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Empowering Principals to Lead Project-Based Learning with Students Historically Underrepresented in STEM

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ABSTRACT

Education thought leaders highlight the need to expand access to high-quality STEM learning for students historically underrepresented in STEM fields, and project-based learning (PjBL) is often seen as a key strategy. Introducing PjBL to classrooms typically focuses on building teacher capacity, but principals also play a key role in effective implementation. This paper describes findings from an action research study that investigated ways to help school leaders learn to support PjBL in ten mid-high poverty schools as part of a federally funded grant to increase access to STEM for underrepresented students. Findings highlight the need to (a) help principals understand how PjBL can support learning needs by observing implementation with similar student populations, (b) provide principals with a variety of targeted learning opportunities to learn how to support implementation, (c) consider school context when planning PjBL support, and (d) ensure plans for PjBL implementation are aligned with systemwide goals.

Keywords: *principals, project-based learning, STEM, equity, instructional leadership, underrepresented students*

The U.S. Federal STEM Strategic Plan identifies the need to improve equitable access to high-quality STEM education as a national priority noting that students from low-income communities are especially likely to face barriers that limit access (Committee on STEM Education of the National Science & Technology Council, 2018). The federal STEM plan also identifies transdisciplinary approaches to learning, including project-based learning (PjBL), as a strategy to make STEM education meaningful and relevant while helping students to develop critical thinking, collaboration, and creativity skills. Similarly, Noguera et al. (2015) note that methods like PjBL that emphasize the development of higher-order thinking skills and learning mindsets can help students from historically underserved groups develop skills important for success in college and careers.

Project-based learning (PjBL) is an inquiry-based approach to learning in which students develop knowledge and skills in critical thinking and collaboration through exploration of real-world problems and development of public products (Baines et al., 2021a). Research has shown that PjBL can improve student outcomes including academic achievement, student engagement, and ownership of learning (Saavedra & Rapaport, 2024), including for students across racial and socio-economic groups (Deutscher et al., 2021; Duke et al., 2020; Krajcik et al., 2023). However, while PjBL's potential is promising, it is a complex methodology that requires a shift from teacher-centered to student-centered instruction (English, 2013), and studies have shown that PjBL can fall short of desired impact when not implemented with fidelity (Capraro et al., 2016; Odell et al., 2019).

School leadership has long been shown to be a key factor in promoting student learning (Grissom et al., 2021; Leithwood et al., 2004). As such, school leadership plays a critical role in introducing PjBL to classroom instruction. When school leaders do not understand the conditions necessary for PjBL to be successful, they can miss important opportunities to support teachers. This is especially important to consider in schools with large numbers of students living in poverty. These schools often focus intensely on high stakes testing, especially when they are formally identified as "low-performing" based on student achievement scores (Jennings & Sohn, 2014). Due to the pressure to raise test scores, these schools often invest significant time helping students learn basic content and skills required to pass tests rather than on higher-order thinking and development of lifelong learning skills (Aydeniz & Southerland, 2012; Hout, 2012; Noguera et al., 2015). Schools that focus primarily on teaching basic facts and skills to pass tests without also engaging students in meaningful learning experiences to develop critical thinking and problem-solving skills are engaged in what Haberman (2010) describes as the "pedagogy of poverty." PjBL presents a strong alternative to this approach, but pressure to focus on basic skills can lead educators in schools labeled low-performing to prioritize teacher-centered rote learning over instructional methods like PjBL that promote higher-order thinking (Noguera et al., 2017). While PjBL has the potential to improve academic outcomes for all students, to do so teachers and principals must understand how to implement it effectively.

This paper presents results from a year-long action research study that investigated ways to help principals develop knowledge and skills to support PjBL implementation in schools with mid-high poverty levels1[1]. The 10 participating schools were part of a federally funded STEM education program with a goal to expand access to high-quality STEM education for students historically underrepresented in STEM fields. The study focused on the following research questions:

RQ1: How can principals develop knowledge and skills to support effective PjBL implementation in their schools?

RQ2: What practices do principals see as essential in supporting PjBL in schools with large populations of students living in poverty?

Literature Review

This section summarizes the literature on high-quality PjBL and common barriers to PjBL implementation. It also includes a summary of literature on school leadership related to leading change in schools and equity-focused school leadership.

1 The National Center for Education Statistics defines mid-high poverty schools as public schools where 50.1 to 75 percent of students are eligible for free or reduced-price lunch (FRPL).

High-Quality Project-Based Learning

PjBL provides an innovative approach to teaching and learning where students gain valuable communication, collaboration, and problem-solving skills as they drive their own learning through inquiry and create projects to demonstrate their knowledge (Baines et al., 2021a). There is no consensus on a single definition of PjBL; however, work has been done to identify important common elements. Condliffe et al. (2017) found that common design principles for PjBL include use of a driving question to motivate learning, targeting of significant learning goals, use of projects to promote learning, inclusion of student choice in learning, and support for collaborative learning. The high-quality project based learning (HQPBL) framework describes six criteria that must be present for PjBL to be considered "high-quality": (a) intellectual challenge and accomplishment, (b) authenticity, (c) public product, (d) collaboration, (e) project management, and (f) reflection (Mergendoller, 2018).

