this study, we examined teachers' pedagogical reasoning in an approximation of practice with experienced teachers. The participants were prompted to professionally notice their students' mathematical thinking in pieces of student written work. The participants noticing of important mathematical elements, teacher actions and purposes were analyzed using the lens of responsive teaching. We encourage teacher educators to use approximations of practice with experienced and prospective teachers to enhance student centered teaching (Grossman et al., 2009; Kavanagh et al., 2020). Our results inform professional development in several ways. First, a teacher needs to be able to notice their students' mathematical thinking to teach responsively. Some teachers may need exposure to learning opportunities (e.g., case studies, video analysis, practice spaces) to develop this component of their teaching practice. Second, a

teacher's ability to engage in responsive teaching involves shifts in both teaching actions and purposes for those actions. A teacher educator could facilitate these shifts in teacher actions through carefully crafted questions, such as, "What does your student understand?" How can you use that understanding to help them think about (mathematical concept)? If on the other hand, a prospective or practicing teacher often poses purposes for a given teacher action that does not work to pursue student thinking, teacher educators could provide learning opportunities that include case studies of teachers who demonstrate a responsive teaching stance. Importantly, the teachers in this study, embraced the responsibility and challenge of PDS partnerships to engage in continuous learning (NAPDS, 2021) and we believe that this established relationship between PDS teachers and researchers helped to create the space for implementing an approximation of practice that allowed teachers to reveal and have their teaching practice examined with an intentional goal of improving student learning (Dresden et al., 2014).

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Preparing and Supporting Elementary Mathematics Specialists through School-University-Community Partnerships

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Abstract: Grounded in a close partnership between a university, school district, and non-profit organization, this 5-year mathematics professional development project involves 27 elementary teachers prepared and supported as Elementary Mathematics Specialists (EMSs). The project aims to develop EMSs who deliver ambitious mathematics instruction in their classrooms and serve as informal mathematics teacher leaders. They complete a university's K-5 Mathematics and Teacher Supporting & Coaching Endorsement programs and participate in Professional Learning Communities and individual mentoring. Described here are the partners, the project's components, and the ways in which the EMSs engaged in teacher leadership across Year 1. Central to the project is the school-university-community partnership, with the components supporting reciprocity with mutual benefits for all partners, such as high quality clinical experiences for teacher candidates, coaching for novice teachers, and engagement with families and caregivers.

KEYWORDS: elementary mathematics education, school-university-community partnerships, Elementary Mathematics Specialists, professional development, teacher education

NAPDS NINE ESSENTIALS ADDRESSED:
Essential 1: A professional development school (PDS) is a learning community guided by a comprehensive, articulated mission that is broader than the goals of any single partner, and that aims to advance equity, antiracism, and social justice within and among schools, colleges/universities, and their respective community and professional partners.
Essential 2: A PDS embraces the preparation of educators through clinical practice.
Essential 3: A PDS is a context for continuous professional learning and leading for all participants, guided by need and a spirit and practice of inquiry.

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Introduction

Described here is our 5-year professional development project focused on the preparation and support of 27 elementary teachers as Elementary Mathematics Specialists (EMSs) that is grounded in a close partnership between a university, school district, and non-profit organization. First, we describe the need for the project, conceptual framings related to the project's professional development and partnership, and the partners themselves. Then, we share information about the project's components, especially the professional development experiences, and how the project supports *reciprocity with mutual benefits* for all partners, with connections to the work of the EMSs during Year 1.

Need for the Project and Framings

International and national assessments indicate far too few students in the USA, especially those from underserved populations, are attaining high levels of mathematics learning (National Center for Education Statistics [NCES], 2019, 2021; Organization for Economic and Cooperative Development, 2020). Further, students have lost opportunities for learning mathematics due to the COVID-19 health pandemic, with educational disruptions and shifts caused by the pandemic highlighting and exacerbating existing inequalities in mathematics education, especially for students historically marginalized (Dorn et al., 2021; Lewis et al., 2021; NCTM, 2021). Specifically, studies have shown that while mathematics achievement was lower for all students, Black and Hispanic students in high-poverty schools were disproportionally impacted, particularly in the elementary grades. The mathematics education of students in the elementary grades is crucial, as the foundational mathematical understandings built in these early years support later success in mathematics during secondary education (Austin et al., 2020; Watts et al., 2015). These findings are deeply troubling, given the importance of students' mathematical capacity for success. This capacity provides them with: critical thinking skills needed to address complex problems, abilities to thrive as global citizens, and tools for meaningful participation in our country's functioning and economy (National Council of Teachers of Mathematics [NCTM], 2014, 2020; Partnership for 21st Century Learning, 2011).

Key to bettering the mathematics education of elementary students is increasing the effectiveness of their teachers. Accordingly, across the past decade there has been growing advocacy for Elementary Mathematics Specialists (EMSs), who are teachers, teacher leaders, or coaches with the expertise to support effective elementary mathematics instruction (Association of Mathematics Teacher Educators [AMTE], 2013a). The joint position of several prominent mathematics education organizations, such as AMTE and the National Council of Teachers of Mathematics (NCTM) (AMTE, 2013b/2022), contends that every elementary school have access to an EMS and that advanced specialist certification be offered via rigorous preparation programs. The importance of these professionals and their specialized preparation is increasingly apparent as 19 states and the District of Columbia have established routes for EMS licensure, certification, or endorsement, with 10 other states in the process of developing pathways (EMSs & Teacher

Leaders Project, 2022). Our state provides pathways for a K-5 Mathematics Endorsement (K-5 ME) and a Teacher Support & Coaching Endorsement (TSCE).

When considering the preparation of EMSs, AMTE's (2013a) *Standards for Elementary Mathematics Specialists* serves as a guide for programs, recommending a focus on: (a) content knowledge for teaching, including well-developed understandings of elementary mathematics (e.g., *specialized content knowledge*); (b) pedagogical knowledge for teaching, including learners and learning, teaching, and curriculum and assessment; and (c) leadership knowledge and skills. Programs should include a supervised internship working with a range of learners, including elementary students and teachers. Learning experiences should be embedded in practice, with meaningful connections and enactment within EMSs' classrooms, schools, and/or school districts (Reys et al., 2017). Our project's professional development, specifically the K-5 ME and TSCE programs, are grounded in these standards and recommendations.

This project involves several key partners, including a university, school district, and non-profit organization. The collaborative partnership is critical to the project's success, with the embedded components promoting the professional growth of all participants and ultimately purposing to improve students' learning and understandings of mathematics. Notably, robust school-university partnerships, such as Professional Development School (PDS) models, support *simultaneous renewal* (Goodlad, 1994) of all partners. This renewal is a process of partners concurrently changing, growing, and improving, with a focus on innovative, high leverage, research-based pedagogical practices (American Association of Colleges for Teacher Education [AACTE], 2018). Central to strong school-university partnerships is *reciprocity*, where there are mutual benefits for all involved stakeholders (National Association for Professional Development Schools [NAPDS], 2021), including K-12 teachers, university teacher candidates (henceforth called teacher candidates), K-12 students, K-12 school and district administrators, university faculty, and others. Partners share the work and benefit from the collaboration, experiencing reciprocity by collectively implementing new strategies and piloting new programs that result in enhanced classroom instruction, improved student learning, and better teacher preparation (Ricci et al., 2018). There is *shared responsibility* for the preparation of teacher candidates, the professional development of teachers, and K-12 student learning (AACTE, 2018; NAPDS, 2021). Related to this project, one aspect of professional learning of teachers emphasized within school-university partnerships is intentional opportunities for teachers' development of leadership capacity so they can productively influence others (NAPDS, 2021). All in all, when considering the collaborative partnership in this project, *reciprocity with mutual benefits* is an especially strong feature, along with *simultaneous renewal* and *shared responsibility* as strong aspects.

School-University-Community Partners

The project partners include Georgia State University (GSU), Gwinnett County Public Schools (GCPS), and Corners Outreach (Corners). The Leadership Team collectively guides project implementation and is composed of four university faculty, the project's program director, two school district liaisons, and one non-profit liaison.

GSU is an urban, minority-serving research university graduating over 300 new teachers each year. Located in Atlanta, Georgia, GSU has a lengthy history of strong partnerships with local school districts, many of which serve students who are living in poverty, racially and ethnically diverse, and have been historically marginalized and underserved in mathematics education. Over time, GSU has closely partnered with GCPS in a number of ways, including through PDS models.

In this project, the Department of Early Childhood and Elementary Education (ECEE) provides two graduate-level endorsements: K-5 ME and TSCE (described in a subsequent section). In addition, the project's teacher candidates are completing the department's undergraduate elementary teacher preparation program. The undergraduate program places approximately 150 teacher candidates each semester in schools across metro Atlanta for clinical experiences. Of these teacher candidates, 75% are from underrepresented groups (non-White) in the teaching profession, 61% are eligible for the federally funded Pell grant program that supports students with exceptional financial need, and 31% are first generation college attenders. The quality of the program is evidenced by retention data indicating 91% of graduates remain in the teaching profession after 5 years.

ECEE's undergraduate elementary teacher preparation program aims to develop teacher candidates as knowledgeable, competent, agentic, and caring educators within the complexity and diversity of educational settings. The program emphasizes the connection of coursework with clinical experiences and research-based practices for instruction of diverse learners in urban school contexts. There is a focus on classroom instruction that values and leverages the varying academic, cultural, and linguistic backgrounds of children as well as their lived experiences in families and communities. Teacher candidates participate in clinical experiences across the 4 semesters of the program, including a yearlong student teaching residency, with strong coaching and mentoring provided throughout. The clinical experiences are designed to meet requirements for working with children across grade levels and ability/exceptionality as well as ensure culturally diverse classroom placements. Across these experiences, each teacher candidate is assigned a university coach who promotes self-directed thinking and action on a consistent basis, and along with the classroom mentor teacher, provides support and feedback on the teacher candidate's strengths and areas for growth.

Located in metro Atlanta, GCPS is the largest school system in Georgia, serving more than 180,000 students. GCPS has been recognized as one of the nation's top urban school districts. It has 80 elementary schools, and the project's recruitment efforts had concentrated on the highest need elementary schools in the district, as determined by the federally-funded free and reduced lunch program rates. This project's 27 elementary teachers work in 22 of the schools, which serve 91% students of color, with the largest populations being 44% Hispanic and 36% Black; 69% of students are eligible for the federally-funded free and reduced lunch program. The teachers self-describe as 24 females and 3 males, with 70% self-identifying as persons of color (41% Black, 7% Hispanic, 7% Asian, 7% Hispanic/White, 4% Hispanic/Black, 4% Black/White). The average age is 39 years (range of 28-62 years), and 30% speak a language other than English. They are a highly educated group, with 100% having a master's degree and 33% holding an educational specialist degree. Further, they are experienced teachers, on average having 10.5 years of teaching experience (range of 5-22 years). Teaching positions vary widely and include: three kindergarten, one first grade, two second grade, five third grade, one fourth grade, seven fifth grade, four STEM/Math Specials, one English to Speakers of Other Languages, one Special Education, one Early Intervention Program, and one Accelerated Content. Of these participants, two teach in Dual Language Immersion settings, including Spanish (2nd grade) and French (5th grade). Within these differing grade levels and foci, all teach mathematics, including some for part of the day and some for all of the day. Notably, this group of participants represents the diversity of teachers from which students learn mathematics in elementary schools.

