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STEM leaders promoting resilience within equity-centered K-12 STEM education organizations

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Introduction: This study examines storytelling's role in supporting organizational resilience for equitable STEM instruction by schools and districts. Within K-12 organizations, some practices may be perceived as mundane, but storytelling supports transformation toward achieving equitable STEM learning opportunities in a school. Therefore, storytelling is a means for achieving organizational resilience.

Methods: Through a comparative case study design, this paper explores challenges identified by educational leaders through focus groups who worked with teams to activate interdisciplinary learning to support thriving STEM programming to enhance equitable science instruction.

Results: We characterize STEM systems' social and organizational phenomena from three educational contexts. We start by sharing these systems' backgrounds and educational goals, with specific attentiveness to their STEM programming. We then share the stories told by their leaders to promote organizational resilience (these characteristics, as previously described, are italicized throughout this section) within each of the given contexts.

Discussion: The STEM stories in this study shared the state of STEM within a school and district, the instructional mission of STEM, and a community STEM story.

KEYWORDS

educational leadership, STEM, organizational resilience, school organizations, educational equity

1 Introduction

Equity-centered policies and practices are instrumental in designing an educational infrastructure that yields equitable STEM learning experiences (Penuel et al., 2016; Penuel, 2019). However, policies and practices employed without intentionally designed organizational structures and practices to promote equitable instruction can yield disruption or even ineffective programming. Policies and management structures guiding decision-making concerning instructional time, resources, and staffing are essential. The enactment of policies and management structures is ultimately decided by those in school and district (a geographic area in which schools share a local administration) leadership positions (e.g., principals, superintendents, and central office personnel) (National Academies of Sciences, Engineering, and Medicine, 2021). Although various federal, state, local, and industry initiatives have promoted STEM education in schools across the USA, a grave disparity in meeting the needs of students of color and those from low socio-economic status (SES) homes persists (National Academies of Sciences, Engineering, and Medicine, 2021). Implementing science and math in conjunction with accountability testing in the USA has resulted in technological and social infrastructures that reflect tensions between testing and equity in science and STEM education (Blank, 2013; Marshall et al., 2024).

Within the USA, science is considered a core content area, while STEM is often an elective and can encompass areas like computer science, robotics, medicine, and engineering–to name a few. However, in some contexts, science and STEM are discussed interchangeably as one discusses the programming that makes up a child's K-12 learning experience. We, therefore, define STEM broadly but recognize the importance of how each school and or district defines and designs its science or STEM program, as there is local control regarding how specific content is taught (Haverly et al., 2022). We define STEM as the approaches educators take to integrate a combination of science, technology, engineering, and math knowledge and skills. This may not mean all four disciplines are engaged simultaneously but that the ideals of each discipline are strategically engaged in various opportunities for instruction (Bybee, 2013; Martín-Páez et al., 2019).

A central component of this study is that equity in science and STEM education can be defined and operationalized in various local contexts. According to Haverly et al. (2022) in their study with local district science leaders, they defined equity in ways specific to access to opportunities for students of color, girls, and, in some cases, non-gender-conforming youth (Haverly et al., 2022). In addition, what and how content is being taught also matters as science and STEM can support students as they develop criticality and engage in inquiry in their own lives and communities (National Academies of Sciences, Engineering, and Medicine, 2021). The *Brilliance of Children and the Strengths of Educators* report offers four specific approaches to equity in science and engineering (National Academies of Sciences, Engineering, and Medicine, 2021). These are: (1) increasing opportunity and access to high-quality STEM learning and instruction, (2) emphasizing increased achievement, representation, and identification with STEM, (3) expanding what constitutes STEM, and (4) seeing STEM as part of justice movements. Therefore, as local contexts address issues of inequity, they may define and then operationalize one or a combination of these definitions of equity. This study explores how storytelling was used by school and district leaders to promote equitable learning conditions in science and STEM, specifically in a rural school and in two schools where over eighty percent of students were students of color. In each of these schools, STEM leaders were explicitly concerned about students accessing rigorous opportunities to engage in STEM.

This study draws on organizational resilience as it attends to the adjustments made to support an organization's infrastructure amid challenging conditions so that organizations are responsive and sustainable (Vogus and Sutcliffe, 2007). When considering the STEM infrastructure within school organizations, it is essential to consider the organization's resiliency. Building on Star's (1999) definition of infrastructure as a "system of substrates (p. 380)" or parts, our study defines *infrastructure* as the relationships that facilitate organized practices (e.g., storytelling) appropriate for policy adoption and successful implementation of specifically STEM programming.

Taken together, the organizational resilience of a school or district's STEM program is the capacity to employ and sustain equitable STEM learning in schools despite various challenges. In this study, equity in STEM will be achieved if all students in all schools have access and opportunity for continued (K-12) STEM learning that honors place (i.e., values the voices, communities, and diverse ways of knowing learners and their families, and learning opportunities), and that supports students as they develop criticality and engage in inquiry in their own lives and communities (e.g., engages local problems and projects). It is important to note that we are not examining outcomes of specific populations (e.g., racial demographics, socio-economic status), but rather, the efforts through storytelling that STEM leaders engage in to work toward equity and transformation in STEM education.

Essential to this study is that various actors are "pushing" reform efforts, and there is a need to establish "real buy-in from various stakeholders" (Jabbar and Childs, 2022, p. 251). The key point is that reforms are often viewed as a "push" rather than establishing the "participation" of stakeholders. This paper explores how teams of science and STEM educators enable or "*activate*" a human infrastructure of interdisciplinary learning to support equity in science and STEM instruction (Spillane et al., 2001; Barasa et al., 2018). The notion of "real" buy-in is essential for equity work. Although storytelling may be viewed as a "minute dynamic," This study bridges "real" buy-in to purpose, and storytelling engages what is needed and could be (Fenwick et al., 2011, p. vii). Pivotal to the stories is that they promote the organizational resiliency necessary to support equitable and sustainable K-12 STEM programming in schools. This study uses a comparative case study design to examine the following,

- Why do STEM leaders tell stories (purpose/ real buy-in)?
- What stories do STEM leaders tell to support their work toward equitable STEM education?
- How are aspects of organizational resilience employed in STEM education organizations (reframing the mundane to integral for transformational work)?

2 Literature review

There is a need to support the sustainability of STEM education programming through intentional attentiveness to factors that promote organizational resilience. This section offers background on STEM education in the US, the STEM policy environment and barriers to sustaining STEM programs, and school leadership (e.g., principals, appointed K-12 STEM school and district leaders) and storytelling.

