Journal of Catholic Education

Volume 26 | Issue 2 Article 5

2023

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Cover Page Footnote

The author wishes to thank the Institute for Educational Initiatives and its Fellows' Grant program for providing the seed grant that funded the data collection for this paper and to Matthew Kloser for his feedback on an earlier draft.

Journal of Catholic Education
Fall 2023, Volume 26, Issue 2, 85–107

https://doi.org/10.15365/joce.2602052023

Becoming a STEM-Focused Catholic School: Insights into Adopting a Curricular Specialization

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Abstract: School choice policies seek to increase access to educational opportunities and stimulate innovations in schooling. This study examines the early stages of one such innovation—school-wide curricular specialization—in three Catholic elementary schools adopting a STEM focus and uses interviews to consider how and why different levels of support exist for the shift and under what conditions private and religious schools are prepared to make significant changes in instructional practice. Findings suggest that school resources—material, human, and social along with professional development—play an important role in shaping engagement in the adoption of a school-wide curricular focus.

Keywords: Catholic schools, curricular specialization, school choice, school organization, STEM

The expansion of public charter schools and the increasing availability of state-funded vouchers and tax credit scholarships in the United States have introduced greater choice into the educational landscape. As more families are provided the means to choose a school, some private and religious schools are seeking to fill academic niches as a way to attract parents and students (Davies & Quirke, 2007). One such curricular specialty is a focus on science, technology, engineering, and math (STEM; Eisenhart et al., 2015; LaForce et al., 2016; Scott, 2012), which has been cited as the best path for improving STEM education (National Research Council, 2011). We know little, however, regarding how previously established private and religious schools undergo a shift in organizational focus, how teachers respond to these changes, and to what extent changes are integrated into curriculum and individual classrooms. As the potential

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for competition for students grows in school choice states, these supply-side impacts on school offerings are important to explore so that school leaders, policymakers, and parents can make informed decisions in their respective roles.

How schools are organized poses obstacles for such curricular shifts. The organizational literature characterizes schools as loosely coupled, with classroom instruction buffered from external and environmental pressures, including administrator-initiated change (Meyer & Rowan, 1977; Weick, 1976). Thus, teacher and principal responses to specialization provide an important opportunity to consider whether, how, and under what conditions schools are able to more tightly couple administrative requests and classroom instruction to make changes to a school's focus.

This study examines the early stages of organizational change in three Catholic elementary schools adopting a STEM focus by taking a close look at stakeholder understandings of the process and considering under what conditions schools are better situated to make significant changes in instructional focus. Using a conception of school organization developed by Gamoran and colleagues (2000), this study considers the influence of resources—material, human, and social—in Catholic and other religious schools making significant changes to curriculum and instruction in the adoption of a specialty theme, specifically a school-wide STEM focus.

Literature Review

External Pressures for Curricular Specialization

Many current school choice policies seek to increase schooling options for a greater number of students and families. A secondary, supply-side motivation behind these policies is that with increased competition, schools will need to innovate and improve in order to attract students (Belfield & Levin, 2002; Figlio, 2009). Some U.S. schools have sought to differentiate themselves in an attempt to appeal to parent and student interest amid increasing state-funded schooling options (Davies & Quirke, 2007) and many charter schools were created with curricular specialization in mind (Loveless & Field, 2009; Renzulli et al., 2015).

For existing private and religious schools, this means either marketing established differences or instituting changes. Catholic schools comprise the largest private school system in the U.S. and have a strong and distinctive brand, denoting high academic standards, strong discipline, and religious instruction (Cheng et al., 2016; Trivitt & Wolf, 2011). Yet, Catholic schools are mainly tuition-driven entities. The introduction of public charter schools to the educational market has provided a tuition-free alternative to the neighborhood public school, leading some parents to choose public charter schools (Louie & Holdaway, 2009) and some Catholic schools to compete more actively for students and state funding in an attempt to stabilize enrollment.