Corners centers on the success of children as a change element in breaking cycles of poverty and has two main programs: (a) Corners Academy, dedicated to improving high school graduation rates through educational assistance, mentoring, and tutoring; and (b) Corners Industries, dedicated to improving career opportunities for underemployed parents. This project focuses on the work of Corners Academy, specifically supporting the after-school tutoring program provided to elementary students in GCPS. Currently, more than 500 elementary students are enrolled in the program. Corners Academy partners directly with teachers, reading specialists, and counselors at Title 1 elementary schools to create individualized tutoring plans for each student. It employs a multi-generational approach to raising education scores for students, meeting with parents, helping parents to better connect with the school through translation and transportation, and offering classes to parents to expand their own knowledge and education. Additionally, while serving populations that experience food insecurity, each student who attends the after-school tutoring program receives a daily snack.

Project Components

Overview

The project involves 27 elementary teachers in high-need, urban schools, who are prepared and supported as EMSs through completion of K-5 ME and TSCE programs. They are provided additional support through a Professional Learning Community and individual mentoring. Undergirded by the collaborative partnership, project goals include the development of EMSs who deliver effective and equitable mathematics instruction and serve as mathematics teacher leaders in a variety of ways, such as coaching teacher candidates, providing professional development to their peer teachers, mentoring novice teachers at their school sites, supporting the non-profit's after-school tutoring program, and engaging in community connections that promote key relationships and shared responsibility for students' learning. The project also aims to promote equity and access in mathematics education, support teacher retention in high-need schools, and situate teacher candidates in a hiring pipeline. Across the 5 years, the EMSs' primary responsibility is teaching students, thus their role as a mathematics teacher leader is an informal one. As the EMSs serve as a "more knowledgeable other" for a community of practice within a school, influencing teachers and the school's mathematics program as a whole (Campbell & Malkus, 2014), students should ultimately benefit by having improved mathematics learning experiences within the classrooms of both the EMSs and the teachers with whom they work.

Participant Selection

The teachers were selected to participate in the project based on criteria that identified them as successful, experienced teachers of mathematics with interest in and aptitude for teacher leadership. To be considered for the project, applicants submitted a variety of documents, including a resume, goals statement, letter of recommendation from a school administrator (that in part addressed student achievement in mathematics of the applicant), transcripts (minimum of 3.0 graduate GPA required), state-mandated teacher effectiveness score (minimum of proficient required), and a standardized test score focusing on mathematics. The Selection Team was composed of three university faculty, the project's program director, and two school district liaisons, who conducted small group interviews with the applicants and thoroughly reviewed the application materials. These reviews focused on meritorious professional achievement, academic accomplishment, knowledge of mathematics, commitment to teaching mathematics, and evidence

of/desire for teacher leadership. These criteria, plus consideration of race and ethnicity, gender, grade level, and school site with the aim of assuring participation of underrepresented groups and diverse school sites and grade levels, informed the selection of the 27 teachers in the project.

Professional Development

In the project, the EMSs are prepared and supported through completion of K-5 ME and TSCE programs during the first 2 years, along with participation in Professional Learning Communities (PLCs) and individual mentoring for the entire 5 years. See Table 1 for elements aimed at preparing and supporting the EMSs, along with the timeline. The endorsement programs include four elementary mathematics content courses integrating pedagogy, one course focusing on teacher leadership and coaching, and two internship courses, with one focusing on mathematics and the other coaching. Overall goals of both programs (AMTE, 2013a, 2017) are development of: effective and equitable mathematics instructional practices (NCTM, 2014, 2020); deep and broad knowledge of elementary mathematics, including *specialized content knowledge* (i.e., "mathematical knowledge needed to perform the recurrent tasks of teaching mathematics to students" [Ball et al., 2008, p. 399]); productive mathematical beliefs and professional agency; and teacher leader capabilities, including coaching skills. Note that due to the COVID-19 health pandemic, all project elements thus far have occurred virtually, with all class sessions, PLCs, and meetings occurring online and synchronously.

Table 1
Timeline and Project Elements Aimed at Preparing and Supporting EMSs

Year 1		**Year 2**			**Years 3-5**
Fall 2020	**Spring 2021**	**Summer 2021**	**Fall 2021**	**Spring 2022**	
1 TSCE course (Teacher Leadership & Coaching)	1 K-5 ME course (Number & Operations)	1 K-5 ME course (Data Analysis & Probability, 2-week summer institute)	1 K-5 ME course (Algebra & Rational Number) and 1 TSCE course (the Internship)	2 K-5 ME courses (Geometry & Measurement and the Internship)	
PLC and Mentoring	PLC and Mentoring		PLC and Mentoring	PLC and Mentoring	PLC and Mentoring

K-5 ME. In the K-5 ME program, the development of effective and equitable instructional practices focuses on learner-centered, responsive instruction (Carpenter et al., 2015; Jacobs & Empson, 2016) and the eight mathematics teaching practices in NCTM's *Principles to Actions* (NCTM, 2014). These include: (a) selection and implementation of instructional tasks with high levels of cognitive demand; (b) use of multiple representations and tools; (c) promotion of problem solving and reasoning, explanation and justification, and connections and applications typical of *standards-based learning environments*; and (d) use of children's thinking and understandings to guide instruction. There is explicit emphasis on equity-based, identity-affirming pedagogy, including fostering of practices that provide access, support, and challenge in learning rigorous mathematics for every student (AMTE, 2017, 2022). EMSs learn about planning for and enacting instruction that leverages children's mathematical, cultural, and linguistic resources/strengths, while nurturing positive student identity in mathematics (Aguirre et al., 2013; AMTE, 2017, 2022;

Bartell et al., 2017; NCTM, 2020, 2021). Learning during class sessions occurs through: (a) active engagement in and analysis of the mathematics in the elementary curriculum, especially through cognitively demanding instructional tasks; (b) study of children's thinking and learning via video clips and written work samples; (c) examination of classroom practice via video clips and written teaching cases; and (d) scrutiny of the research base on elementary mathematics education and of critical aspects of equity and access with connections to classroom practice and schools (e.g., culturally responsive teaching, instruction for multilingual learners, and mathematics as a lens for understanding, critiquing, and changing the world). There is a substantial focus on the professional development materials from *Cognitively Guided Instruction* (e.g., Carpenter et al., 2015) and *Developing Mathematical Ideas* (e.g., Shifter et al., 2018).

In the K-5 ME program, key assignments include six clinical-style interviews of children's understandings of mathematical concepts, with three focusing on number and operations, two emphasizing equality and relational thinking, and one focusing on geometry and measurement. These interviews involve significant analysis, including instructional decisions with justification. Another assignment includes selecting, adapting, or generating, analyzing, and solving cognitively-demanding instructional tasks spanning grades K-5 and aligned with the concepts of each course (10 per course, 40 total). The Task Analysis Guide in the *Five Practices for Orchestrating Productive Mathematical Discussions* (Smith & Stein, 2018) is used for examination of cognitive demand of tasks. A portion of these instructional tasks must evidence connections to children's *funds of knowledge* related to their community, culture, language, lived experiences, and interests (Aguirre et al., 2013; Bartell, 2011, 2017; Civil, 2007), along with mathematics as a lens for understanding, critiquing, and changing the world. EMSs also complete an in-depth data design, collection, and analysis project. They also prepare written syntheses and oral presentations of research on elementary mathematics education, aligned with the concepts of each course (one per course, four total). Last, during the Internship course, they create a professional portfolio documenting proficiency in teaching elementary mathematics, including data from classroom observations by a university coach.

TSCE. The TSCE program has a concentrated focus on the EMSs' preparation as teacher leaders by developing their understandings of teacher development, coaching, and facilitation of professional development. It aims to develop: knowledge of adult learning and the continuum of teacher development across the career span; and coaching skills that support instructional change through cognitive coaching (Costa & Garmston, 2016), observations of classroom practice, analysis of student work, and examination of lesson components. The cognitive coaching cycle is an iterative process that includes a pre-conference focused on goal setting, followed by a lesson observation using specific data collection techniques, and then a post-conference involving sharing of data with connection to goals and actionable feedback, with the coach encouraging reflection and decision-making centered on the mentee's concerns. Coupled with cognitive coaching, there is a focus on coaching for equity, specifically a transformational approach (Aguilar, 2020) involving coaches and their mentees continual analysis of behaviors (what we do), beliefs (what we think), and ways of being (who we are). EMSs are immersed in these understandings and approaches during the first course, Teacher Leadership & Coaching.

Then, in the second course the EMSs apply their learning in an internship focused on coaching a teacher candidate or novice teacher. With an understanding of adult learning and teacher development, the EMSs identify their coaching approach (Orland-Barak & Wang, 2020) and adjust their style, as needed, to alleviate resistance and to promote mentee reflection and self-

direction (Costa & Garmston, 2016). They develop a trusting relationship with their mentee, engage in goal setting, and provide continuous, targeted opportunities for collaboration and sharing feedback. The EMSs implement the cognitive coaching cycle at least 3 times across the course with their mentee, and also provide support through teacher development activities dependent on the differentiated needs of their mentees (e.g., curriculum and lesson plan support, data analysis focused on student learning, modeling, co-teaching, video self-study).

PLCs and Individual Mentoring: Support for Teacher Leader Activities. In addition to preparation for teacher leadership in the endorsement programs, support for the EMSs as they serve as teacher leaders is provided through a PLC and individual mentoring, both facilitated by the project's program director. PLCs and individual mentoring focus on: building a community of learners within each PLC, augmented support for developing effective and equitable mathematics instruction, and targeted support for their selection and implementation of what is called in this project *teacher leader activities*. The three PLCs are clustered around grade levels/teaching focus, with each having nine EMSs, and meet monthly eight times across the school year.

To lead instructional change and support wide-ranging improvements, the EMSs engage in a number of teacher leader activities across the 5 years in their school, district, community, and other contexts, applying their teacher leader understandings and capabilities learned in the K-5 ME and TSCE programs and the PLC. Two primary teacher leader activities include: (a) coaching a teacher candidate each year, and (b) supporting the nonprofit's after-school tutoring program for at least 1 of the 5 years. Other teacher leader activities are selected based upon the needs of the school and in consultation with school leadership. The PLC serves as a context for collaborative selection, planning, and reporting on teacher leader activities, in addition to individual conferences with the program director.