2.1 Science and STEM education in the US

Schwarz et al. (2017) describe the current science education reform agenda as working toward opportunities for "students [to] make sense of the natural and designed world by engaging in science and engineering practices (p. 4)." In tension with this agenda is that it is often the case that science and STEM education decisions made by educators in schools and district leaders are responsive to the various federal, state, and local policies, people, and the needs of the community within their local contexts (Odden and Marsh, 1988; Marshall et al., 2021). In the US context, science and STEM education are often deprioritized to adequately allocate time to reading and math, especially at the elementary levels, as it has been believed that students could catch up in later grades (Marshall et al., 2022). Decreased time allocation and attentiveness to science and STEM have primarily been framed by behaviors aligned to federal educational policies associated with specific accountability measures (e.g., Common Core State Standards, No Child Left Behind) (Haverly et al., 2022). Consequently, in many states, federal, state, and local education policies do not often foster schooling environments in which students in elementary grades are offered quality, transformational, and rigorous science (Achieve, 2019). A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (National Research Council, 2012). (hereafter referred to as the Framework) and the corresponding standards offer a vision for what science education could be. However, various factors currently result in organizational resistance (e.g., not having a shared vision for an organization, limited human capacity, financial limitations, etc.) rather than organizational resilience.

This study engages what have been called transformative approaches to education in that they work toward radical, systemic change that extends beyond the classroom and challenges dominant institutional structures. Echoing (Freire, 1989) notion of emancipatory education (1989), transformative STEM education aims to expose the workings of power by engaging students in projects that address real-world problems in their local communities. Trends toward transformative education are facilitated by the increasing utilization of Place-based learning in STEM programs to solve community problems. Place-based approaches pursue learning opportunities from a specific community's cultural, economic, environmental, and geographical aspects. Students employ anthropological and field-based methods to address community problems, immersing themselves in the reality of what it means to address issues specific to a location. Research indicates that Place-based learning supports scientific engagement (Zimmerman et al., 2016), sustainability (Kates et al., 2001), and inclusive educational practices (Davidson-Hunt and O'Flaherty, 2007).

In addition to Place-based education, Problem- and Project-based learning complement transformative approaches. Rather than focusing on a defined solution, for example, Problem-based learning encourages exploration and experimentation and enhances group collaboration and communication to develop knowledge acquisition. Project-based learning, meanwhile, revolves around a sustained, real-world project to create something tangible, like an event or a product, and typically includes interdisciplinary activities (e.g., research, scientific exploration, multimedia production, etc.).

2.2 STEM policy environment and barriers to sustaining STEM programs

A constant dilemma of education policy implementation generally, and STEM programming specifically, is sustainability. In this sense, sustainability refers to extending a program or project or coordinating organizations beyond the initial funding period (Shediac-Rizkallah and Bone, 1998). In Ford (2017) study, sustainability in STEM schools depended on continual investment in instructional and administrative capacities. This included investing in teacher professionalization, providing pathways for school leadership, and collaborating with business and industry. Nevertheless, stable funding streams to support recurring investments are rare in STEM education. When new STEM policies are introduced, schools and districts are typically awarded additional funding for a limited period (typically 2–3 years) to support implementing a specific program or project. Unsurprisingly, research on STEM policy implementation shows that finances significantly impact sustainability. At the same time, the constant threat posed by short-term funding has entailed innovative strategies in STEM education (Carroll et al., 2019). More specifically, initial infusions of resources limit the long-term sustainability of STEM programs unless supportive social and organizational structures accompany them.

Research indicates that sustainability is dependent on several organizational characteristics, including funding arrangements (Akerland, 2000), training (Elias et al., 2003), and support (Stevens and Peikes, 2006). Further, studies show that conditions for sustainability need to be planned for early in the implementation process (Paine-Andrews et al., 2000). In this respect, leadership practices that cohere instructional systems and coordinate resources are essential in STEM policy sustainability. In partnership work, coherent instructional systems incorporate and coordinate the various elements of STEM programs–professional development systems, instructional materials, and supplemental student support–into implementation processes (Newman et al., 2001). Having clarity and coherence around core instructional purposes is especially critical as STEM programs often bring together diverse groups around ambiguous goals. For example, an analysis of goal and vision-setting processes for Computer Science for All (CS4All) found that stakeholders expressed seven distinct rationales for adopting universal computer science education programs. More simply, explicitly planning and evaluation for sustainability improves the durability of STEM programs. This means developing and maintaining ongoing, mutually beneficial partnerships that align STEM policy goals with local needs (Vogel et al., 2017).

2.3 School leadership and storytelling

Stories have been used to build capacity and transmit culture (Aidman and Long, 2017). Aidman and Long (2017) note a need to understand the impact of storytelling, specifically on school climate and employee turnover. This means the stories school leaders tell are essential to developing a positive school culture and can impact the school community long-term. According to Weick (1995), "A good story, like a workable cause map, shows patterns that may already exist in the puzzles an actor now faces, or patterns that could be created anew in the interest of more order and sense in the future." He goes on to say, "[stories] explain. Moreover, they energize (p. 61)." Therefore, stories can mobilize the practice and work of a school or district community.

School principals and leaders are instrumental in implementing school reform efforts (Spillane et al., 2002; Coburn, 2005). Although researchers have argued that principals spend the majority of their time on administrative tasks (Kmetz and Willower, 1982; Spillane and Hunt, 2010), others have found that as much as twenty to thirty percent of a principal's time in today's accountability era is spent on instructional matters (Spillane and Hunt, 2010). Coburn (2005) examined the role of principals as they influence teacher learning about implementing new reading policies. Coburn noted explicitly that school leaders participate in the "meaning making that have the potential to influence the 'conditions for teacher learning' (p. 477)." She also notes that there are social considerations for one's work. Part of meaning making involves the policy stories leaders tell, and framing, as they serve as mediators by conveying policy ideas and focusing the attention of those listening to stories to specific ideas.

Van Hulst and Yanow (2016) draw on frame analysis as they describe "framing as the work of storytelling. (p. 100)" The authors build on work by Rein and Schön (1977, 1996), who named three components of framing: naming (conveying an understanding of the problem), selecting (what to tell), and storytelling (binding pieces together), which often involves a policy issue. In today's schooling environment, having people on board presents as essential to the work of employing innovations like those bolstered by three-dimensional learning, Place-, Project-, and Problem-based instruction, and *the Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (National Research Council, 2012). Therefore, we examine the stories leaders describe they have told to understand how stories can promote organizational resilience for K-12 STEM and science programming.

2.4 Organizational resilience

Deriving from physical and ecological sciences, organizational resilience has been described as the capacity to "absorb shocks" by various systems, including social. Social systems are complex and require adaptability to be responsive (Barasa et al., 2018, p. 491). In a systematic review of the empirical literature, Barasa et al. (2018) describe chronic shocks as everyday challenges, like competition, financial difficulties, etc.