Curricular Specialization and Catholic Schools

In recent decades, Catholic schools have faced enrollment and financial difficulties. The cost to educate has risen sharply and enrollment has dropped significantly, particularly in large, urban areas (Goldschmidt & Walsh, 2013). Some Catholic elementary schools have recently adopted innovative school models in response, embracing a focus such as blended-learning (Stocking, 2017; Davis & Venugopal, 2012), dual language (Winters, 2017), classical liberal arts (Fain, 2016), and STEM (Zubrzycki, 2015) in an attempt to attract and retain students.

Although Catholic schools hold a reputation for strong academics and high expectations in a communal environment (Bryk et al., 1993; Trivitt & Wolf, 2011), the curricular subjects of science and math have not been considered specific strengths of Catholic elementary schools, with studies reporting lower student growth in math compared to public schools (Elder & Jepsen, 2014; Reardon et al., 2009). STEM-focused schools have become commonplace educational institutions across sectors and are considered an important means for improving STEM education (National Research Council, 2011) and a preference among parents (Prieto et al., 2019). Thus, the move toward an explicit focus on STEM within a Catholic elementary school may signal efforts to remedy a perceived shortcoming and to focus on an area of increasing demand to attract new students.

Research on STEM-Focused Schools

Adopting a STEM-focused identity is a fairly new school model and, to date, relatively few empirical studies have examined related student outcomes. In addition, multiple definitions of STEM and models of STEM school designs have been developed (Hansen, 2014; Kloser et al., 2018). Research has primarily focused on high school STEM models, which have been around longer and which target preparation for college study and career readiness in STEM fields. Elementary school STEM models are fewer in number (Chiu et al., 2015; Peters-Burton et al., 2018) and have been developed independently in a number of different schools across the country (Sikma & Osborne, 2014). Based on research in the field, the common components of STEM-focused school models include an emphasis on the STEM subjects, instruction in the form of project- or problem-based learning, integration of STEM across disciplines, prepared faculty and staff with time and opportunities for professional development, engagement with the extended community, specifically professionals, businesses, and organizations in the STEM fields, and an inclusive focus that attempts to reach all students (Kloser et al., 2018).

Elementary schools influence students much earlier in their educational trajectories and operate in distinctly different organizational structures than high schools, with many early elementary teachers responsible for a self-contained classroom (Hansen, 2014). Elementary school teachers instruct students in some or all of the academic subjects and thus are not specialized science or math teachers and likely have less content knowledge compared to, for example, a high school

chemistry teacher (Nadelson et al., 2013). Further, there is a strong emphasis on reading and math in the early grades that may introduce tensions when attempting to focus on STEM in the elementary curriculum (Sikma & Osborne, 2014). However, because elementary teachers teach students multiple subjects they may have the opportunity for greater integration of STEM across the curriculum and may succeed in developing student interest and inquiry skills that may better prepare students for studying science in high school (Peters-Burton et al., 2018).

Some research exists on STEM-focused elementary schools in the form of descriptive case studies. One case study of a magnet school (Sikma & Osborne, 2014) details emerging conflicts in the change process after the STEM adoption was mandated by the district. In the early stages, the curriculum design process was hindered by a lack of clarity around what a STEM-focused school was or offered. Without a clear direction, teachers felt frustrated. A group of teachers stepped up to bring the school together to determine their goals and vision for the STEM school, leading to a distributed leadership model that argued for targeted professional development to assist with the pedagogical and curricular changes being made. Another study of a public school (Peters-Burton et al., 2018) identified critical components in the STEM model that led to its success, including a strong leader; teachers involved in leadership and decision making, open to new ideas with a willingness to improve; support for teachers through professional development; the integrations of STEM throughout the curriculum; and the use of an engineering approach to improving the model. Professional development has been found to play an important role in the shift (Nadelson et al., 2013) as well as a "whole school commitment" to professional development to support meaningful changes to STEM instruction (Livers, 2022).