PjBL is a complex instructional methodology that challenges traditional modes of teaching and learning, requiring a major shift in the mindsets and practices of both teachers and students (English, 2013). Teachers who are successful in PjBL implementation tend to focus on becoming facilitators of learning where they exert less teacher control, incorporate more student choice in learning, and work to turn management of tasks and processes over to students (Dole et al, 2016). Because it can be challenging to implement PjBL with fidelity, teachers benefit from intensive training and on-going supports including instructional coaching, protected planning time with colleagues, and support with developing learning assessments (Odell et al., 2019; Saavedra et al., 2024). Instructional leaders need to consider these shifts in practice required by PjBL when supporting implementation in classrooms.

Barriers to PjBL for Students Navigating Poverty

It can be helpful to understand some of the unique challenges students living in poverty face in order to create conditions for them to be successful in PjBL. Core challenges commonly faced by these students can include acute and chronic stress, related emotional support needs, and cognitive challenges due to adverse conditions in their home, community, and educational environments (Jensen, 2009). Although these challenges can have significant negative impacts on learning, well-designed PjBL incorporates several instructional strategies that have been shown to counteract these stressors, including relationship building, supporting students in building key academic and social skills, and using proactive coaching to support success (Baines et al., 2021b).

Purposefully designed PjBL has been shown to increase student engagement (Zeiser et al., 2014) and improve student academic outcomes for students across demographic groups including race and socioeconomic status (Deutscher et al., 2021; Duke et al., 2020; Harris et al., 2015; Krajick et al., 2023). This aligns with the finding that teaching for meaning and the development of advanced skills can increase outcomes for students from low-income families over a more traditional approach focused on basic skills and remediation (Knapp et al., 1995; Noguera, 2017). Fostering strong, secure relationships among students and teachers is also critical in building a classroom culture conducive to PjBL where students' academic, social, and emotional needs are addressed (Krajcik, 2021). By helping students build core skills in problem-solving and perseverance, and by providing encouragement and coaching, educators can counter potential negative impacts of poverty on cognition (Jensen, 2009). Providing scaffolding to help students access academic content and skills in critical thinking and collaboration is also important for student success (Anderson et al., 2022). All of these strategies align closely with a student-centered instructional approach that emphasizes development of critical cognitive skills which students living in poverty often are not provided with (Noguera et al., 2015).

Leadership for Equity and Instructional Change

The literature on leading instructional change specific to PjBL and equity is limited. More extensive literature exists on leading instructional change in general, and separately, on leadership for equity. A clear theme from the literature on leading instructional change is that introducing new practices needs to start with a clear vision aligned with collective values. In a report on preparing education leaders for deeper learning that surveyed educators, leaders, and policy makers across the U.S., Cator et al. (2015) identify several components of leadership that are essential in leading change including vision setting, change management, instructional and distributive leadership, and advocating for students. Grissom et al. (2021) note that effective education leaders pay attention to alignment of school mission, vision and culture, and relationships. Knecht (2019) describes this type of approach as having "coherence," saying that "great schools possess coherence among their culture, structures, and instruction driven by shared beliefs in how learning happens" (p. 39). Schoolwide implementation of PjBL can support coherence in instructional expectations for both students and teachers (Saavedra & Rapaport, 2024), and schoolwide implementation of PjBL has been shown to benefit both high and initially low-achieving students (Bitter et al., 2014). Schools shifting to an inquiry-based approach like PjBL also benefit from a coherent vision aligned with systems priorities and structures at the district level (Zavadsky, 2016).

Principals can have a significant impact on learning for students of color and students impacted by poverty (Grissom et al., 2021). Despite sustained school reform efforts over the years, poor student outcomes persist, especially among low-income students (Hanushek et al., 2022). Yet, many reform efforts continue to focus on traditional instructional methods as the right approach for students impacted by poverty and other marginalized groups (Noguera, 2017). A different approach is needed if low-income students and students of color are to access the benefits of student-centered instructional strategies. Nadelson et al. (2019) find that leadership for equity and social justice begins with an education equity mindset that supports actions and practices that increase opportunities for all students to achieve at their highest capacity through transformative leadership, collaborative leadership, organizational influence, and evidence-based decision making. While a number of these attributes align with other themes highlighted in the literature, leading with an equity mindset involves approaching all leadership practices with a clear focus on equity. Given broad differences in mindsets of school leaders, there is a need for professional development to foster an equity mindset and related practices through critical reflection (Brown, 2004; Nadelson et al., 2019). This aligns with Knecht's (2019) finding that school leaders may need focused support to build capacity in areas in which they lack expertise.