There are six key factors identified by Barasa et al. (2018) that contribute to organizational resilience (2018) that are pertinent to the purpose of storytelling and this study. They are: (1) material resources, (2) preparedness and planning, (3) information management (e.g., clear communication, organizational goals and achievements are communicated across the organization), (4) the organizational culture views challenges from an "opportunistic perspective" in that there are areas of growth and development (Barasa et al., 2018, p. 499), (5) that human capital is motivated toward the organizational goals, (6) the success of leveraging social networks and collaborative relationships. These key factors that promote organizational resilience guide the analysis of the role of storytelling in K-12 organizations to promote the sustaining and improvement of equitable K-12 science and STEM programming.

TABLE 1 Sampled educational systems*.

	Westwood STEMM High School	Community High School	Able Elementary School
System	Public school district	Public school district	Public school district
Region	Midwest	Midwest	Midwest
Area	Suburban	Urban	Rural
Grades	9–12	9–12	K-5
Enrollment	100–150	550–600	250–300
Free/reduced lunch	65–70%	80–85%	65–70%
Students of color[1]	80–85%	85–90%	5–10%
Student-to-teacher ratio	10:1	20:1	15:1

*Data for this table were gathered from the National Center for Education Statistics (NCES). [1]Includes students who are identified as American Indian, Black, Hispanic, Native Hawaiian/Pacific Islander and two or more races according to NCES.

3 Materials and methods

We used a comparative case study design to explore the strategies schools and STEM leaders use to mobilize collective action within the STEM social infrastructure to support the improvement of science and STEM instruction (Bartlett and Vavrus, 2017). According to Yin (2009), case studies are empirical studies that examine contemporary phenomena within a "real-life (p. 18)" where the contextual factors contribute to the phenomenon at hand. In this study, we draw on three cases to understand their context, STEM priorities, policy goals, and the stories school leaders tell to support the social and educational needs within a school or district to enhance science and STEM learning. Comparing multiple cases enabled us to explore the nuances and complexities of storytelling as a critical factor in developing organizational resilience and to gain a deeper understanding of this process than would be possible with a single case study.

Data were collected from three schools across three districts in one Midwestern state during the 2021-22 school year. The schools and districts were selected from a larger multi-year project to support the development of a state-level science and STEM digital infrastructure, which included the production of an online repository of instructional materials, professional development resources, program design templates, implementation guidance, and illustrative program examples. As part of the project, school-level and district-level teams of educators and their community partners apply for and receive funding to support innovative STEM instruction. We purposively sampled public schools with enrollments with a high proportion of low-income students and representing various educational contexts (see Table 1).

Despite their differences, all three schools used Place-, Project-, or Problem-based pedagogies and worked with community partners to implement integrated science and STEM curricula. Together, the three sampled schools have utility for answering our research questions because they were each engaged in similar initiatives to improve their science and STEM programs.

3.1 Data collection

In 2021-22, we collected data from focus group interviews, application materials, and relevant artifacts, such as school websites, previous publications (e.g., case study write-ups and surveys from other organizations), and audio-visual recordings of project implementation in three systems. One primary goal of the focus group interviews and other data collection was to develop case studies for the department funding this programming. Participants engaged in a focus group and a follow-up interview to clarify ideas shared in their written case study. The authors wrote the case studies of this paper.

3.1.1 Focus group interviews

The focus groups included participants from one school building in one district. Typically, the group was identified by and included a school or district STEM coordinator and ranged in size from two to five people. Although the groups varied in composition across each of the sampled school sites, each group included participants involved in the implementation of innovative STEM practices and who were best qualified to offer insights into the kinds of instructional and organizational practices that supported the advancement of state STEM policy, which emphasized the incorporation of Place-, Project, and Problem-Based approaches into STEM programming. In addition to the STEM coordinator, participants may have been school principals, teacher leaders, School Improvement Grant (SIG) coordinators, district officials, or any other individual named by the STEM coordinator to be pertinent to the development of STEM programs in the school or district.

The focus group interviews were semi-structured and lasted ninety minutes each. Focus group participants were asked questions about the history of Place-based education (PBE) in participants' schools and districts, their views on the benefits and challenges of PBE in the context of STEM learning initiatives, and their experiences with sustaining and developing STEM programs that incorporated PBE pedagogies. The diverse composition of the focus groups allowed us to observe dynamic, conversational responses amongst the participants that reflected the complexity of implementing integrated STEM programs that included, among other things, real-world applications of the science curriculum, hands-on experiences, out-of-class activities, the co-development of educational programs, and community-based learning. Altogether, the focus group data assists with answering questions on the relationship between storytelling and organizational infrastructures that support equitable STEM programming. All focus group interviews were recorded and transcribed.

3.1.2 Applications

The schools and districts sampled for this paper were chosen to participate in a larger project based on a selection process that included a written application and live presentation. In the application, the STEM leader shared the background, vision, and rationale for PBE learning, strategies previously attempted in the school or district, a list of STEM partners, and insights as to how the STEM team would know their practice is successful. The live presentation, meanwhile, included a 20-min multimedia slide deck and 20-min Question and Answer (Q&A) session that probed applicants for more information about their instructional priorities and implementation activities, how they integrated Place-, Problem-, Project-Based pedagogies into their STEM programming, and their commitment to equitable STEM practices. All live presentations were recorded and transcribed, and all materials used were collected and cataloged.

3.1.3 Relevant artifacts

The focus group interviews and application materials were supplemented by collecting a wide range of relevant artifacts. All participants in the larger project were asked to submit relevant education artifacts that helped to illustrate how PBE was implemented as a part of STEM learning in each school or district. These materials were systematically collected and cataloged. Relevant artifacts included lesson plans, curriculum scope, sequence outlines, district and school improvement plans, STEM policy, and vision statements. Relevant artifacts also included research publications and public relations materials, such as school and district case studies, STEM program profiles, survey analysis, press releases, promotional flyers, school and district websites, audio-visual recordings of program activities, student and staff testimonials, and media reports.

3.2 Data analysis

To analyze multiple sources of data and answer three research questions, we conducted qualitative content coding (Miles and Huberman, 1994; Corbin and Strauss, 2015). Our coding and analysis began with reading and exploring each case to become "thoroughly absorbed in the data" (Dey, 2003, pg. 116). During the initial rounds of coding, we engaged in deductive and inductive coding of the focus group interviews and application materials. The deductive codes were grounded in the literature on storytelling and organizational resilience. As such, we developed and applied codes on components of storytelling (e.g., purpose, content) and concepts from organizational resilience (e.g., information management, organizational culture). For example, we first coded focus group interviews for storytelling patterns and the motivations to share those stories expressed by STEM leaders. We also, for example, coded application materials for stated organizational goals and to identify community partnership structures.