Toward the beginning of the school year, each EMS proposes 3-6 specific teacher leader activities in writing to the program director, describing in detail the anticipated activities (i.e., Teacher Leader Plans), after discussion with school leadership. The program director consults with the project's Leadership Team and collaboratively refines with each EMS a plan for specific teacher leader activities to accomplish across that school year. Check-ins related to progress across the school year are included in both PLC meetings and individual conferences. PLC meetings also include time for EMSs to collaborate on these activities, as there are often multiple EMSs implementing similar efforts. This collaborative planning time cultivates support for individuals, productive brainstorming on shared ideas, and positive working relationships between EMSs, who because they are in schools across the district would not otherwise interact. Each EMS provides documentation at the end of each year of this work in a Teacher Leader Record (TLR), providing a detailed description of each activity's content, duration, frequency, and outcomes. For their work as EMSs and participation in the project, the teachers are provided an annual stipend through the grant funds.

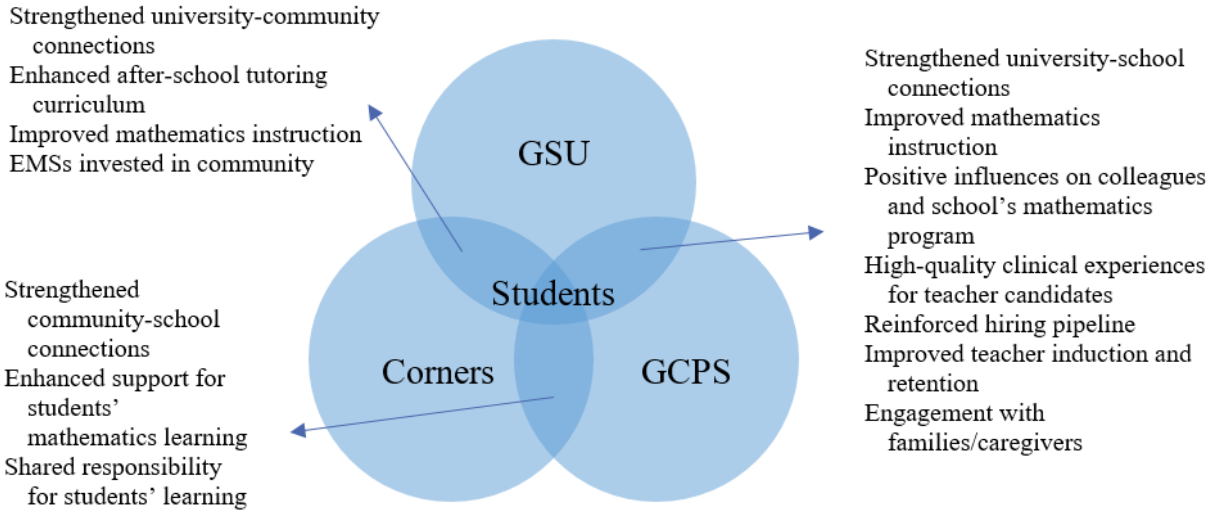
Project and Mutually Beneficial Partnership

The project's components, supported by the collaborative partnership, are grounded in *reciprocity with mutual benefits* for all partners and have the ultimate goal of improved student learning. Specifically, the *proximal* goals of improving EMSs' mathematics instruction with them in turn supporting others (e.g., fellow teachers) in doing the same, should influence the *distal* goal of enhanced student learning and understandings in mathematics. Figure 1 displays some of the mutual benefits, with supporting students and their mathematical capacity for success at the center.

The text following the figure provides further description, including connections to the teacher leader activities of the EMSs during Year 1 as reported in the TLR, since the project is currently in its second year of implementation (see Table 1 for preparation and support timeline). During the first year, the EMSs provided teacher leadership in a number of ways, with each reporting 3-6 distinct teacher leader activities, dependent upon the scope and scale of each activity. These activities provide several benefits for all partners, including the EMSs and their fellow teachers, teacher candidates, students, school and district administrators, university faculty, teachers at Corners Academy, and other key stakeholders, such as parents and families. Further, these activities illuminate how the project supports the position that school-university partnerships should intentionally develop teachers' leadership capacity, in order for them to productively influence others (NAPDS, 2021).

Figure 1

Project Partners and Mutual Benefits with Students at the Center



During Year 1 of the project, each EMS coached a teacher candidate, serving as a classroom mentor teacher and/or university coach. A total of 27 teacher candidates were impacted, strengthening the university-school partnership, contributing to high quality clinical experiences for teacher candidates, building teacher capacity for coaching others at the school sites, and reinforcing the hiring pipeline for high-need, urban schools. Notably, the EMSs having specialized training and developed expertise in coaching, which is too often not the case for those who host teacher candidates, should allow for especially meaningful, supportive experiences for teacher candidates placed in their classrooms. Further, this aspect of the project should contribute to a coherent vision and meaning for the expectations of the clinical experiences—that is, the teacher candidate and mentor teacher/university coach, in this case the EMS, will have common understandings as the EMSs continue to serve in this role. In addition, when considering effective mathematics instruction, the emphasis of the K-5 ME program for the EMSs aligns with that of the undergraduate mathematics methods courses completed by the teacher candidates, supporting

congruency related to theoretical underpinnings and pedagogy within mathematics education. Too often there are pedagogical mismatches between what teacher candidates learn in university teacher preparation programs and what they observe and experience in K-12 schools. Shared understandings of effective mathematics instructional practices will improve the clinical experiences and quality of the field placement classrooms for teacher candidates. The EMSs' mathematics instruction should provide an example of innovative, high-leverage, research-based practices (AACTE, 2018), with their classrooms providing space for teacher candidates to implement the same.

Beyond the project period, the EMSs' classrooms will be targeted as those that provide exceptional experiences for teacher candidates, building upon the enhanced partnership developed via the project. This is critical as GSU places many teacher candidates in schools across metro Atlanta, with quality of clinical experiences evidencing variability as some school districts use self-selection of mentor teachers rather than strategic placement. Over time, teacher candidates in the EMSs' classrooms are in a pipeline for being hired at the high-need, urban schools. Within the current national and local contexts of a pervading teacher shortage exacerbated by the COVID-19 health pandemic, this positioning of teacher candidates especially serves the needs of GCPS.

During the first year of the project, over one-third (n=10) of the EMSs supported Corners Academy after-school tutoring program, promoting school-university-community partnerships. This support was driven by the needs of the after-school tutoring program, based upon consultation with the program's leaders. The EMSs' initial efforts largely focused on collecting, organizing, and sharing tools and resources to support remote learning, which reinforced the mathematical concepts students were concurrently learning in their classrooms and prioritized problem solving, reasoning, and enjoyment of the subject. Then, they engaged in analyses of the after-school mathematics curriculum followed by revisions. First, they met with the curriculum developer at Corners Academy to discuss the types of changes and focal points desired for the curriculum, which included an increased focus on conceptual understanding for students and added elements that make tutoring more engaging. The EMSs then carefully analyzed the year-long curriculum for all grades and provided feedback on how to increase cognitive demand during instruction, implement instructional tasks that are worthwhile and engaging for students, and utilize more manipulatives and tools to improve conceptual understanding. They provided additional resources and supplements to that curriculum, with the continued aim of increasing rigor, conceptual understanding, and enjoyment of mathematics. All in all, these teacher leader efforts focused on curriculum development should lead to improved mathematical learning experiences for students in the after-school tutoring program. Since some of these students are in the EMSs' classrooms, the EMSs should receive direct benefits from this work via their students.

Additional teacher leadership was evident in Year 1, with 11 participants leading professional development of some kind for fellow teachers at their schools that focused on mathematics education (e.g., PLC, grade level planning sessions, districtwide and schoolwide professional development). As the EMSs serve as a "more knowledgeable other" for a community of practice within a school, influencing teachers and the school's mathematics program as a whole, students should ultimately benefit by having improved mathematics learning experiences within the classrooms of both the EMSs and the teachers with whom they work. These teacher leader efforts across the 5 years of the project and beyond aim to have a wide-ranging effect on mathematics teaching and learning at their school sites. In addition, 10 EMSs formally mentored new teachers at their schools, beyond coaching a teacher candidate. This coaching of novice

teachers fosters retention during these mentees' induction period in the profession. Support for teacher retention is critical, as nearly 1 out of every 2 teachers (44%) leave the profession within 5 years (Ingersoll et al., 2018), and with teacher turnover comes negative impacts on student learning (Ronfeldt et al., 2013; Sorensen & Ladd, 2020). Notably, a body of research shows that individual mentoring of those in the first 3 years of teaching is critical for persistence in the profession (Maready et al., 2021; Ronfeldt & McQueen, 2017; Smith & Ingersoll, 2004).

Additional teacher leader activities focused on outreach to parents and families. Twelve EMSs facilitated a Math or STEM Community Event for families and students in their respective schools. Twelve led workshops or created resources for parents focused on mathematics as a direct response to remote learning struggles or language barriers (e.g., instructional videos, bilingual resources). Community connections and intentional interactions with parents and families such as these promote key relationships and shared responsibility for students' learning in mathematics. This is especially true for supporting multilingual learners in mathematics, with "engagement with families" (NCSM and TODOS, 2021, p. 2) described as key for their success in the subject. With GCPS having the largest population of English Language Learners in the state compared to other school districts, these types of connections are particularly important. While the fore-mentioned categories of activities were the most frequently reported, the EMSs also engaged in a number of other activities, all of which were mathematics focused. Examples include co-presenting at national conferences, serving on leadership teams within the school district, creating original content for use with teachers and students, facilitating after-school boot camps or tutoring for students, and writing grants in order to procure resources.

When considering benefits and impacted individuals of the collaborative partnership, this project prepares and supports 27 EMSs at 22 elementary schools, who across the 5 years will affect over 10,000 elementary students and numerous teachers at the high-need, urban schools. This project intentionally supports students who have been historically marginalized and under-served in mathematics education, with the EMSs' schools serving 91% students of color. Further, selection criteria for the project ensured the EMSs are a diverse group, with 70% identifying as persons of color. This is significant as increasing research shows students of color benefit from having teachers of color (Carver-Thomas, 2018; Egalite & Kisida, 2018; Yarnell & Bohrnstedt, 2018). In addition, across the project, at least 135 teacher candidates will be impacted as the EMSs serve as their mentor teacher and/or university coach. Notably, for these teacher candidates, program data show 75% are from underrepresented groups (non-White) in the teaching profession, contributing to the much needed diversity of the teacher workforce as recent data show 78% of public school teachers in the USA are White (NCES, 2022).