Methodology

This study applied qualitative action research methodology to investigate leadership practices for PjBL. Action research aims to generate knowledge at the intersection of research and practice where participants are engaged as collaborators whose lived experiences in the community are important to understand the issues at hand (Stringer, 2014). Additionally, qualitative action research is often used to address complex issues in education and can lead to deep and meaningful insights that inform decision-making and lead to positive change (Reason & Bradbury, 2008). However, action research also has limitations. At a foundational level, action research is highly context dependent and knowledge generation can only happen through a rigorous application of inductive qualitative data analysis methods (Miles et al., 2020). Thus, it is imperative that action researchers work to ensure both process and outcome validity (Herr & Anderson, 2015). This study used triangulation, or the inclusion of multiple perspectives, to ensure process validity, and study findings were discussed and verified

with participants to ensure outcome validity.

The researcher collaborated with ten principals and a district assistant superintendent to investigate which types of supports are helpful in developing principals' understanding of PjBL in mid-high poverty schools as part of a federally funded STEM education grant. Ideally, action research seeks to engage participants in the inquiry and solution-forming process (Stringer, 2014), yet time and resource constraints often require that action researchers navigate between roles of leader and collaborator in a study (Herr & Anderson, 2015). Given that the participating principals were extremely busy with competing priorities, the researcher approached collaboration in two ways. First, he worked to build relationships and channels of ongoing communication with principals through brief but regular one-on-one and group check-ins to discuss the study. Secondly, he worked with principals and school district leaders to provide as much flexibility as possible when engaging in learning opportunities and ongoing supports. Principals were also allowed to work with their teachers to decide which would be the first to engage in PjBL training and support. Ideally, the researcher would have collaborated more closely with participants during development of the investigation, but the study was conducted during the 2021-2022 school year when the COVID-19 pandemic was still directly impacting school schedules and staffing, and principals had limited availability to engage as co-investigators.

Setting & Participants

The study was conducted in the second year of a three-year STEM education grant program in ten schools within a relatively large public school district that had 89 schools in total at the time. The ten participating schools included seven elementary schools, two middle schools, and one high school. The schools were connected in a common attendance area where the seven participating elementary schools fed into the two participating middle schools, which fed into the participating high school. Given the grant's goal to increase access to STEM education for students historically underrepresented in STEM, the district selected these schools based on their large proportion of students of color and students qualifying for federal free or reduced-price lunch (FRPL) programs. In describing the schools, district staff noted that the selected schools were in an under-resourced area that typically did not receive the type of enrichment opportunities that the STEM program would provide. The percentage of students of color and those qualifying for FRPL for each school are shown in Table 1.

School	School Level	Total Enrollment	Free or Reduced-Priced Lunch (%)	Students of Color (%)	Principal Race/Gender
ES1	Elementary	543	57	82	Black/Female
ES2	Elementary	292	61	80	White/ Female
ES3	Elementary	177	53	79	Black/Female
ES4	Elementary	365	61	76	Black/Female
ES5	Elementary	382	59	89	White/ Female
ES6	Elementary	288	63	76	White/ Female
ES7	Elementary	402	60	90	Black/Female
MS1	Middle	571	60	85	White/ Female
MS2	Middle	309	67	81	Black/Male
HS1	High	892	53	86	Black/Female

Table 1. School Demographic Data for 2021-2022 School Year

Study participants included the principals of the 10 schools taking part in the STEM grant program. Nine of the principals were new to PjBL with no previous training. One of the middle school principals had helped to bring PjBL to the school she had been principal of previously, but PjBL was new to the staff of her current school. Because their schools were part of the same attendance area, the principals held a monthly vertical leadership meeting which the researcher attended each month to share program updates and discuss progress on the study. The assistant superintendent, who was also the principals' supervisor, participated in some of the STEM grant planning and training activities and was interviewed as part of the study. Study participants also included 43 teachers who attended PjBL training and who received PjBL coaching as part of the STEM grant. Ten of these teachers participated in focus groups as part of data collection activities.

Positionality

Positionality is important to consider in qualitative research since a researcher's life experience, beliefs, and proximity to research participants can have implications for data collection and interpretation (Holmes, 2020). The researcher and author of this paper is a white male with 11 years of experience using PjBL extensively as a middle school teacher. While he did not teach in mid- or high-level poverty schools, he worked for five years as a PjBL instructional coach and technical trainer in high-poverty schools where he gained an appreciation for several of the unique challenges faced by students and teachers in these settings. The motivation for this study grew out of conversations with classroom teachers new to PjBL who often asked if there were ways to help their principals understand how to better support teachers implementing PjBL.