We coded our data iteratively, analyzing the data for each case first, and then comparatively across the three cases. Throughout the initial engagement with our data, we recognized a need that traversed across schools: the desire to engage various stakeholders to participate in their district or school's overall educational mission. As a result, stories were shared and utilized in various ways to onboard and activate practices and decision-making of various stakeholders. During subsequent rounds of coding, these stories were extracted and examined with rounds of inductive coding. Our inductive coding revealed four broad storytelling functions

TABLE 2 Four storytelling functions.

Function	Definition	Example
Manage public image	Storytelling is aimed at influencing the general public's perception of the school or district	STEM leader tells a story about an exemplary project to a news station
Garner community support	Storytelling is aimed at generating support from people and organizations in the local community	STEM leader shares student success stories with community partners
Shape institutional culture	Storytelling is aimed at influencing the school or district culture	STEM leader tells story about a teacher successfully adopting a new practice at a staff meeting
Engage in self-reflection	Storytelling is aimed at better understanding one's own beliefs and practices	STEM leader shares hypothetical scenario about what might happen to a school program if they left the school

utilized by STEM leaders: (1) to manage the public image of the school or district, (2) to garner community support, (3) to shape institutional culture, and (4) to engage in self-reflection (see Table 2). These functions guided the decisions of what to tell, described as "selecting," a key component of framing (Rein and Schön, 1977, 1996). Relevant artifacts were coded during later rounds of coding to triangulate data and refine our codes and themes (Creswell and Miller, 2000).

After engaging in multiple rounds of coding, we drafted matrices and memos to shed light on responses to our research questions. First, we created matrices to summarize information, determine patterns related to leaders' storytelling in carrying out equitable STEM education, and link those patterns to the six aspects of organizational resilience (also referenced in Table 3). Second, we wrote memos containing illustrative quotes associated with storytelling and organizational resilience that elucidated key themes. Together, these analytic techniques enabled us to ascertain the storytelling strategies told by STEM leaders to communicate needs and enact equitable and resilient organizational improvement.

4 Results

We characterize STEM systems' social and organizational phenomena from three educational contexts. We start by sharing these systems' backgrounds and educational goals, with specific attentiveness to their STEM programming. We then share the stories told by their leaders to promote organizational resilience (these characteristics, as previously described, are italicized throughout this section) within each of the given contexts. Finally, our discussion section, which follows this section, compares the phenomena from our findings section across cases and illuminates the meaning and significance of our findings in the context of our research questions. It is important to note that pseudonyms are used for the people and the schools.

4.1 Westwood STEMM (science, technology, engineering, math, and manufacturing) middle college high school

Westwood STEMM's dual enrollment program resulted from a partnership with a local community college. The partnership underpins the essential infrastructure for Westwood STEMM, in which enrolled students complete a fifth year at Westwood and spend much of the fifth year at the community college. Officially launched in 2015, Westwood STEMM's primary mission is to "prepare students for success in college, career, and life through mentor relationships and by providing real-world, STEM-based experiences." According to the Institute of Education Sciences (IES), "middle college high schools," also known as "early college high schools," offer five years of accelerated coursework. During the program, in addition to a high school diploma, students can obtain an associate degree or up to two years of college credit (Institute of Education Sciences, 2009).

During its first seven years of the program, the high school, collegiate, and post-secondary success of Westwood students had markedly improved, as summarized in their program application:

> Since the STEMM Middle College's founding, 578 students have enrolled; 294 students graduated, and 3464+ college credits have been earned by our high school students, which has transformed education in our community and changed the trajectory of our lives.

In addition to completing a minimum of 15 college credits that lead to a certification, transfer agreement, or associate's degree, students enrolled in Westwood STEMM are required to take engineering and manufacturing courses. Westwood STEMM serves a student population where 65-70% of students are on free or reduced lunch, indicating the majority of the families are of low socioeconomic Status (SES) (see Table 1). More than eighty percent of the students are students of color (Sixty-three-percent Black, seven-percent Latino/a). According to Mr. Richardson, one of the main goals is to provide youth and their families an opportunity to obtain college credit while in high school. According to the Westwood STEMM program application, "[a] majority of the students who choose our school come from minority backgrounds and low socioeconomic homes with a median household income of only $36,000. Despite the financial, social, and academic barriers we face every day, the support systems we build are our chance to succeed." Mr. Richardson, the lead teacher for Westwood STEMM, shared that they provide bussing to make sure students can get to the program and that they provide support some students "might not have at home or have from [other] family members."

The Westwood STEMM program grew from a well-established history with FIRST (For Inspiration and Recognition of Science and Technology) Robotics. FIRST is a mentor-based program where teams of students, teachers, and volunteers from industry and various fields compete by building a robot to complete specific tasks. FIRST emphasizes "hands-on, problem-solving engineering and manufacturing skills," which Westwood STEMM adopted into a curriculum and a middle college structure to support the local community. When designing the fundamental structures of the

TABLE 3 Case study schools and functions of storytelling.

	Westwood STEMM	Community HS	Able Elementary
Story	Sharing the current state of STEM within the school and district	Instructional STEM story	Relational STEM story with the community
Storytelling functions	Garner community support; Engage in self-reflection	Manage public image; Shape institutional culture	Garner community support
Transformational	Project- and Problem-based education	Place-based education	Place-based education
Mission	"[P]repare students for success in college, career, and life through mentor relationships and by providing real-world, STEM-based experiences."	"[T]o develop a community of learners prepared to live, work, and contribute to an ever-changing society."	"We strive to develop learners who will be confident, college/career-ready, and competitive in pursuing their individual objectives."
Barriers to achieving equitable STEM	Lack of a social infrastructure between the school and community members/partners	New teachers and administrators working toward the same mission	Limited fiscal and human capital to support Place-based programming
STEM leader engaging in storytelling	District STEM coordinator	District School Improvement Grant Coordinator	Elementary principal
Characteristics of organizational resilience			
Material resources	Fiscally not sustainable long-term	Vertipool installed	Large investment in land, however, needed social support from the community
Preparedness and planning	Strategically plans with colleagues	Place-based education included in School Improvement Grant plan	Sharing the school's story pivotal so that community members would vote for bonds
Information management	Strategically plans with colleagues	Purpose of programming not strategically discussed	Strategically sharing updates with the community about the school
Opportunistic perspective	Yes, but fearful	Yes	Yes
Human capital motivated toward organizational goals	In progress	Developed through storytelling	Yes
Success of leveraging social networks and collaborative relationships	Some, but not sufficient	Yes	Yes

school, Westwood STEMM drew on the core structures of FIRST robotics (e.g., establishing relationships between students, industry mentors, teachers, and community members, engineering, solving problems through design, etc.) and Problem-based education.