This project aims to support teacher retention of the EMSs, an aspect that is addressed in the high-quality preparation and support as well as the community of teacher leaders being cultivated. Notably, the extant literature shows that teachers who engage in teacher leadership perceive an upward professional trajectory, thus increasing their own satisfaction and retention in the profession (Tricario et al., 2015). With this project occurring in the context of the COVID-19 health pandemic, the sudden, unanticipated shift to emergency remote teaching followed by concurrent instruction of face-to-face and virtual learners have generated tremendous challenges and angst for K-12 teachers. Those were and continue to be trying times for teachers, testing their resilience, fortitude, and persistence in the profession. Throughout, the EMSs have found community and comradery with one another, the project providing a space for supportive and open, safe conversations as they grapple with the tremendous demands placed upon them as educators,

which has been illuminated through both anecdotal data and initial interview findings. Their passion for and commitment to mathematics education are apparent, which brings us hope that our goal of retaining EMSs in GCPS will be successful.

Concluding Thoughts on Partnership

In conclusion, this project supports the *simultaneous renewal* of all partners, fostering change, growth, and improvement, with a focus on innovative, high-leverage, research-based pedagogical practices (AACTE, 2108) in mathematics. Further, the project's components support all partners having *shared responsibility* for the preparation of teacher candidates and the professional development of teachers, ultimately aiming to improve students' learning experiences in mathematics (AACTE, 2018; NAPDS, 2021). Development of the EMSs' leadership capacity is central, which is an important aspect of school-university partnerships (NAPDS, 2021). Further, the partners are sharing the work and benefiting from the collaboration, thus promoting *reciprocity with mutual benefits* for all involved stakeholders. Research involving mixed methods is being conducted across the 5 years of the project, which will provide insights into the functioning of the partnership and the development of the EMSs' mathematical content knowledge, instructional and coaching practices, beliefs, and teacher leader skills. The continued data collection and analyses provide a unique and exciting opportunity to follow the trajectory of the project participants as EMSs in high-need, urban schools serving diverse student populations, providing continued understandings related to reciprocity with mutual benefits of the partners. The project's through-thread of addressing issues of equity and agency offers the EMSs' students, teacher candidates, and fellow teachers an advocate for effective and equitable mathematics instruction, made possible by the collaborative school-university-community partnership.

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Developing a Schoolwide Instructional Vision in a STEM School Partnership

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Abstract: This article describes an intentionally mutually-beneficial partnership between a university, a local school district, an international company with local presence, and a community to design and create a school focused on STEM education and project-based learning. This article provides a thorough description of the iterative process of establishing an instructional vision, including collecting feedback from all participants, and how the process of establishing an instructional vision supported the creation of the school.

KEYWORDS: instructional vision, school-university partnership, STEM education

NAPDS NINE ESSENTIALS ADDRESSED:
Essential 1: A professional development school (PDS) is a learning community guided by a comprehensive, articulated mission that is broader than the goals of any single partner, and that aims to advance equity, antiracism, and social justice within and among schools, colleges/universities, and their respective community and professional partners.

Essential 2: A PDS embraces the preparation of educators through clinical practice.

Essential 4: Reflection and Innovation—A PDS makes a shared commitment to reflective practice, responsive innovation, and generative knowledge.

Essential 5: A PDS is a community that engages in collaborative research and participates in the public sharing of results in a variety of outlets.

Developing a Schoolwide Instructional Vision in a STEM School Partnership

Common practice in schools and other organizations is to create mission and vision statements to orient shared work. A mission statement describes the purpose of the school or organization and broadly guides decision-making (Boerema, 2006; DuFour et al., 2008). A vision statement, in contrast, describes the ideal future state for the school or organization (DuFour & Eaker, 1998; Gurley et al., 2015). From a strategic planning perspective, the creation and existence of these documents support organizational improvement (Bryson, 2012). It is also well established that a shared vision is necessary for supporting change (e.g., Elmore et al., 1996; Newmann, 1996).

In the context of partnership work, a shared vision is even more important, because each partner enters with varied experiences and expectations. In this paper, we describe work aimed at developing and enacting a shared vision in the context of designing a new prekindergarten (pre-K) through eighth-grade public school focused on STEM. Specifically, we focused on creating an instructional vision to orient our collective work around instruction. An instructional vision is a vision in that it articulates what we are aiming for, and it is instructional in that it focuses on what classroom instruction should look like. Developing an instructional vision and other concrete visions for day-to-day work in schools is not as common a practice as mission and vision statements. However, we argue that instructional vision creation is necessary for supporting improvement work.

The focal partnership between a university, a school district, an international company with a local presence, and a community was established to become a research-practice partnership over an extended time. A research–practice partnership is "a long-term collaboration aimed at educational improvement or equitable transformation through engagement with research" (Farrell et al., 2021, p. 5). The partners quickly agreed that the school should be a "STEM" and "PBL" school, without clear definitions for those terms. As they moved beyond the decision to operationalize those terms, they immediately found the need for a shared instructional vision when discussing what "STEM" or "PBL" would look like in the classroom. For example, some members of the partnership were particularly committed to project-based learning; others were more committed to the problem- or place-based learning structures. There was a need for a concrete set of underlying principles that could unify these different approaches and give the partnership a base of support for moving the work forward—both with respect to teaching and learning, and the adoption of related supports like curriculum materials. The schoolwide instructional vision was intended to support coherence across content areas and orient our collective work as partners designed and opened the school.

Conceptual Frameworks

Coherence

Several scholars in educational leadership and policy have written about the importance of coherence. Some scholars focused on coherence between school and district goals, strategies, and policies (e.g., Cohen et al., 2017; Honig & Hatch, 2004). Other scholars have focused on school-level coherence. For example, Elmore et al. (2014) defined internal coherence as "a school's capacity to engage in deliberate improvements in instructional practice and student learning across classrooms over time, as evidenced by educator practices and organizational processes that connect and align work across the organization" (p. 3). We adopt this internal coherence perspective but acknowledge the importance of also attending to the alignment with external goals (e.g., district expectations around student achievement), strategies, and policies, because they can impact the

internal coherence. A key feature of many of these scholars' work is focusing on coherence as a process rather than a state. While some describe coherence as alignment with a focus on the process of "coherence making" (Fullan & Quinn, 2016, p. 30), others describe coherence itself as a process (Honig & Hatch, 2004); in either case, there is a heavy emphasis on the ongoing work involved in building connection and alignment across the organization.

The importance of coherence has largely been demonstrated by how reforms or other initiatives fail to take hold or be sustained when there is a lack of coherence. When schools or districts adopt a new curriculum, the extent to which it is aligned with other initiatives and adequately supported tends to make a big difference (e.g., Coburn et al., 2012; Stein & Coburn, 2008). Further, when one initiative conflicts with another school-, district-, or state-level project, there can be challenges in enacting the initiative. For example, in the Inquiry Hub project, a research–practice partnership between the University of Colorado Boulder and Denver Public Schools, a conflict between instructional innovation and the teacher evaluation system arose (Penuel, 2019). Even though the high school science instructional materials were codeveloped by researchers and school and district staff, when used in classrooms, the partners discovered a lack of alignment between proposed instructional innovations and the teacher observation rubrics. The research–practice partnership team created a crosswalk tool and an accompanying two-page guide to navigate the potential lack of alignment (Penuel, 2019). Instructional innovation likely would be deemed incompatible with teacher evaluation and deprioritized if this lack of alignment were not addressed. Much more generally, there is considerable evidence that alignment between values and activities within schools makes for more effective schools (e.g., Rosenholtz, 1985; Robinson et al., 2017).

Further, researchers have highlighted several fundamental components of schools and districts to support coherence (Elmore et al., 2014; Fullan & Quinn, 2016). One such essential component is leadership for instructional improvement, where principals are expected to share instructional leadership responsibilities with teachers (Elmore et al., 2014). For example, teachers are a part of the decision-making process for the entire school rather than only their singular classroom. A second fundamental component is a school culture of learning and collaboration. Through shared instructional leadership, leaders focus on building a culture of learning and trust, which supports risk-taking and innovation (Bryk & Schneider, 2002; Elmore et al., 2014; Fullan & Quinn, 2016). A third fundamental component is the set of structures and processes for organizational learning and collaboration that allow the culture of learning and collaboration to flourish (Elmore et al., 2014; Honig & Hatch, 2004; Horn & Little, 2010). A fourth fundamental component is a shared understanding of effective practice, which goes beyond a general vision statement that is aspirational and does not provide concrete suggestions for improvement. Instead, a shared understanding of effective practice, or a "shared instructional vision," offers concrete guidance and direction for instructional improvement (Forman et al., 2017; Fullan & Quinn, 2016). The development of a shared instructional vision is the focus of this paper. We further elaborate on the notion of a shared instructional vision in the following section.

Instructional Vision

Forman et al. (2017) described the importance of "developing a vision for the instructional core" (p. 60). For them, and Cohen and Ball (1999), the focus on the instructional core attends to the teacher, student, and content, as well as interdependence between those three. Therefore, a vision for the instructional core is grounded in classroom activity. We call such a vision an

instructional vision. Hammerness (2001) studied teachers' "personal" (instructional) visions and described them as "a set of images of ideal classroom practice for which teachers strive" (p. 143). Research has suggested that teachers' instructional visions vary, change over time, and influence teachers' instructional practice (Munter, 2014; Munter & Correnti, 2017). Further, teachers' colleagues can influence their instructional visions (Munter & Wilhelm, 2021). In particular, teachers can be exposed to their colleagues' instructional vision through interactions, which can shape teachers' instructional visions. We expect that many individual teachers have a personal instructional vision that is not necessarily aligned with their school or district instructional vision, especially at the start of a new initiative.

To support coherence in the partnership school, a schoolwide instructional vision was needed. The intent was to use the instructional vision as a shared artifact to guide all instruction and instructional-support decisions in the school planning and implementation. A solid instructional vision based on research and practice could serve an initial purpose and then continue to evolve as the teachers, and school leaders, took it up in the school (Forman et al., 2017). Regardless of whether the vision looked the same as what we had developed initially, the practice of starting with a shared vision and continuing to use a standard, prominent, and instruction-focused vision for teacher and leader decision-making allows for the continued development of a shared instructional vision over time.

Goals for Student Learning in Math and Science and for Project-, Problem-, and Place-Based Learning

Given the agreed-upon STEM and PBL focus for the school, the project began by identifying clear goals for students' learning. Based on institutional constraints, project partners knew that students would have different mathematics, science, English language arts, and social studies time allocations rather than integrated cross-curricular periods. In turn, they were not necessarily focused on integrated STEM but instead on what innovative instruction looks like across the science, technology, engineering, and mathematics (STEM) disciplines and, hence, focused on ambitious goals for student learning in science and mathematics as a foundation for the instructional vision.