The researcher's experience as a PjBL teacher, trainer, and coach was both an asset and a potential source of bias in the study. His experience was an asset in understanding the challenges students and teachers face when implementing PjBL and the types of supports they need to be successful. At the same time, the researcher's experience with PjBL has led him to believe that PjBL can work for all students in most any school setting given the right support. Left unchecked, this belief could result in overlooking factors that teachers and principals see as real barriers to PjBL implementation. To mitigate potential bias, the researcher engaged study participants and colleagues as "critical friends" to inform study design and data analysis (Herr & Anderson, 2015, p. 73).

Intervention

The STEM grant supporting the participating schools had an explicit goal to improve teacher and principal capacity to implement STEM focused PjBL in order to increase access to students historically underrepresented in STEM fields. The program focused on equipping teachers to implement what Condliffe et al. (2017) describe as teacher-initiated PjBL where teachers develop customized PjBL units that are aligned with instructional goals and curriculum standards. As part of the program, 43 teachers attended a five-day PjBL summer institute that included orientation to inquiry-based learning practices aligned with STEM instruction, as well as PjBL methodology and planning support. Teachers also received monthly instructional coaching support by trained PjBL coaches, and an additional follow-up one-day workshop during the school year for reflection on practice and additional planning support.

The STEM grant program also provided several leadership supports designed to help principals develop knowledge and skills to support PjBL implementation and address barriers to implementation. Specific interventions for principals included the following activities:

1. Initial planning meetings: Planning meetings included an overview of grant goals and activities, learning about principals' existing understanding of PjBL, and discussion of how PjBL aligned with their vision for instruction.

2. Leading PBL [PjBL] workshop: A half-day professional learning workshop aimed to build understanding of PjBL and ways to support implementation.
3. Monthly leadership meetings: These meetings provided principals with a regular opportunity to receive updates on program activities, share about progress with PjBL implementation, and discuss related challenges.
4. Monthly Leading PBL [PjBL] Insights videos: Ten-minute instructional videos provided principals with an on-demand resource from which they could continue to build understanding of PjBL, equity practices for PjBL, and related teacher support strategies.
5. PjBL school visits: Visits to neighboring school districts focused on schools with similar student populations to the schools participating in the study. The visits included observation of PjBL in a STEM-themed elementary school in one district, and observation of a districtwide approach to STEM and PjBL across three schools in another district.

Data Sources

Data collection for the study included evidence of the impact of intervention activities on principal leadership practices and teacher experience with PjBL implementation. Data collection occurred throughout the 2021-2022 school year and included the following sources:

1. Work products: Work products collected from leadership support activities included notes from meetings with participants throughout the year as well as participant reflections and evaluations from the Leading PBL [PjBL] Workshop, monthly leadership meetings, and PjBL school visits.
2. Principal and district leader interviews: The principals of the 10 schools were interviewed individually at the end of the 2021-2022 school year. The assistant superintendent for K-12 instructional programs was also interviewed. (See Appendix A for interview questions).
3. Teacher focus groups: Two teacher focus groups were held at the end of the school year to understand to what extent principals created conditions in their schools so that teachers felt supported in implementing PjBL as a new instructional practice. Ten of the 43 teachers in the STEM program participated in the focus groups including five elementary, three middle school, and two high school teachers. (See Appendix B for focus group questions).
4. Field notes and analytic memos: Field notes were kept throughout the data collection process to capture observations related to the principal support activities.

Data Analysis

Data analysis involved review and qualitative coding of all data sources. Miles et al. (2020) note that analytic memoing can be useful to synthesize data and distill emerging themes during data collection and throughout data analysis. Based on this awareness, the researcher engaged in analytic memoing throughout data collection during the school year and throughout the data analysis process. Data from interview transcripts, field notes, and work products were condensed through multiple cycles of coding using in vivo and descriptive coding to develop a codebook before engaging in post-coding analysis. St. Pierre and Jackson (2014) make the compelling case that coding should not be equated with qualitative data, and that while there is no set recipe for post-coding analysis, the process should be reflective, interpretive, and critical. Data analysis resulted in three major themes. Because member checking is a critical part of ensuring process and outcome validity in qualitative action

research (Herr & Anderson, 2015), resulting themes and related findings were confirmed and clarified with participants.

Findings

This study examined ways to help school leaders learn to support effective PjBL implementation in schools with large percentages of students from groups historically underrepresented in STEM fields. The study investigated the following research questions:

RQ1: How can principals develop knowledge and skills to support effective PjBL implementation in their schools?

RQ2: What practices do principals see as essential in supporting PjBL in schools with large populations of students living in poverty?

This section describes four major findings based on themes that emerged from data analysis, along with supporting evidence from participant data. Pseudonyms have been used to maintain anonymity. The first two findings respond to RQ1, and the second two findings respond to RQ2.