4.1.1 Naming the problem

Despite having a robust cultural and institutional template for fostering mentor-based programs, Westwood STEMM has yet to replicate FIRST Robotics' successes in this area. "I think the bigger issue," explained Mr. Richardson, "is getting partners in the schools engaging with students so it's not just me talking about engineering." To clarify the difference, the FIRST Robotics program at Westwood is supported by over 50 mentors, while other school STEMM programs have only a handful, if any. Mr. Richardson expressed concern about the relative lack of social infrastructure and what it portended for the sustainability of the broader middle college STEM program.

4.1.2 Story #1: Sharing the current state of STEM within the school, district, and with partners

Mr. Richardson was critical to the STEMM program. Beyond his contracted teaching commitments, he spent countless hours attempting to sustain the program by seeking grants (*material resources*) and local partnerships (*collaborative relationships*) beyond those volunteering with the FIRST program. This was a significant concern of his, so much so that he discussed the need for himself and other staff members to establish relationships with partners and work alongside them on a regular basis. For Mr. Richardson, these social interactions were crucial. However, he was concerned that he had direct relationships with partners rather than strong programmatic relationships between the school (and several individuals) and local partners:

> [I think] informing the partners about your school's history and some things about your school would be useful. I had a not [so] good experience with a community partner one time who reacted in a bad way to a student who wasn't acting very well. [W]e have students who are dealing with trauma and racism and everything, and sometimes they respond in certain ways...[T]his confrontation didn't turn into anything bad, except the community partner left.

In other words, the function of Mr. Richardson's storytelling was explicitly aimed at garnering community support through personal networks, which—because of prior experiences like the one described above—he believed was essential for sustaining the program in the long term. Mr. Richardson thought community partnerships built on strong personal networks also had the potential to mitigate other problems, such as those created by Westwood's high teacher turnover rate. Past experience with colleagues suggested that collaborative work helped to build and reinforce social networks that made STEM programming more sustainable. Therefore, a key component of Mr. Richardson's organizational resilience was successfully leveraging social networks and establishing collaborative relationships. Richardson prioritized knowing who the partners were to maintain relationships; however, he struggled to motivate a collaborative support network.

Mr. Richardson strategically included his colleagues in meetings and *planning* so that there was shared knowledge about the program. However, Mr. Richardson was struggling to *manage the information*. To Mr. Richardson, knowing the program's story meant a direct connection to social capital with local partners and networking, but relationships were not yielding participation of the partners (*human capital*) as they were not motivated toward the organizational goals. Central to partnerships are the individuals partnering between organizations. While collective meetings were important, there needed to be a specific plan for strategically maintaining these relationships between organizations. Essentially, if one person left an organization or was no longer available to continue relationally, there is no longer a partnership.

What is often not discussed concerning STEM programs, as with the case with Westwood STEMM, is the labor related to sustaining STEM programs (*human capital* and *material resources*). The labor endured by Mr. Richardson exuded a lot of pressure in how he spoke– his stress was palpable to us and anyone else listening despite the virtual interview. At one point in the interview, Mr. Richardson was queried about how much he was compensated to serve as the STEM Coordinator in his district. Mr. Richardson chuckled and shared that he had never calculated his hourly pay, saying, "It would be too depressing." He also revealed that his wife would be "very upset" if she knew how many hours beyond his job as a teacher he put into being the STEM coordinator. In many ways, Mr. Richardson was shouldering a program and understood the grave risk posed by his departure, both to students and to the community:

> I'm thinking I want these partnerships to be sustainable. Like if something happened to me or to Ali, that's actually why I include Joe in everything I do, too. It's like what if something happened [and] I wasn't here, because what happens a lot... people leave, then partnerships are gone. And [our program] needs to be sustainable, right? Or, hey, we get this grant money, so we can do this stuff, or I can do this robotic stuff. But what if those grants are not there, then we're done. So, like the funding, like having these things be more structured. And maybe have a template for [everything].

This quote represents the storytelling function of self-reflection and, content-wise, was a common story we heard throughout this study from participants—that is, a story based on the hypothetical question, "What would happen if one key person left the school or district?" During the interview, for example, Mr. Richardson stated (and others posed similar questions), "What if I fell off a cliff?" It was understood that their presence was essential to the functioning of their STEM program. Mr. Richardson was so immersed in the everyday challenges and the limitations of the existing STEM infrastructure that he was inhibited from exploring other opportunities.

According to Mr. Richardson, despite striving to achieve a shared culture and mission, Westwood struggled to achieve their stated goals. Additionally, Mr. Richardson communicated that grant funding was another measure of programmatic success. Again, he shared that the program would need to be sustainable; however, even applying for grant funding became a task as they ended up chasing funding that makes you "do this stuff," and then you get different funding so you can "do this robotic stuff". And if you are not able to get these different sources of funding, then you are "done." Importantly, chasing funding to sustain a K-12 STEM program, as illustrated by Westwood's example, resulted in a lack of coherency and potentially limited opportunities to achieve organizational resilience.

Despite the coherent vision for STEM education laid out in their application and other program materials, as Mr. Richardson shared their collective story, it became apparent that, in his view, Westwood's STEM program was in a state of urgency, verging on despair. Mr. Richardson's work behind the scenes had gone unacknowledged and was, ultimately, undervalued. Mr. Richardson had a K-12 vision for a STEM pipeline and convinced teachers and community partners across the district to attend K-12 STEM meetings. However, senior leadership would not attend despite these efforts and apparent successes. Without district-wide support from leadership, he believed the program would never be successful in the long run as these district leaders did not recognize their role within the STEM infrastructure toward the organizational vision Mr. Richardson hoped to nurture. The specific pieces of Westwood's story offered by Mr. Richardson involved a vision that seemed to go unrecognized by others within his district and school. Mr. Richardson shared a vision and a contrasted hypothetical reality of what would happen if he did not work tirelessly toward a vision for STEM. Mr. Richardson hoped to garner leadership's attention so their program could be prioritized.

4.2 Community High School

The mission of Community High School (CHS) is to develop a community of learners prepared to live, work, and contribute to an ever-changing society. The district follows the tenets of Whole School, Whole Community, Whole Child (WSCC) and, therefore, works to actively engage learners through connections to the school and community (Association for Supervision and Curriculum Development [ASCD] and Centers for Disease Control and Prevention [CDC], 2014). Since 2011, CHS has worked with a regional hub at a local university that centers on supporting educators and students to engage as steward of the local community through Place-based education. As CHS applied for a School Improvement Grant (SIG) from the state, teachers were "insistent" that Place-Based Education offered them a means to employ inquiry-based instruction. With the assistance of the Community School district's SIG Coordinator, they developed a 5-year plan to support the program's training, implementation, and sustainability.