Science

The *Framework for K-12 Science* (National Research Council [NRC], 2012) describes three dimensions of science and engineering education in which students should have knowledge and understand the practices of by high school completion. The first dimension, called *practices*, outlines the investigative behaviors of scientists and design procedures that engineers apply as deeper capabilities than knowledge or skills alone. This dimension stresses student engagement in science and engineering education for direct experience in learning as important ways for students to develop the cognitive, social, and physical application that inquiry learning necessitates. The second dimension, called *crosscutting concepts*, links the practices shared by science disciplines to concepts and processes across scientific domains. For instance, those links include patterns, similarities, and differences; these concepts may be juxtaposed and interrelated for students to develop organizational schemas in their thinking and knowing. Crosscutting concepts relates to the third dimension, called *disciplinary core ideas*, to propel such learning into classrooms. This dimension stipulates that core ideas should have broad importance or serve as crucial organizing concepts; provide tools to understand and investigate complex ideas or problems; relate to

students' personal or societal concerns; and be teachable as integrated with engineering, technology, and the application of science. By attending to these domains together, the practices, crosscutting concepts applicable to and linking all scientific disciplines, and core ideas can be woven together as dimensions through which high-quality science instruction occurs.

Mathematics

In mathematics, two complementary frameworks describe ambitious goals for student learning: the Five Strands of Mathematical Proficiency (NRC, 2001) and the *Principles and Standards for School Mathematics* (National Council of Teachers of Mathematics [NCTM], 2000). The Five Strands of Mathematical Proficiency are five components believed to be necessary for individuals to successfully learn mathematics: (a) conceptual understanding, (b) procedural fluency, (c) strategic competence, (d) adaptive reasoning, and (e) a productive disposition (NRC, 2001). These strands are depicted as a rope to illustrate their interdependent nature as individuals develop mathematical knowledge, skills, abilities, and beliefs (NRC, 2001).

The NCTM (2000) standards describe Content and Process Standards as a set of learning goals for mathematics. The Content Standards include five interrelated content strands: Number and Operations, Algebra, Geometry, Measurement, and Data Analysis and Probability. The Process Standards include five "ways of acquiring and using content knowledge" (NCTM, 2000, p. 29): (a) problem-solving, (b) reasoning and proof, (c) communication, (d) connections, and (e) representations.

PBL

Whereas PBL is commonly associated with student-centered or inquiry-based learning, different individuals in the partnership had varying notions of what the "P" in PBL stands for. Problem-, project-, and place-based learning are instructional approaches that have gained traction in K-12 education and were possibilities they wanted to allow for within the instructional vision development. The project team entered the development phase with a generic view of PBL to provide the opportunity for the community, corporate partner, district, and university stakeholders to meld their conceptions into a single vision within a larger instructional framework. Next, we briefly review the three instructional approaches and describe their differences to lay a foundation for how they can be coherently interwoven into a schoolwide instructional vision.

Project-based learning is typically associated with a product, whereas problem-based learning is the process of creatively solving ill-defined problems. Both project- and problem-based learning share origins in the work of Dewey and Kilpatrick in the early 20th century (Savery, 2015) but were fully articulated in the 1950s and 1960s. Developed in schools of medicine seeking to promote more complex problem-solving capabilities in students (Barrows, 1996), problem-based learning poses challenges to students that do not have a formulaic path to a single solution. Defining features of problem-based learning, such as student-centered learning and the problem forming the organizing focus or stimulus (Barrows, 1996), are closely mirrored through current frameworks for project-based learning (Dean et al., 2016). Project-based learning refers to teaching methods through which students engage for an extended time to investigate and respond to an authentic, engaging, and complex question, problem, or challenge (Larmer, 2020). Dean et al. (2016) contended that the overlaps between problem-based and project-based learning make differentiating them difficult and questioned the cost-benefit of adopting one over the other.

Place-based learning, also called place-conscious education (Gruenewald, 2003) and community-oriented schooling (Theobald & Curtiss, 2000), might be more distinct from the other "Ps" but was important to the partnership, as they sought to provide authentic learning experiences in a particular community. Place-based learning seeks to break down the isolation of education as occurring within the school walls to extend practice and pedagogy toward local contexts, honoring students' real-life experiences, and centering the community (Gruenewald, 2003). However, scholars are increasingly identifying educational institutions as promoting placelessness through standardized educational environments and curricula that disregard the connection between people and place (Augé, 2008; Bertling, 2018).

Counter to this globalization narrative, the partnership chose to situate its instructional vision within its locale. Commitments to problem-, project-, and place-based instruction and the strong focus on STEM helped the project partners identify relevant frameworks as they sought to inductively build a schoolwide instructional vision to support coherence-making.

Context

The Neighborhood STEM School (NSS, a pseudonym) is a pre-K through eighth-grade community school in a large, urban public school district in the southwestern United States, in a state that has not adopted the Common Core State Standards (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010). A local university received a 3-year planning grant from an industry partner to facilitate the development of the school ahead of the opening of the school for seventh and eighth graders. In the year following the seventh- and eighth-grade opening, the school would open for pre-K through first-grade and grow with the younger children each year. Additionally, the NSS would continue to have students from other feeder pattern elementary schools in the large, public school district join the school community in seventh grade every year.

The NSS is a partnership among the school district, the university, the industry partner, and the community, and the design of the planning activities was intended to represent that partnership. For example, decisions were made with representatives from each partner but often led by the university due to the funding and time allocations. Because of the grant, the university had more time to devote to project planning activities. Other critical partners were nonprofit organizations working as wrap-around service providers (e.g., afterschool programs, tutoring programs) in the community, who would serve an important formal role in the community school.

The project partnership was organized into a set of design teams to support the planning activities. The work to develop the NSS instructional vision was at the intersection of two design teams: (a) Instructional Innovation and Equity and (b) Professional Learning and Distributed Leadership. To summarize, the work was led by two members of the university team (the university leads) and involved members from all four project partners (community, district, industry partner, and university) who were jointly planning for the curriculum, instruction, professional learning, and leadership within the school.

Core decisions related to the instructional vision, described in greater detail above, were the STEM emphasis in the school and the flexible definition of PBL. Another crucial contextual element is that the industry partner was funding this project to develop a model for STEM school development in the focal community and other communities. The emphasis on a replicable model had implications for their approach to planning. For example, the adopted curriculum materials had to be open source to be financially easy to adopt in other contexts. Some initial curriculum

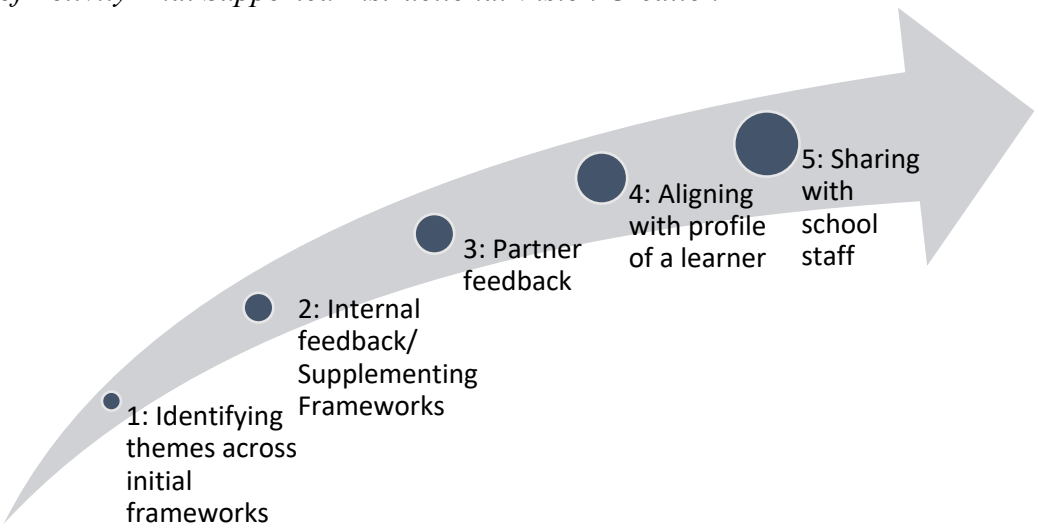
work involved creating project-based and place-based learning units, which helped the university team quickly see that they did not have the capacity to develop a comprehensive curriculum for the NSS. Therefore, they had to supplement what was created with existing open-source curriculum materials, and they needed a set of criteria for deciding which curriculum materials to use. Given the scope of the project and the importance of coherence, they needed a common framework that would help guide the project work around matters of curriculum and instruction.

The project team set out to create a framework that could be used as the instructional vision for the NSS. They intended for it to be immediately helpful for both supporting curriculum adoption and developing teacher professional learning and instructional leadership routines. Ahead of the opening of the school, the university team designed professional development intended to introduce teachers to the NSS instructional vision, both generally and within teachers' specific content areas.

Data, Analysis, and Results

The university leads engaged in an iterative process of pulling together several frameworks, inductively coding to extract themes from the different frameworks (Ravitch & Carl, 2015), and seeking repeated feedback from other partnership members. To avoid redundancy, in what follows, we describe the data, analysis, and results at each stage of the project, describing their results before moving on to the next step. We use these rounds to organize the different activities and related revisions as iterations on the development. In total, there were five distinct rounds of activity, with related revisions to the instructional vision framework (see Figure 1).

Figure 1
Rounds of Activity That Supported Instructional Vision Creation

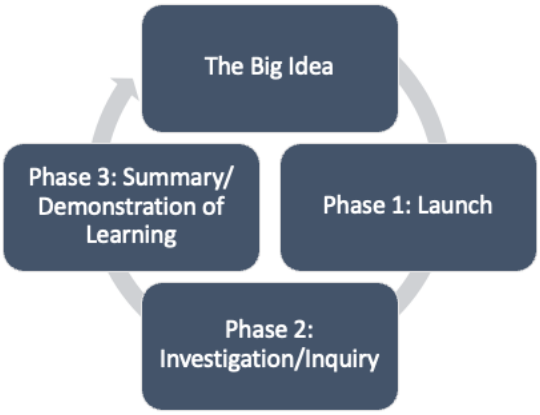


Rounds 1 and 2 of NSS Instructional Vision Development

The two university leads engaged in an affinity grouping exercise (Hanington & Martin, 2017), pulling and grouping different dimensions from four foundational frameworks—Ambitious Science Teaching (Windschitl et al., 2018), Mathematics Teaching Practices (NCTM, 2014), a Project-Based Learning checklist, and the district instructional framework—described in greater detail below. With an overarching orientation toward ambitious problem-, project-, or place-based

instruction, the university leads first organized the affinity grouping exercise around a common unit and lesson structure in inquiry-based teaching: a launch-explore-summarize format. They added on a fourth structural category corresponding to the big idea for the unit, for aspects that did not conform to one phase within the lesson or unit. This process resulted in four overarching structural categories: (a) the Big Idea, (b) Phase 1: Launch, (c) Phase 2: Investigation/Inquiry, and (d) Phase 3: Summary/Demonstration of Learning (see Figure 2). These categories roughly mapped onto phases of units or lessons, with the "Big Idea" category being more closely related to planning or design, the Launch related to introducing the activity or unit, the Investigation/Inquiry phase being about exploration, and the Summary phase focusing on demonstration or consolidation of learning.