Finding 1: Seeing is Believing

Principals identified several activities as helpful in developing their understanding of PjBL and how to support teachers. Participants identified study visits to observe other PjBL schools and districts with students similar to theirs as one of the most impactful learning experiences during the year. Linda, an elementary school principal captured this sentiment in her interview saying, "I think that was the most powerful training or experience that we were able to have, being able to see teachers and students in person, teaching and learning through project-based learning." Another elementary school principal, Mary, noted that it was helpful to visit schools with "students like mine" to see how PjBL can work in a similar context with similar students. These visits to observe PjBL in other schools helped principals reimagine what instruction could look like in their own schools and what strategies and structures would be needed to make PjBL successful.

Seeing the positive impact of PjBL on student engagement and learning in their own students was also critical in helping principals see the value of PjBL. Students presented their work at a large-scale public PjBL exhibition held in the spring of the school year, and this was a pivotal moment for several principals. After the event, Mary commented, "Our students did a great job with it… Once our teachers saw that our students and other teachers were being recognized, that helped them to buy into it for next year as well." In observing students from her school engage in PjBL, elementary school principal Anne commented, "It's like their maturity level has changed." Anne also identified a noticeable impact on school culture after the PjBL exhibition: "The excitement from the students, the growth and the pride that came with it, it helped our school culture as well." In addition to seeing the impact of public presentations for students, several other principals identified a noticeable increase in student engagement and learning during instruction. For example, elementary school principal Tonya commented that:

> PjBL truly increased student engagement. And the students become the producers of knowledge. The teacher is that facilitative role and that's something that we should be doing as educators anyway and an increase in student confidence in speaking about their learning.

The value of PjBL as a student-centered approach was shared by middle school principal Tom who noted the impact on hands-on science learning:

> I think they understood (science) a lot better once PjBL was implemented…It made that real life experience for those kids to understand and say, "okay, so this is what we're doing." Instead of looking at theory and saying, "Hey, this is not something that I can imagine, but when I'm putting my hands on it, then I can do this and I understand it a lot better."

Seeing PjBL's impact on their own students and seeing it in action with students in other districts was pivotal in helping principals understand how PjBL can influence student learning. However, these observations came late in the school year for several principals which suggests it could be helpful to take principals (and teachers) to visit other PjBL schools with similar demographics to their own as an early orientation to PjBL practice.

Finding 2: Principals New to PjBL Benefit from On-going Professional Learning and Support

In addition to seeing PjBL in action, principals described several other supports as helpful in developing the capacity to lead PjBL in their schools. Principals identified the Leading PBL [PjBL] Workshop, monthly leadership check-ins, leadership instructional videos, and the provision of tools and frameworks all as helpful in learning to support PjBL implementation. The timing and sequencing of learning opportunities were also important. During end-of-year interviews, principals commented that it helped to have an initial leadership workshop the summer prior to implementation, followed by regular check-ins and on-demand PjBL leadership instructional videos. Linda noted the benefit of having the flexibility to view the videos in building understanding over time: "It's been helpful to view the videos after a year of working through StarWARD STEM and having a better understanding of expectations and what PjBL really looks like in a classroom."

In addition to these supports two principals attended the weeklong PjBL summer institute for teachers which was offered as an optional for principals. Elementary school principal Terry commented on the benefits of the experience:

> During [summer] training, there were just so many things presented to us and so many resources given to us that we were able to use coming into the school year. I think that once we start doing training while we're in the school year, it's harder to implement those changes. But when we get them in the summertime, we can really develop a good plan for how we're going to implement things and what's going to look different and make those changes before the school year starts.

This comment highlights the importance of providing well-timed training and resources so that principals have time to access them outside of the demanding schoolyear.

In addition to well-timed workshops, principals identified opportunities to collaborate with peers to address common challenges as important to their system of supports. For example, several principals identified monthly vertical leadership meetings as a helpful opportunity for networking, collaborating, and problem-solving around PjBL implementation. Principals also identified having one-on-one check-ins with an outside expert as helpful. Mary commented that "Checking in like we did this year…was always good for me. I just like to have a check-in to make sure I'm doing what I'm supposed to be doing. Because sometimes I forget." Another principal commented about the value of having time during a workshop to reflect on resources in a workshop evaluation form: "The most helpful component of the workshop was the breakout sessions to reflect on the resources provided to implement PjBL within our schools." This is a helpful reminder that as adult learners, principals

benefit from time to reflect and plan similar to teachers.