According to the Place-Based Education Teacher Leader, Ms. Harper, Place-Based Education has offered students the freedom to "say what they want to say" and to interpret data, as their ideas and inquiries are vital to investigations. CHS added a vernal pool to their school site due to a problem identified by students. The school grounds became the home of migrating mallards. However, there was no food source or water. In 2011, students asked, "How can we help the ducks so they don't die?" The vernal pool was installed with the support of the aforementioned regional hub (*material resources and leveraging collaborative relationships*). Ms. Harper shared that students from across the school asked questions based on their "noticings" of the vernal pool, enhancing natural curiosities and criticality.

4.2.1 Naming the problem

Although CHS had a well-established program and several passionate teacher leaders to support inquiry-driven instruction and Place-Based Education, they expressed concerns over some teachers not participating in the school project. The high teacher turnover at the district level added further challenges, resulting in inequitable student learning opportunities. This meant many of their newer teachers within the school and district had minimal, if any, experience in PBE as they were new to the district and school.

4.2.2 Story #2: Their instructional STEM story

CHS's university partner allowed several staff members and administrators to attend an international PBE conference. As a part of this opportunity, CHS leaders were asked to offer a tour of their school to the conference guests in town from around the world. They had a vernal pool and a duck pond that the guests visited and observed. This experience made the school leaders realize the potentially powerful impact of storytelling on the organizational infrastructure supporting PBE. As the SIG Coordinator shared during the CHS focus group interview (emphasis added by the authors):

> Look at the vernal pool and, look at the duck pond, and look at the projects that were there and we hosted. I don't know. Were there 36 people from all over the world? About that many people came in as part of that conference to look at what was going on. It was at that point that we realized that because we had to take time and tell our story to these people, the biggest problem was we weren't telling our story about what was going on in the building to the staff because the staff did not understand [our story]. So, we literally redid the tour and the informational [session] that we did for all those people that came from around the world (*preparedness and planning*); we did it for our staff. I think that was a hook and a turning point because they were like, "Wow," "Yeah." We see the ducks, yeah, we see the vertipool. Yeah, we know kids. We know something's going on.

This quote shows how the function of telling stories can shift depending on the context in which stories are being told. The original storytelling function (i.e., the reason CHS told their story in the first place) was to manage the school's public image for strangers visiting a conference. This opportunity resulted in the STEM leaders recognizing that they were trying to convince the staff to employ Place-based practices, participate in training, and buy-in. Although CHS staff had been responsive to student inquiry years before and had created an ongoing space for inquiry with the support of a local partner, there was a need to make sure new staff at CHS knew their story (*information management*). Many staff members did not know the institutional history of Place-based practices. Thus, storytelling was revealed to have another critical function, to shape institutional culture and build organizational resilience in the form of buy-in to Place-Based Education approaches from new staff members. The SIG Coordinator elaborated on this point during the focus group interview:

> Then we identified some leaders... and then we're going to have them help staff to develop projects either that were solo or that were able to be tagged on to a current project or seeing a place in a current project.

After a shared understanding of the vision, trained leaders in Place-Based Education could support other staff members to develop their own projects or in conjunction with previously developed projects to support *developing skills and practice of new colleagues*. In this case, the story to be told served a specific goal: to *motivate the collective toward shared organizational goals*. Without a shared purpose, there was limited participation from some teachers, meaning the potential for context-specific classroom instruction could not be fully taken advantage of in many classrooms.

We must note the role of school and central office administrators at CHS. First, the interviews conducted with CHS included both central office and school-level administrators. This is important because the administrators particularly understood the need to generate support for a shared vision within the school and how to do it. The administrators at CHS also had specific responsibilities and made decisions to coordinate PBE programming. According to the SIG Coordinator, it was an intentional decision to include PBE in their School Improvement Plan, communicating the high priority the school and district placed on PBE pedagogies and programming. Therefore, installing a vernal pool was not just another school project but was a strategic move central to the district's core mission, which also implied a need to engage faculty at the school. This need was addressed by telling their instructional story.

4.3 Able Elementary

Able Elementary's journey toward PBE began in 2017 when the new superintendent of Able Community Schools began. District leaders made a substantial commitment to PBE by purchasing 43 acres of land to support outdoor learning in this rural district. Able Elementary's primary mission was "to develop learners who will be confident, college/career-ready, and competitive in pursuing their individual objectives." According to Principal Long, Able Elementary School "got away from science and social studies for a long time . . . it wasn't a priority, wasn't necessarily done, or taught a whole lot." The regional PBE hub, part of a statewide network of PBE hubs, supported the superintendent's vision and experiences with PBE. The school's vision for broad-based PBE instructional programming gained momentum when the new principal of Able Elementary, Principal

Long, a former high school science teacher, was hired to be the principal at Able. Long's practice as a science teacher was also nurtured by the regional PBE hub for many years, giving him a fundamental understanding of the value of Place-based instruction for all students. According to Principal Long, Able Elementary "got away from science and social studies for a long time . . . it wasn't a priority, wasn't necessarily done, or taught a whole lot." Under the leadership of Principal Long, science was now a priority.

To develop a clear vision for PBE, an elementary STEM facilitator and teacher were hired. The STEM facilitator's background and expertise in environmental education complemented the school's vision for PBE instruction by encouraging students to go outdoors and engage with their environment. According to their application, Able Elementary leadership believed PBE offered students opportunities to develop life skills and gain leadership experience. Through PBE programming and outdoor learning, in particular, students, they opined, would improve their social-emotional-behavioral health and enhance their ability to express and enact their voice within the community. Likewise, by enacting meaningful, real-world PBE projects, the local community–school leaders believed–would come to value youth as community contributors.

4.3.1 Naming the problem

Over time and under the supervision of the STEM facilitator and Principal Long, Able Elementary educators did indeed develop robust connections with families and community partners through PBE projects. PBE requires support from the community, which could mean a variety of things, including financial or *material resources* from local businesses, local volunteers (*leveraging social networks and collaborative relationships*), or voting on a local mileage [voting for money to address a specific school-related need for that community] to acquire what the district needed to enhance PBE (*preparedness and planning*). According to Principal Long,

> [L]ately in this [Midwestern State], there are some different opinions on educators and education and what's happening, and so this would be a great way to tie the community and the school together. You know, it's not here's the school, here's a community.