Figure 2
Four Structural Categories for Themes in Round 1



Given the adopted emphasis on STEM, the university leads began by identifying Ambitious Science Teaching (AST; Windschitl et al., 2018) and the Mathematics Teaching Practices (MTP; NCTM, 2014) as frameworks for high-quality science and mathematics teaching. The AST model (Windschitl et al., 2018) was developed out of a desire to provide teachers with more concrete suggestions for high-quality teaching in science, consistent with the NRC framework. The AST model consists of a set of practices that encourage teachers to develop a shared language about their common, ambitious instructional practices geared toward intellectual engagement and attention to equity. Windschitl et al. asserted the principle of equity as meaning that teachers provide opportunities for all students to "take advantage of situations that are designed to support learning" (p. 12). Through that equity principle, teachers can cohesively utilize the four AST practices: (a) plan for student engagement using the big ideas, (b) elicit student ideas, (c) support students' continually changing ways of thinking, and (d) draw together evidence-based explanations (Windschitl et al., 2018).

In 2014, the NCTM published the eight MTP, which constitute a framework that illustrates "a core set of high-leverage practices and essential teaching skills necessary to promote deep learning of mathematics" (NCTM, 2014, p. 9). Those practices include the following (NCTM, 2014, p. 10):

- Establish mathematics goals to focus learning.
- Implement tasks that promote reasoning and problem-solving.
- Use and connect mathematical representations.
- Facilitate meaningful mathematical discourse.
- Pose purposeful questions.
- Build procedural fluency from conceptual understanding.
- Support productive struggle in learning mathematics.
- Elicit and use evidence of student thinking.

The MTP were designed to improve the teaching and learning of mathematics for all students, in accordance with the NCTM process standards. Specifically, the MTP aimed at strengthening productive beliefs around the teaching and learning of mathematics for all students and sought to eliminate the persistent opportunity gaps related to race, ethnicity, and socioeconomic status (NCTM, 2014). Improving teaching and learning for all students connects with the equity component of the *Framework for K-12 Science* (NRC, 2012) and principles within the AST (Windschitl et al., 2018).

The team next added the design checklist for the project-based learning units and the district's overarching framework for high-quality instruction. The PBL unit design checklist was created by experts in PBL on the curriculum team and had four top-level categories of design elements: (a) standards and skills driven; (b) community context and relevancy; (c) supportive, responsive culture; and (d) assessment practices. Each of these had four or more bullets that specified features of PBL units. Finally, the district's learning framework was created as part of a strategic planning effort to create a vision for the district's learning, technology, and facilities design. The district's learning framework included six dimensions: (a) inspire: motivate and inspire the learner; (b) aim: define goals and develop a plan for success; (c) explore: seek new knowledge through productive struggle; (d) create: develop and validate flexible, novel solutions, (e) apply: deploy knowledge and skills to relevant situations; and (f) reflect: pursue constructive feedback with a focus on goal progression.

These four frameworks (AST, MTP, PBL checklist, and district framework) representing STEM, project-based learning, and high-quality instruction in the school district formed the foundation of the instructional vision. The university leads approached the affinity grouping exercise by pulling different dimensions from the frameworks and grouping them with similar ideas from other frameworks. The four overarching structural categories in Figure 2 served as the backbone for this round of affinity grouping. Within these categories, they examined the dimensions from the frameworks to pull out themes. Rather than trying to identify themes that were most often common across frameworks, they identified themes in a manner that represented the *breadth* of each framework. They wanted to ensure that everything within each framework was represented within their emerging instructional vision.

The second round involved meeting with internal university staff members of the NSS project team who were also familiar with high-quality teaching in STEM or project-based learning. The university leads made some changes to the language of the themes to address their feedback. They also expanded their reading and coding to include two additional frameworks, one that they were already planning to add to attend to place-based education more explicitly (i.e., culturally sustaining pedagogy; California Department of Education, 2022; Paris, 2012), and one that was recommended to address some holes identified by university partners in their initial draft, the

Science Teachers Learning from Lesson Analysis (STeLLA) two-lens framework of strategies for effective science teaching (Roth et al., 2017).

The culturally sustaining pedagogy framework builds upon asset-based pedagogies, including culturally relevant (Ladson-Billings, 1995) and culturally responsive (Gay, 2018) pedagogies, to view schools as places in which cultural ways of being can be sustained in communities of color (California Department of Education, 2022). Utilizing this framework allowed the team to focus on teachers' and students' cultures and contexts as assets for learning. The STeLLA two-lens framework was selected to round out some perceived holes with respect to effective science teaching, particularly around lesson and unit coherence (Roth et al., 2017). In that framework, the two lenses are student thinking and science content storyline. Further, within the science content storyline lens, the emphasis is on strategies to create a coherent science content storyline.

The results from Rounds 1 and 2 are summarized in Table 1. The team identified 20 themes across the four initial frameworks, which formed Round 1. An "X" in a given cell indicates a connection between a dimension within the existing framework and that theme. As an example, we have mapped the dimensions to emergent themes for just the last category (i.e., Phase 3: Summary/Demonstration of Learning) in greater detail in Figure 3. This mapping was done for each of the categories, but we have only included one such mapping as an example. In Figure 3, the top four groups of phrases correspond to the relevant pieces of the four frameworks used in Round 1. For example, students' ideas being represented publicly and worked on by the class is part of the AST framework and is related to the themes of "share understandings or products" and "authentic contribution to a community of practice." The right two columns of Table 1 represent the two additional frameworks added in Round 2. The two additional frameworks had dimensions related to a number of the 20 themes identified in the first round, but also surfaced four different themes that were important to the NSS instructional vision: (a) driven by what the community wants to sustain or change, (b) coherence, (c) building on what children already know, and (d) teacher investigates children's learning.

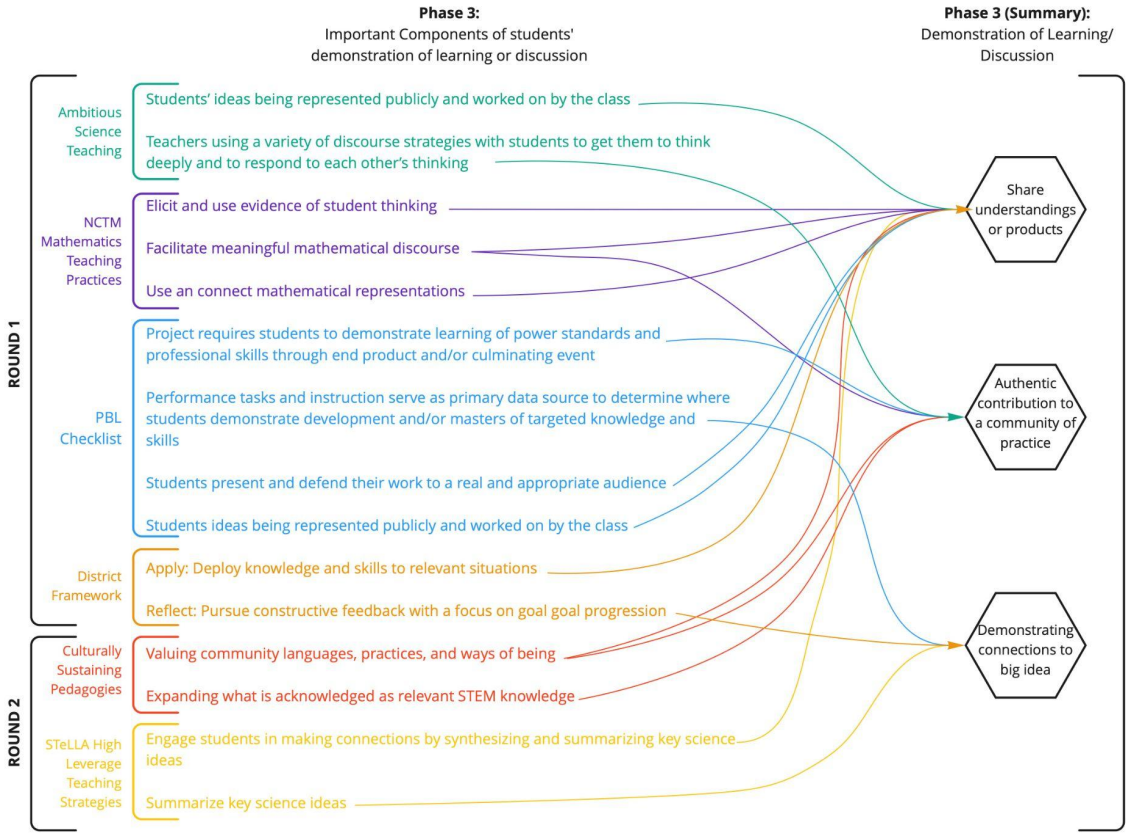
Figure 3 is intended to exemplify the mapping of ideas from frameworks to the emerging NSS instructional vision themes as we transitioned from Round 1 to Round 2, focusing on one structural category within the emerging vision, Phase 3: Summary/Demonstration of Learning. For example, Figure 3 illustrates how dimensions from all six frameworks related to the theme "share understandings or products," indicated by the arrows from at least one dimension of each framework to that theme in the top hexagon. The other two themes in the Phase 3 category, represented by the bottom two hexagons, were also aligned with dimensions of a number of the six frameworks.

Table 1
Coding Summary of Themes Mapped to Frameworks

Themes	Round 1				Round 2	
	PBL	MTP	AST	District	CSP	STeLLA
The Big Idea/Enduring Understanding/Purpose of Unit						
Driven by big ideas/enduring understandings	X	X			X	
Driven by what the community (including students) wants to sustain/change					X	
Expansive definition of STEM (and other disciplines)	X	X			X	
Coherence						X
Connected to content and process standards	X					
Developmentally appropriate expectations for students	X					
Phase 1: Launch						
Authentic connections to the world and/or discipline	X		X			
Building on what children already know					X	
Clear goals		X	X			X
Student voice and agency	X				X	
Sparks interest and curiosity	X	X		X		
Phase 2: Investigation/Inquiry						
Students engage in an iterative sensemaking process	X	X	X	X	X	X
Modeling and representations	X	X	X	X		X
Collective understanding		X	X			
Discourse	X	X	X		X	X
Student-driven decision-making/next steps	X		X	X	X	
Ongoing assessment	X					
Consulting experts	X					
Scaffolding			X			
Foregrounding big idea before the details/practice		X				X
Teacher investigates children's learning					X	
Phase 3: Summary/Demonstration of Learning						
Share understandings or products	X	X	X	X	X	X
Authentic contribution to a community of practice	X	X	X		X	
Demonstrate connections to big ideas	X			X		X

Note. PBL = problem-, project-, and place-based learning. MTP = Mathematics Teaching Practices. AST = Ambitious Science Teaching. CSP = culturally sustaining pedagogy. STEM = science, technology, mathematics, and engineering.