By the end of the study, the participating principals were able to describe several factors that need to be considered in supporting PjBL implementation in their schools including the following items:

1. Instructional shifts: Principals noted that PjBL requires instructional shifts that include how teachers plan, how they think about student engagement, and how they can intentionally release control so that students develop ownership of the learning process.
2. Teacher collaboration: While several principals noted that collaboration was already part of their school culture, they also noted that many teachers have not learned how to collaborate with each other, and they need guidance on how to work together to plan PjBL.
3. Addressing standards within PjBL: Principals noted that teachers need guidance and support to plan PjBL projects that address core learning standards.
4. Addressing equity in PjBL: Principals appreciated that PjBL provided opportunities to reinforce high expectations for all students while also planning appropriate scaffolding and supports. One teacher described seeing other teachers "dumb down" PjBL for students and responded, based on her experience, "I think everyone that thinks a child can't do something would be amazed if you just let them go."
5. Supporting beginning teachers: PjBL can overwhelm even experienced teachers. Several principals highlighted the importance of considering the needs of beginning teachers with a focus on having them engage with PjBL over time.

The fact that these principals, most of whom were new to PjBL, could articulate key considerations for supporting teachers indicates that the interventions provided had a positive impact on their overall understanding of PjBL.

Finding 3: Principal Support Needs to Start with Understanding Context

Principals in the study noted that it is important to understand the unique challenges teachers face in supporting large numbers of students living in poverty and the pressure that comes from having their school labeled as low-performing due to related academic challenges. Several principals mentioned that PjBL can be challenging if students are missing foundational skills and that some students need more support in critical thinking and problem-solving. Terry described this challenge in this way:

> If they're missing things when they come in, it's hard to do those PjBL activities because you are so focused on bringing up those kids in how low they are, and all of the other things. I think that it would be different with a different demographic of students... If Johnny comes in and knows how to spell his first and last name and can read, then it's different than my kids who come in and don't know their ABCs and don't know their colors.

Given the need to address foundational skills, some principals also described the academic needs of students in terms of time and competing priorities as illustrated by this comment by Tonya:

> [Students] just need the time. And I say that because most of the schools in [our area] are low-performing schools. So most of our time in planning is spent on ensuring that our scholars are demonstrating proficiency in all content areas as it relates to the [end-of-grade testing.]

While studies have shown that PjBL can address fundamental academic skills and content knowledge for students in low-income schools (Duke et al., 2020; Krajcik et al., 2023), it can be difficult for teachers and principals to commit to do so given the pressures of high-stakes testing.

Principals also articulated how pressure to focus on improving student test scores was exacerbated by the COVID-19 pandemic and resulting teacher shortages. The STEM grant supporting PjBL implementation in this study was first introduced to schools during the pandemic in 2020, and schools continued to experience related impacts of the pandemic during the 2021-2022 school year, when the study took place. A comment from Terry captures how several factors had a combined impact on PjBL implementation at the time:

> For some teachers, [PjBL] flew to the back burner because they were focused on [proficiency]. Then we had a teacher who went out for a grade level on extended sick leave. The [other teachers] took on the responsibilities making sure those students were proficient and ready for the next grade level. These are added stressors that are somewhat unavoidable when there's a teacher shortage.

It is important to note that by the end of the study, principals and teachers were able to describe positive ways PjBL was impacting their students. In addition to the positive impacts described in Finding 1, principals identified increased confidence and ownership of learning, increased use of academic vocabulary, increased collaboration skills, and increased engagement among past low-performing students as direct results of students engaging in PjBL. Tonya commented that "some of the best learning experiences come when students are able to be creative, to be collaborative, to communicate and practice those skills and facilitate learning, amongst themselves. PjBL has really fit into that vision."

Despite these signs of positive impact, concerns about the academic performance of the lowest-performing students in most of the participating schools resulted in intensive pressure to focus on fundamental math and literacy skills. PjBL was consistently viewed as competing for valuable time for preparing students for academic success rather than an effective instructional strategy for learning essential skills and knowledge. These observations illustrate the unique challenges that may need to be considered when supporting principals and teachers implementing PjBL in similar schools.

Finding 4: Principals Need Alignment of Vision and Curriculum at the District Level

Principals identified several ways that leading PjBL implementation in their schools needed a systems approach that aligns instructional support with a broader vision for PjBL implementation. As part of a school district with 89 schools, the ten participating principals were part of a system much larger than just their individual schools. During the initial Leading PBL [PjBL] Workshop, the facilitators shared past comments from PjBL teachers about what they need from administrators to support PjBL implementation. In response to the data several principals asked, "When do we get to tell our supervisors what we need?" This sentiment highlights the fact that neither teachers nor principals are isolated actors when it comes to implementing a new instructional practice like PjBL. They are part of a system where vision, goals, resources, and other supports need to be aligned. This idea was reinforced during the mid-year study visit to a neighboring school district that had a track record of successful STEM-focused PjBL implementation. The district leader hosting the visit commented, "[Change] can't just start at the top, and can't just come from the bottom. It has to be both." This highlights the importance of employing a systems approach to instructional change that accounts for all the members in the system.