In the above quote, Principal Long refers to state politics during COVID-19, which frequently framed public education and teachers as not doing enough to support the needs of families upon re-starting in-person schooling during the pandemic. However, crucial to said support is the community knowing what is happening at the school. During the focus group interview, Principal Long also emphasized the importance of storytelling:

> There's a superintendent in [another Midwestern State] who does a great job, and he says, It's like, if there's a school if you don't tell your story, somebody's going to tell it for you, and they're probably going to tell you the story that they remember.

In other words, the Able Elementary community got on board with the school's vision for PBE because a key administrator, in this case, Principal Long, understood the importance of telling Able Elementary's story (*information management*).

4.3.2 Story #3: Their relational STEM story with the community

When discussing the relationship between Able and the local community, Principal Long shared,

> [T]he businesses and nonprofits that are supporting [the school] know what's happening because they're working with [us]. They don't hear it on the news or in the newspaper. . .I think that's [significant]. It also helps bridge the gap between the school and community to support one another. . .. And the [community members] have that relationship; they have that partnership, when they know about what you're going to do with [the bond election (where community members vote to authorize a local government to pay for specific projects or services)], they're probably more apt to support, whatever that would be.

Again, Principal Long emphasized the importance of community members knowing the school's story to align the community's needs with those of the school. This illustrates how storytelling can garner community support and, in turn, build organizational resilience. In this case, storytelling was an indispensable tool for ensuring community members and the school community were *motivated toward the same organizational goals*.

As stated by Principal Long, the alternative of *not* sharing the school's story would result in a different, possibly inaccurate, or even harmful, story being created. Like CHS, Able also used storytelling as a function to manage their school's public image. Put differently, telling one's own story supplanted the opportunity for other stories to take hold or be created. Able Elementary's story motivated community members to act, vote, and be responsive to the school's needs. Able Elementary's story was one of investment into the local community's future. Therefore, telling the school and district STEM story materialized as opportunities for the collective, community-based work necessary to mobilize transformative approaches like Place-Based instruction to carry forward. Please see Table 3 for a summary of the cases.

5 Discussion

The STEM stories in this study shared the state of STEM within a school and district, the instructional mission of STEM, and a community STEM story. In each of these cases, stories were utilized as material being prioritized in the foreground, rather than the background, by school leaders to activate and motivate practice toward a shared vision of equitable STEM instruction (Fenwick et al., 2011). According to Jenkins (2020), a school's reputation can act as a "site of struggle" as it can yield a challenge with school partners. Although Jenkins (2020) centered the impact of a school's reputation in a context where school choice was a central factor, as the coordination of multiple groups of stakeholders was essential for each school and district described in this study, in many ways, schools employing innovative STEM opportunities are reliant on these same stakeholders. Therefore, telling stories can maintain the relationship between STEM leaders and stakeholders.

In this study, stories were found to be used as tools by school leaders (e.g., principals, SIG coordinators, STEM coordinators, etc.) to meet their school's programmatic STEM education mission. Given current US policies that limit the prioritization of science and STEM education, it is crucial that there are leaders, educators, and various stakeholders at all levels who understand the gravity of the problem, and, as this study illustrates, storytelling is one means of supporting this awareness. In the analysis presented here, STEM leaders used key components of storytelling—identifying the problem, selecting the story, and piecing together key information—to convey their story. Critical to selecting a story was the functionality of the story (i.e., managing public image, etc.). This functioning of each story told was a means of developing a connection internally and externally to support collective action toward equitable and transformative STEM education. Therefore, these stories exemplified three overarching purposes to engage a collective educational context toward transformational and meaningful equitable STEM opportunities, which were: (1) to establish a shared purpose, (2) to mobilize support for equitable science instruction from industry partners, community members, and teachers, and (3) to sustain a STEM program.

5.1 Establish a shared purpose—Internally and externally

Based on the three cases presented, sharing a story offered the purpose of employing transformational STEM programming in each context. Teachers needed to know the story to motivate them to actively engage in professional learning opportunities and modify their practice to align with the school or district's vision. Given past research, even when teachers believe they have changed their practice in alignment with a specific reform, it is very likely they have not (Cohen, 1990). Sustained and long-term professional learning is instrumental to changing practice (Darling-Hammond and McLaughlin, 1996). However, beyond professional learning, teachers need to know the vision toward which they are practicing. We also saw a need for a shared purpose to carry out the vision if someone were to "[fall] *off a cliff*." Although this is a morbid analogy, this imagery was offered multiple times, demonstrating the urgency of offering security for STEM programs. As shared by Mr. Richardson, his primary focus was understanding a shared purpose with another STEM leader, as the district leadership may have supported him as he had space to do the work; however, their actions to support said efforts were not visible (Marshall and Khalifa, 2018).

Although there are many conversations about the challenges of teacher turnover in sustaining Science and Math programs (Carver-Thomas and Darling-Hammond, 2017), limited analyses consider the impact of teacher turnover on adopting school-wide STEM initiatives. This study offers school leaders insights into approaches to onboarding teachers, schools, and district administrators to a shared vision for transformational STEM education. Specifically, instructional practices like PBE should align with a shared mission that is then deliberately communicated to new teachers. The school's mission and vision should not be treated as intuitive; rather, the instructional story matters regarding how we got to the adopted instructional practices.

This study also offers insights into the need to establish a shared purpose beyond the school walls. Principal Long offered insights to what oriented him to having an image for science, resources offered through local organizations. He also shared how he understood that communicating to the local community was the difference between securing funding or not, as stakeholders could not align with a vision (e.g., with their time, resources, vote) if it was never communicated with them. Although this article did not speak directly to the role of parents, Khalifa (2018) and others have urged school leaders to actively engage community members and parents, as they often share perceptions, ideals, and visions for schooling. Therefore, establishing a shared purpose internally and externally are pivotal to a resilient STEM program.

5.2 Mobilize support for equitable science—Internally and externally

Stories have the potential to establish a plan, motivations, and a vision based on what people are already facing, with hope they can see the potential for future outcomes (Weick, 1995; Lane, 2023). In addition, stories motivate stakeholders to act. According to Dailey and Browning (2014), organizational storytelling serves as a means for organizational members and stakeholders to "make sense of themselves and their relationships (Lane, 2023)." Enabling organizations to overcome resistance (Boje, 1994), in this case, to transform STEM education. In each case presented, stories were drawn on to support a needed collective action, as the participants could not transform STEM instruction as individuals. They recognized the need, in other words, for a network of various stakeholders to support equity-centered STEM learning, and STEM leaders used stories to mobilize needed action. What was observed in this study aligns with suggestions noted by VanGronigen et al. (2023) in reference to work by Mezirow (1978), that "transformational learning can facilitate the alteration of peoples' schemata and shift their ways of thinking about and interacting with the world (p. 702)."