Figure 3
Example: Phase 3 Mapping of Dimensions of Six Frameworks to Related Themes



Note. Arrows from the frameworks to the emerging themes (in hexagons) indicate alignment.

Round 3 of NSS Instructional Vision Development

In Round 3, the draft of the instructional vision that followed from Rounds 1 and 2 was then shared with a larger group of NSS project team members representing all of the different project partners in two other feedback sessions. People from all four project partners who were members of the Instructional Innovation and Equity and Professional Learning and Distributed Leadership design teams were invited to provide feedback at this stage of the process. They used the Constructivist Tuning Protocol (School Reform Initiative, 2021) and walked them through the four structural categories of the vision to elicit what people liked, what they needed more information about, and what they feared might be missing, walking them through the four structural categories of the vision.

The feedback the university leads received in Round 3 from multiple feedback sessions with representatives from different project partners focused on several different features, including three improvements needed: (1) making the language resonate with disciplinary communities other than science and mathematics; (2) supporting teachers to enact this vision in a district heavily focused on teaching the state-adopted content standards; and, (3) condensing it to be more manageable for teachers. The university leads took this feedback into Round 4, which involved

addressing the feedback from the larger project team while also checking for alignment with another key project tool, the Profile of a Learner.

Round 4 of NSS Instructional Vision Development

Although the focus of this paper is the instructional vision, a critical and parallel planning activity was the development of the Profile of a Learner (see Table 2). Similar to the vision development, the development of the Profile of a Learner was iterative and sought input from representatives of each project partner.

The task of aligning the instructional vision with the Profile of a Learner helped the university leads to see that they could streamline the instructional vision by moving away from the four categories they initially used (represented in Figure 2) to three different categories, the first two of which were focused on the student experience and one focused on designing for learning (see Table 3). The two main categories for the student experience were (a) teachers balance student agency and learning goals and (b) teachers facilitate student engagement in an iterative sensemaking process. The themes underneath those headers in Table 3 further flesh out those categories. To continue the example description of the evolution of themes that began in Figure 3, several of the themes were moved into the category pertaining to designing for learning and reworded as "contributing to a community of practice" and "demonstrating connections to big ideas." The "share understandings or products" theme was removed because it was represented in several others, including utilizing discourse, developing and revising models and representations, and working toward collective understanding, all within the category of "teachers facilitate student engagement in an iterative sensemaking process." Other themes outside of the scope of the example in Figure 3 were added as well, including "embracing productive struggle," to more visibly connect to the profile of the learner and the mathematics teaching practices, as well as others.

Table 2
Neighborhood STEM School Profile of a Learner

Broad idea	Selected examples
Critically conscious & culturally competent	· Value their own backgrounds and identities with confidence that their school values these as well (including students' full linguistic repertoires). · Seek to learn about other people and cultures and exhibit cultural humility. · Dream big and advocate for themselves, their peers, and their communities in order to pursue goals/visions for the future.
Engagement in authentic scholarship	· Ask and pursue answers to researchable questions or problems. · Consider problems in context. · Follow a clearly articulated problem-solving process to methodically gather, critique, and analyze information. · Engage in discipline-specific modes of epistemic reasoning to create and refine knowledge claims (e.g., students engage in scientific, mathematical, or historical reasoning rather than simply learning the content knowledge of these disciplines).
Confident and persistent	· Dream big: aspiring to lofty, impossible dreams and identifying barriers that stand in the way of those dreams as well as resources and sources of assistance that can facilitate overcoming such barriers. · Actively encourage (and be encouraged by) peers to take intellectual risks. · Identify stumbling blocks, assess needs for support, and learn from failure.
Effective collaborator	· Collaboratively set long- and short-term goals. · Recognize and value collaborators' strengths and contributions. · Give and receive meaningful feedback, carefully considering the thoughts of others before critiquing them.
Effective communicator	· Engage in perspective-taking to understand stakeholders' values, communicate one's own values, and build a shared sense of ownership in desired outcomes. · Engage in effective written, spoken, or visual communication (including email) for a variety of audiences and purposes, and draw on wide linguistic repertoires (i.e., multiple languages, dialects, or registers).

Note. Truncated from *A Shared Vision: Applications of WDSS Instructional Vision and Learner Profile*, by J. Gravell and Q. C. Sedlacek, 2021, presentation at Caruth Institute for Engineering Education Friday Research Talk Spring Conference, Southern Methodist University, Dallas, TX.

Table 3
Neighborhood STEM School Instructional Vision

Category	Themes
Teachers balance student agency and learning goals	• Creating space for student voice • Articulating clear goals for learning • Sparking interest and curiosity • Expecting what is developmentally appropriate
Teachers facilitate student engagement in an iterative sensemaking process	• Working toward collective understanding • Building on what children already know • Embracing productive struggle • Utilizing discourse • Developing and revising models and representations • Intentionally consulting others • Assessing in an ongoing manner • Scaffolding
Teachers design for learning driven by big ideas, enduring understandings, and what the community wants to sustain or change	• Contributing to a community of practice • Promoting an expansive view of disciplines • Emphasizing coherence • Valuing and designing for variation • Fostering authentic connections • Driven by what the community wants to sustain or change • Driven by big ideas/enduring understandings • Demonstrating connections to big idea

Round 5 of NSS Instructional Vision Development

To prepare for the instructional vision to be used as a guiding document with teachers and school leaders, the university leads created a version with descriptors for each of the themes and used this document to share the vision with school leaders and teachers. These descriptors are represented in the second column of Table 4; the first column of maps onto the themes listed in Table 3.

Table 4
School Staff-Facing Version of Neighborhood STEM School Instructional Vision

Theme	Descriptor
Teachers balance student agency and learning goals	
Creating space for student voice	Teachers engage in routines and structures that require student input on direction of learning and outcome of learning. Students authentically contribute to the learning agenda.
Articulating clear goals for learning	Everyone in classroom community knows the purpose and plan for the day and how it connects to the larger learning/project goals and Texas Essential Knowledge and Skills.
Sparking interest and curiosity	Instruction is focused on questions rather than absolutes. Students are encouraged to ask questions and focus on aspects of the subject that especially interest them. Learning connects with lived experience as identified by students and adults.

Theme	Descriptor
Expecting what is developmentally appropriate	Students engage in roles, routines, and procedures that are developmentally appropriate to allow for complex knowledge building. Supports are available, but students are not restricted from attempting complex work due to age or reading level.
Teachers facilitate student engagement in an iterative sensemaking process	
Working toward collective understanding	Teachers and students work to build a shared understanding by engaging in conversations and collaborative, iterative refinements of group and individual ideas.
Building on what children already know	Teachers approach student contributions as connected, important, and containing understandings to build upon and integrate with new information rather than something to be fixed.
Embracing productive struggle	Classroom activity requires students to engage in collaborative, complex knowledge building. Teachers utilize activities that will build on what students know and are able to do yet require perseverance in achieving the goal.
Utilizing discourse	Teachers use a variety of discourse strategies to encourage students to think deeply and to respond to each other's thinking. Students have small-group and whole-class opportunities for discussion with peers. Students prompt each other to engage in sensemaking talk during investigations and other activities.
Developing and revising models and representations	Teachers identify representations and models aligned with the learning goal and facilitate classroom activity around those representations and models. Students engage in rounds of developing, using, and connecting representations and models.
Intentionally consulting others	Teachers and students decide when they need to draw on others' expertise based on their progress toward their goal(s). This can include teacher lecture, consulting disciplinary experts, students sharing their expertise and experience, consulting texts, etc.
Assessing in an ongoing manner	Teachers use a range of evidence (e.g., students' work, talk, demonstrations of learning) to understand students' thinking and use those understandings to design instruction and scaffold learning for individual learners. Students have opportunities to receive feedback, revise work, and reflect on their progress.
Scaffolding	Teachers utilize appropriate supports for students to meaningfully participate in class activity.
Teachers design for learning driven by big ideas, enduring understandings, and what the community wants to sustain or change	
Contributing to a community of practice	Students are engaged in the work of the field in which they study—rather than receptacles of knowledge, they are participants in the work of that field as an apprentice rather than expert.
Promoting an expansive view of disciplines	Teachers value everyday science and math, tinkering, traditions of speech and oral literacy/history, and current cultural ways of knowing.
Emphasizing coherence	Teachers develop a plan for instruction that predicts possible hiccups or misunderstandings while signposting places to return to the learning goal path.
Valuing and designing for variation	Classroom activities allow for and encourage variation in activities and products.
Fostering authentic connections	Students can articulate how their classroom work represents or relates to the world or work of experts in their field of study.
Driven by what the community wants to sustain or change	Leaders, students, and teachers investigate student, family, and communities to understand what is valued to be sustained and what is identified by the community as in need of change.
Driven by big ideas/enduring understandings	Important conceptual ideas from content areas are the driving force behind instructional planning and in-the-moment classroom instruction.
Demonstrating connections to big idea	Teachers make connections for students and facilitate student's own connections from their experiences in class to the enduring understandings/big ideas.

The goal of Table 4 was to provide concrete but concise elaboration of each theme with explicit attention to describing the range of what counts for that theme. After experiencing the instructional vision through content-area activities and discussions, the university leads administered a survey that asked teachers to review the instructional vision document and rate the clarity and confidence related to each aspect. In particular, they asked (a) "To what extent is this aspect clear to you?" and (b) "To what extent are you confident enacting this in your classroom?" The 4-point Likert scale ranged from 1 (*not at all clear/confident*) to 4 (*very clear/confident*). Other responses were 2 (*a little clear/confident*) and 3 (*somewhat clear/confident*). Ten (of 20) members of the school staff consented to having their responses used as part of this research. Participants were mostly teachers (including math, social studies, art, English language arts, and special education), but also included one school leader. Table 5 summarizes results from the survey for those 10 staff members.