Principals and teachers also noted the need for greater curricular alignment for PjBL within the system throughout the school year. Because the STEM grant introducing PjBL to schools was

initiated during the COVID-19 pandemic, coordinating curricular details with district leadership was challenging. This resulted in a lack of alignment between district curriculum expectations and PjBL implementation. A comment from elementary school teacher Sherry captured how PjBL was seen to compete with the district's expectations for instruction: "As soon as those more focused curriculum-based things [from the district] started popping up…the focus on [PjBL] started to get less and less." Sam, a middle school teacher, noted that district pacing requirements were a significant challenge:

> The county was like, "Okay, you need to be here at this point." I was kind of like, "Okay, well, where can I fit and piece this in so that I can finish what I need to do?" But I cannot make anybody in the county mad because I'm not where I'm supposed to be on the pacing. So it was just a lot.

This frustration about lack of alignment with district pacing requirements was shared by principals as well. High school principal, Denise, commented:

> For the county, [teachers] have pacing guides that they have to follow. [They] have content they have to do. So, you have to do all that, and you're preparing them for…end of year test. So, you have to cover that content. I think that if we can have our PjBL…on track with the content, the instruction based upon what they need to learn, I think that is good.

The need for alignment between PjBL and other district curriculum priorities was consistently identified by participants as one of the most significant challenges with PjBL implementation. The lack of alignment contrasted with what participants observed during one of the study visits to a neighboring PjBL district. During that visit, the principals' supervisor, Carey, noted:

> It helped to see [PjBL] implemented at a full scale at the school system [level]…I saw a K-12 progression. That helped me see it more clearly…knowing the capability of what we could bring back through our discussions and our vertical principal updates of what could be the possibility.

This highlights the need to ensure that PjBL is aligned with curriculum at the systems level when asking principals to introduce it in their schools. Conversely, a lack of aligned vision, curriculum expectations, and related instructional supports can contribute to PjBL being viewed as a competing priority rather than a cohesive part of a strategy to improve student learning.

Discussion

Study results demonstrated that having access to a variety of supports and resources aligned to the vision for PjBL is critical for principals who are leading PjBL for the first time. Principals identified several supports that helped build their understanding of PjBL including workshops, study visits to see PjBL implementation in other schools and districts, brief monthly check-ins during virtual leadership meetings held for all participants, and on-demand PjBL instructional videos. This desire for a variety of well-timed supports aligns with the literature on professional development for school leaders that finds that professional learning needs to be relevant, well-timed, and purposefully scoped and sequenced because of the intense time constraints principals face (Johnson et al., 2021; Zepeda et al., 2014). Participants noted that providing leadership workshops in the summer was ideal because it provided them with time to reflect and apply learning in planning for the coming school year, and they indicated that having protected time to reflect and discuss their learning with colleagues in

schools like theirs was valuable throughout their experience.

While the learning opportunities for principals in this study led to improved understanding of how to support PjBL implementation, a stronger focus on equity practices in professional learning experiences for principals would likely enhance their ability to support PjBL with historically underserved students. Riordan et al. (2019) highlight the need to center equity in professional learning for teachers and model practices that promote equity to help teachers adopt equity-focused practices. In a similar way, centering equity in professional learning for leading PjBL in schools with students impacted by poverty is likely to improve principals' ability to support implementation and address related barriers.

Study findings also point to the benefit of providing principals with the opportunity to see PjBL working with students similar to theirs. Principals noted that PjBL is challenging when students lack foundational skills and when schools face increased pressure from being labeled low-performing. Understandably, this caused them to be cautious about introducing PjBL to their schools. However, after seeing students like theirs succeeding with PjBL in other districts, and after witnessing positive impacts on learning in their schools, principals' confidence in PjBL improved. By the end of the study, principals described practices important for PjBL to be effective including holding high expectations for learners, ensuring PjBL is aligned with learning goals, and providing scaffolding to support students in developing problem solving and collaboration skills. These practices align with studies that point to similar indicators of successful PjBL implementation including holding high expectations for students, aligning PjBL with learning standards, and the use of scaffolds to support student learning (Baines et al., 2021a; Condliffe et al. 2017; Okilwa & Barnett, 2017). While the participating principals highlighted several supports as helpful to their learning, seeing the positive impact of PjBL on students similar to theirs was pivotal in increasing their understanding of what effective implementation could look like in their school.

Principals consistently noted that leading PjBL in their schools needed a systems approach. When the study began, PjBL was not part of the district's vision for instruction nor its curriculum plan. This made introducing PjBL to teachers challenging. In contrast, after principals observed the positive impact of a cohesive systemwide vision for STEM and PjBL in other schools, they began to think more concretely about what an effective vision might look like for STEM and PjBL in their district. This realization of the need for an aligned systemwide vision reflects Zavadsky's (2016) findings that a coherent approach centered on a clear systemwide vision for learning is important to sustain PjBL and high-quality instruction across schools. A key insight from this study is the importance of having principals and district leaders work early on to articulate how PjBL aligns with the overall vision for student learning, especially when that vision includes improving outcomes for students impacted by poverty.