5.3 Sustain a STEM program

Stories #1 and #2 offer STEM leaders' insights into how they achieved *information management* with teachers and other leaders. We want to be clear that although these stories about STEM leadership may present as negative stories, given the barriers, these STEM leaders were proud of their achievements. What was palpable was the precarious nature of each program and the immediacy with which barriers to STEM learning needed to be addressed. Overcoming these barriers was the difference between their STEM programs persisting or swiftly being gone. This in itself is unlike content areas like English Language Arts and Mathematics. English Language Arts and Mathematics and curriculum that support these programs in districts and schools tend to persist, even if factors and people within their infrastructure change. This is not typically the case for science and STEM, which are often sacrificed for reading and math, especially for students

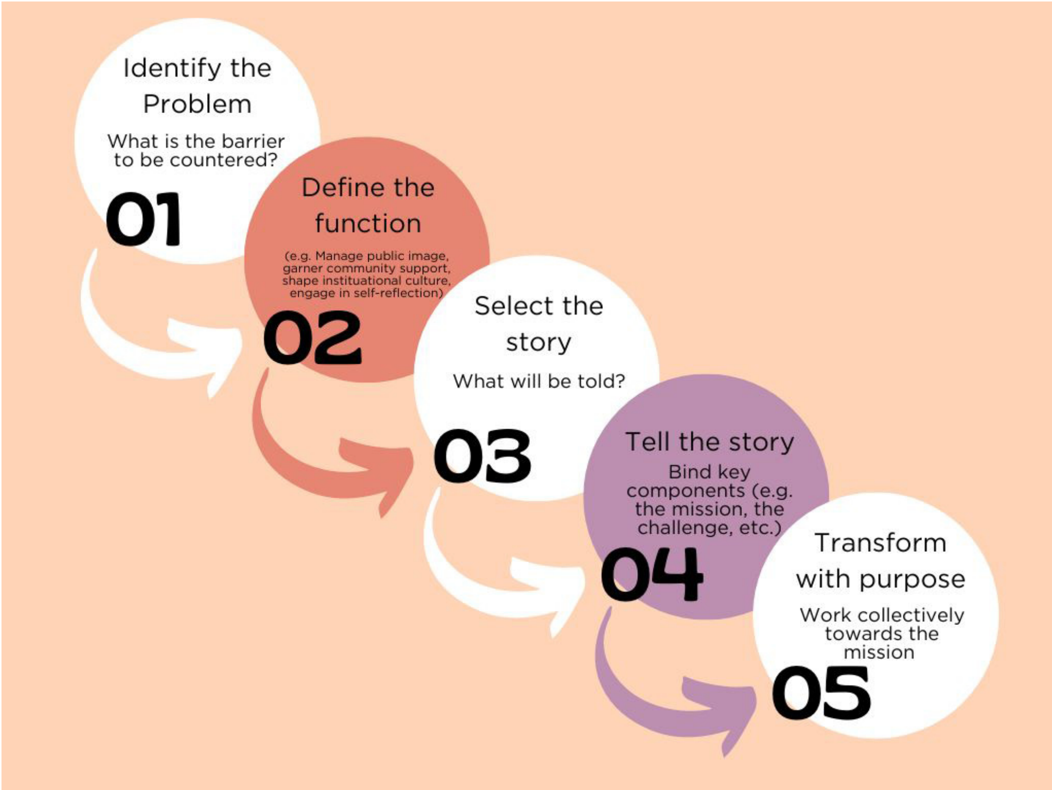

FIGURE 1
Storytelling toward organizational resistance (Rein and Schön, 1977, 1996). Created using Canva.

of color, specifically leading to inequitable opportunities (National Academies of Sciences, Engineering, and Medicine, 2021; Marshall et al. 2022, 2024; Marshall, 2023).

The sustainability of a school or district's STEM program was the most significant concern of our participants, and, essentially, why they participated in the program funded by the Midwestern state in which this study took place (Ford, 2017). However, funding was not the only need articulated by the participants. For example, the story shared by Westwood STEMM's participants highlighted the need for school and district leaders with decision-making authority to support the school's STEM efforts. While Mr. Richardson led and coordinated Westwood STEMM's program, this work was largely voluntary because the finances allocated to support his work were minimal. Mr. Richardson desperately desired more support and attention to the STEMM program to sustain it. According to Jenkins (2020), a school's reputation directly impacts the partners that can be attained and sustained (Jenkins, 2020). It contributes to how community members demonstrate their support (e.g., voting for mileage, volunteering, contributing financially). Meeting equitable STEM goals with community support and sustainability would represent a transformation worth striving for.

The stories STEM leaders tell can be purposeful, as they recognize they cannot orchestrate, sustain, and activate innovative learning opportunities alone. We found that beyond framing a story (identifying the problem, selecting the story, and telling the story), STEM leaders also defined a function for the stories as they worked toward mobilizing a shared purpose to transform their STEM instruction. By identifying a purpose, the STEM leaders could define a specific audience for the needed story grounded in the meta narrative that aligns with the organizational mission (Lane, 2023). We therefore offer additional steps to storytelling toward organizational resistance in Figure 1. Steps 1, 3, and 4 draw on Rein and Schön (1977, 1996), key components of framing, and in light of this study we have added steps 2 and 5, define the function and transform with purpose, as they have demonstrated to be relevant in storytelling toward equity in STEM education.

This study explores how storytelling was used by school and district leaders to promote equitable and transformational learning conditions in science and STEM. By coding the stories STEM leaders tell based on the components of organizational resilience, we can specifically recognize the role of storytelling in a school organization's information management, cultural views, motivating people toward organizational goals, and how they are used to leverage social networks and collaborative relationships. There is needed work in STEM education to better understand the support needed amongst these STEM leaders, as many of them learn on the job and from their challenges. There is also a need for more research examining the infrastructure of STEM programs in schools in districts. Given the various components of extensive and often resource-limited STEM programs, resources, and strategies to enhance organizational resilience are essential to sustained programming.

Additionally, this study, in conjunction with work on design thinking, can strategically inform professional learning experiences to promote transformational learning (VanGronigen et al., 2023), for example, through storytelling. Workshops that are interdisciplinary to research educational leadership for specific content areas, like science and STEM, would be valued (Marshall et al., 2024). As this study illustrates, science and STEM education have their politics, which frame decision-making, resource allocation, and leadership patterns.

Data availability statement

The datasets presented in this article are not readily available because this data set is based on a specific state program and therefore the participants would be identifiable, which is prohibited given our IRB.

Ethics statement

The studies involving humans were approved by the organization was Michigan State University. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contribuitons

SM: Conceptualization, Formal analysis, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. SG-H: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing.

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