Table 5
Neighborhood STEM School Staff Survey Results

Theme	Clarity			Confidence			Diff.
	Obs.	*M*	*SD*	Obs.	*M*	*SD*	*M*
Creating space for student voice	10	3.90	0.32	9	3.67	0.50	0.33
Articulating clear goals for learning	10	3.80	0.42	9	3.67	0.50	0.22
Sparking interest and curiosity	10	3.80	0.42	9	3.33	0.50	0.56
Expecting what is developmentally appropriate	10	3.30	0.48	9	3.22	0.44	0.11
Working toward collective understanding	10	3.70	0.48	10	3.40	0.52	0.30
Building on what children already know	10	3.90	0.32	10	3.70	0.48	0.20
Embracing productive struggle	10	3.60	0.52	10	3.30	0.82	0.30
Utilizing discourse	10	3.80	0.42	10	3.70	0.48	0.10
Developing and revising models and representations	10	3.60	0.52	10	3.30	0.67	0.30
Intentionally consulting others	10	3.20	0.63	10	2.90	0.57	0.30
Assessing in an ongoing manner	10	3.60	0.52	10	3.50	0.71	0.10
Scaffolding	10	3.70	0.48	10	3.70	0.48	0.00
Contributing to a community of practice	10	3.50	0.71	10	3.20	0.79	0.30
Promoting an expansive view of disciplines	10	3.70	0.48	10	3.20	0.79	0.50
Emphasizing coherence	10	3.50	0.71	10	3.30	0.67	0.20
Valuing and designing for variation	10	3.60	0.70	10	3.30	0.67	0.30
Fostering authentic connections	10	3.70	0.67	10	3.50	0.53	0.20
Driven by what the community wants to sustain or change	10	3.00	0.82	10	3.10	0.74	-0.10
Driven by big ideas/enduring understandings	9	3.44	0.53	9	3.56	0.53	-0.11
Demonstrating connections to big idea	9	3.33	0.50	9	3.44	0.53	-0.11

Note. Scores based on a scale of 1 (*not at all clear/confident*) to 4 (*very clear/confident*).

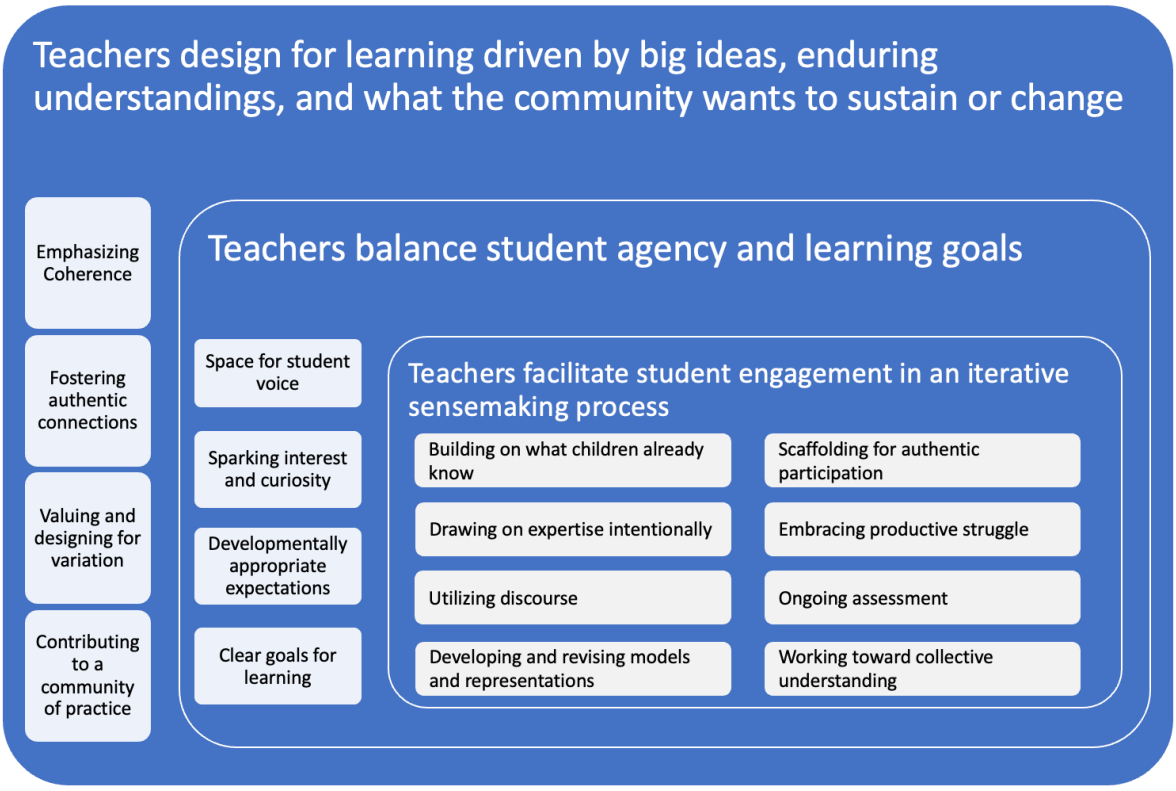
A few themes (i.e., aspects) stood out as less clear to NSS staff, with a mean value corresponding to a response near *somewhat clear* rather than *very clear*. Those themes were "intentionally consulting others" (*M* = 3.2) and "driven by what the community wants to sustain or change" (*M* = 3). In general, clarity and confidence appear to be related, with lower scores on clarity corresponding to lower scores on confidence. Further, teachers generally rated the clarity of the statement higher than their confidence in enacting it in the classroom. To control for the potential lack of clarity in the description influencing teachers' confidence, and to surface additional themes that teachers were less confident in enacting, we subtracted a teacher's score for confidence from a teacher's score for clarity to create a difference score (see the last column in Table 5). Two themes stand out as practices that teachers found clear, yet were less confident in how to enact them: "sparking interest and curiosity" (*M* difference = 0.56) and "promoting an expansive view of disciplines" (*M* difference = 0.50). Also of note are several themes for which

teachers actually rated their confidence higher than the clarity of the description: "driven by what the community wants to sustain or change" (*M* difference = -0.10), "driven by big ideas/enduring understandings" (*M* difference = -0.11), and "demonstrating connections to big ideas" (*M* difference = -0.11).

Overall, teachers seemed to think that the descriptions of the instructional vision were clear and that they were somewhat confident or very confident in enacting them in the classroom. However, following the survey-based feedback and professional development sessions with school staff, the university leads made a few minor changes to the organization of the instructional vision and the wording of categories and themes (see Figure 4). For example, they changed "intentionally consulting others" to "drawing on expertise intentionally." Another significant change was to move the two themes related to what drives instruction (e.g., "driven by what the community wants to sustain or change") into the category title for instructional design, rather than having them stand alone as separate themes. This move of the themes to the header was intended to indicate their centrality within decision-making and makes it more parallel with the category describing iterative sensemaking for students.

The resulting instructional vision (see Figure 4) has three nested categories: instructional design at the outermost level, teachers' goals and orientations at the next level, and students' experiences at the innermost level. At the outer level is the category entitled "teachers design for learning driven by big ideas, enduring understandings, and what the community wants to sustain or change." At the middle level is the category named "teachers balance student agency and learning goals." The innermost level holds the category "teachers facilitate student engagement in an iterative sensemaking process."

Figure 4
Neighborhood STEM School Instructional Vision



The intention was for the instructional vision to be revised over time as the school staff collectively make sense of it together. However, based on the iterative process they undertook and the feedback from school staff, the university leads are optimistic that the instructional vision, in its current and future forms, has the potential to support teachers as they make changes to their instructional practice in support of the student learning goals outlined in the Profile of a Learner.

Discussion

This article describes the effort to design an instructional vision in the context of a school-university partnership that also included partners from a corporation and the community. The project team set out to support a coherent focus on ambitious and equitable teaching practices across disciplines in a new public community school with a STEM focus, in order to support both teacher inquiry and student learning. This task involved an iterative process centered on bringing together existing frameworks for ambitious and equitable instruction across disciplines and incorporating partner feedback. The process resulted in an instructional vision emphasizing inquiry-based instruction, allowing for problem-, project-, and place-based instruction. In particular, the resulting product, the NSS instructional vision (see Figure 4), has three nested categories: (a) teachers design for learning driven by big ideas, enduring understandings, and what the community wants to sustain or change; (b) teachers balance student agency and learning goals; and (c) teachers facilitate student engagement in an iterative sensemaking process.

This instructional vision was intended to provide concrete guidance about essential aspects of enacting inquiry-based instruction in classrooms, seeking to avoid the problem of an all-purpose adoption of an inquiry approach (Furtak et al., 2012). It would provide concrete guidance in the areas of design for curriculum, teacher professional development, and supplemental programming. With respect to curriculum adoption, the instructional vision would be used as a measuring stick of sorts to check that the curriculum supports all three categories and related aspects of NSS instruction. In the area of professional development, the team organized initial sessions around the instructional vision, using it to guide decisions about whole group learning and content-area break-out meetings. They also used the instructional vision to orient ongoing learning for teachers over the course of the year. Teachers identified which pieces of the vision they might need the most support with and wanted to focus on over the coming year. Connecting to supplemental programming, the team shared the instructional vision with nonprofit partners and modeled instruction aligned with the vision for them so that they could imagine what it would look like in the classroom and start to imagine corresponding shifts in their programming.

In addition to actively centering the instructional vision in design work, the team also worked to support coherence making (Forman et al., 2017; Fullan & Quinn, 2016) by anticipating points of tension or challenges and addressing (mis)alignment head on. One such challenge they expected was aligning the instructional vision and teacher evaluation, given research and experience from other partnership efforts focused on instructional improvement (e.g., Penuel, 2019). Therefore, they mapped examples from the instructional vision to the teacher evaluation framework to show school leaders and teachers how the instructional vision was compatible with the district expectations. Thus, teachers and school leaders would be less likely to feel pulled in different directions as they were trying to innovate.

The NSS instructional vision is centered on STEM and project-, problem-, and place-based instruction, aiming to provide concrete guidance for school designers and school staff to support coherence making (Forman et al., 2017; Fullan & Quinn, 2016). Even though this instructional vision was developed by starting with science, math, and project-based learning frameworks, it was intended to support high-quality instruction across the whole school, including other content areas and electives. The project team ensured this cross-curricular inclusion by bringing in partners with expertise in different content areas to provide feedback along the way. We believe that this framework could support other schools needing a shared inquiry-based instructional vision to support instructional improvement. This framework can support the conceptualization of high-quality, culturally sustaining pedagogy across content areas, which can support cross-disciplinary research on instruction.

Implications

Creating the instructional vision document was valuable both as a process and a product. The process of creating the shared vision forced the partnership to have concrete conversations about goals for instruction and provided grounded opportunities for feedback and the development of a shared vision. The product gave the partnership team something to use to evaluate the quality and fit of curriculum options and a yardstick against which teachers could identify areas of growth they wanted to focus on in professional learning communities. Administrators and instructional leaders helped balance competing initiatives and explicitly defined the buzzwords thrown into the mix by the district, university, and corporate partner. Similar to the longstanding method of instructional planning known as Understanding by Design (Wiggins et al., 2005), the instructional

vision focused the partnership team on the "enduring understandings" they identified all students need when heading off to high school while leaving space to serve the particular community history and context. Specifically, the NSS Instructional Vision provides a broadly applicable and carefully specified framework for inquiry-based teaching, with roots in culturally sustaining pedagogy, allows for adaptation to various contexts, and prioritizes ambitious learning goals for students.

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