Conclusion

This study investigated ways to help principals build capacity to support PjBL implementation in mid-high poverty schools as part of a federally funded STEM education grant. The study explored how principals can develop knowledge and skills to support effective PjBL implementation, and it looked at practices that are important in supporting PjBL in schools with large populations of students living in poverty. While this study contributes to the literature on leadership for PjBL and equity, it is limited by the fact that action research is highly context dependent, and results are not readily generalizable to all contexts (Stringer, 2014). This paper has attempted to address this limitation by contextualizing study findings within the broader literature. Evidence that PjBL can improve learning outcomes for all students, including those most impacted by poverty, continues to grow. Given this trend and continued interest in using PjBL to expand access to STEM

education, more research is needed on how to center equity in leading PjBL implementation so that teachers are well-supported and so that students gain the full benefits that PjBL has to offer.

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Appendix

Interview and Focus Group Questions

Principal Interview Questions

1. What professional development, activities & supports have you participated in this school year related to PjBL and the [STEM grant] program?
2. When you hear the phrase "project-based learning" or "PjBL," what does this mean to you?
    a. In what ways has your understanding of PjBL changed this school year?
    b. Which [STEM grant] activities have most influenced your understanding of PjBL?
3. What are some of the instructional shifts you'd expect to see for a teacher implementing PjBL vs. a more traditional approach to instruction?
4. How did the [STEM grant] program influence your vision for instruction this school year?
5. How prepared are teachers in your school to engage students in PjBL?
6. What supports do teachers in your school need to successfully engage their students in PjBL? How does supporting PjBL differ from supporting other forms of instruction?
7. In what ways has your understanding changed this school year about the type of support teachers need to implement PjBL effectively?
    a. Which [STEM grant] activities have most influenced your understanding about how to support teachers?
8. How prepared do you feel to provide those supports to teachers? Describe why you think so.
9. Is there anything unique about the needs of your teachers when it comes to implementing PjBL with your student population?
    a. IF YES: How have you tried to address those needs?
10. How would you describe teacher collaboration at your school currently? Both in terms of types of collaboration and level of collaboration.
11. To what extent do you feel supported as a school leader to implement PjBL at your school? In what ways?
    a. Has that support changed since beginning [STEM grant]? How so?
12. What additional support do you need in your role to support effective PjBL implementation?

District Leader Interview Questions (Principal Supervisor)

1. When you hear the phrase "project-based learning" or "PjBL," what does this mean to you?
    a. In what ways has your understanding of PjBL changed this school year?
    b. Which [STEM grant] activities have most influenced your understanding of PjBL?
2. How did [STEM grant] align with your vision for instruction in schools?
3. What supports do principals in your schools need to ensure PjBL is implemented effectively in schools?
4. What supports do teachers in your schools need to successfully engage their students in PjBL?
    a. How does supporting PjBL differ from supporting other forms of instruction?
5. Is there anything unique about the supports that Title 1 schools need when it comes to implementing PjBL?
    a. IF YES: How have you tried to address those needs?
6. What have been the most significant challenges or barriers to PjBL implementation this year in schools?
    a. What have been some of the bright spots with PjBL that you've observed or heard

about from school staff?
7. What factors are most critical for sustaining PjBL as an instructional strategy year after year?
8. Is there anything else you'd like to share that I haven't asked about

Teacher Focus Group Questions

1. What professional development, activities & supports have you participated in this school year related to PjBL and the [STEM grant] program?
2. Were there any barriers that kept you from engaging in more [STEM grant] professional development, activities, and supports?
    a. What factors facilitated your participation?
3. When you hear the phrase "project-based learning" or "PjBL," what does this mean to you?
    a. In what ways has your understanding of PjBL changed this school year?
    b. Which [STEM grant] activities have most influenced your understanding of PjBL?
4. What has been most beneficial about the [STEM grant] program so far?
    a. What has been the least beneficial?
5. Have you engaged students in project-based learning in your classroom?
    a. IF YES: Please describe the activity or project. Describe any benefits to students. Describe any challenges faced.
    b. IF NO: Why not? Are you interested in PjBL?
6. How supported do you feel in developing your capacity to implement PjBL? That is, how supported do you feel to receive professional development and coaching around PjBL?
    a. In what ways has your principal supported you with PjBL implementation this school year? What has been most helpful?
7. What additional supports would be helpful for implementing PjBL in your classroom in the future, if any?
8. What opportunities currently exist in your school for teacher collaboration?
    a. What challenges are there with collaboration?
    b. If possible, describe an instance when you collaborated with other teachers on a lesson, activity, or project for the [STEM grant] project.
9. Have you had any challenges or concerns related to implementing PjBL in general?
    a. If yes, how so?
    b. What about with the [STEM grant] project specifically?
10. Is there anything else you'd like to share that I haven't asked about?