Research on Catholic-STEM Focused Schools

In a case study of four Catholic schools adopting a STEM focus, Trott (2021) found that principals and other stakeholders reported that it took time and professional development to ensure that all members of the school community understood the concept and objectives related to becoming a STEM school, findings that echo public school's experiences (Nadelson et al., 2013; Peters-Burton et al., 2018; Sikma & Osborne, 2014). In addition, Catholic schools adopting a STEM focus must also find a way to incorporate a STEM identity into an already established organizational identity as a Catholic school. Kloser and colleagues (2018) examined how Catholic schools incorporated a STEM identity, with the most successful schools aggregating or combining the identities in a hierarchical manner with the STEM focus a secondary identity to the school's Catholic identity. One school determined that the two identities were at odds which led to a rejection of the STEM identity and another compartmentalized the STEM identity which kept the two identities separate but also resulted in less integration of STEM into other subjects. Some schools have chosen to adopt what they have termed a STREAM (science, technology, religion, engineering, arts, and math) focus to better incorporate the religious aspects into the STEM focus (Zubrzycki, 2015).

Schools as Organizations

From an organizational perspective, schools have been described as loosely coupled systems (Meyer & Rowan, 1977; Weick, 1976), as external pressures can have little to no impact on what goes on in individual classrooms. The school administration serves as a buffer between the external environment and classroom, and individual teachers enjoy a norm of professional autonomy. This framework provided an explanation for the relative inability of schools to institute large-scale changes in instruction. More recent research suggests this framework may oversimplify the relationship. Under certain circumstances, messages from the external environment do permeate the separation between principals and teachers and allow for tighter coupling (Aurini, 2012; Coburn, 2004; Gamoran et al., 2000), particularly related to increased accountability (Kelly, 2012) and more sophisticated understandings of teaching and learning (Gamoran & Dreeben, 1986; Spillane & Burch, 2006).

While classroom instruction may be separate from school administration, principals may be able to influence the technical core of schooling—teaching and learning—through the allocation of resources. Gamoran and colleagues (2000) articulated different types of resources—material, human, and social—along with the role of professional development in improving teacher practice, conceptualizing the flows within this model as reciprocal, allowing for influence to occur in more than one direction.

Within this framework, organizational resources play important roles. *Material resources* include curriculum materials, supplies, and adequate time for teachers to plan and prepare for instruction as well as funds to further develop their knowledge and skills. *Human resources* encompass the skills, knowledge, dispositions, and learning of the teaching and administrative staff as well as the capacity of the administration to lead with a clear mission and vision and reinforce it through operational and personnel decisions. *Social resources* refer to the extent that teaching and administrative staff form a professional community characterized by social capital that allows for information and shared understandings, obligations, and norms of improvement to flow within the school. *Professional development* becomes the "engine of change" (Gamoran et al., 2000, p. 52), allowing for interplay between different types of resources that enable momentum around change. Gamoran and colleagues' (2000) framework has been referenced in several studies related to professional development and resources for STEM teachers and in the introduction of STEM initiatives in schools (Estapa & Tank, 2017; Grigg et al., 2013; Lee et al., 2009; 2016).

Catholic Schools and Organizational Change

Catholic schools provide an important case for considering curricular specialization. Usually sponsored by a parish community, Catholic elementary schools are only loosely affiliated with

other schools within the diocese, are locally governed, and are not subject to district mandates to the extent of public schools (Bryk et al., 1993). Catholic schools have the organizational flexibility to implement curricular specialization and thus provide a timely consideration of how changes in curricular focus unfold which can inform other private or religious schools interested in pursuing similar shifts and policymakers in understanding the process and likelihood of change in existing schools. This study focuses on the curricular shift to a STEM focus in Catholic schools but other research has examined the challenges of negotiating multiple organizational identities, specifically when adding a STEM focus to the traditional emphasis on faith formation and academic excellence in Catholic schools (Kloser et al., 2018).

Data and Methods

I use interview data from stakeholders in three schools to consider how school leaders and teachers navigate curricular change from a traditional Catholic school to a STEM-focused Catholic school. Case studies are best suited for considering questions of how and why, particularly in studying programs and processes (Yin, 1994), and the case study provides a holistic understanding, allowing for an examination of complex social units influenced by multiple variables (Merriam, 1998). Schools are one such social unit with principals, teachers, parents, and students interacting amid different levels of resources, external pressures, and organizational dynamics. The multiple case study approach is appropriate here as it allows for both within- and cross-case analysis for considering theory (Baxter & Jack, 2008).

Sample

The inclusion of a STEM focus is a new phenomenon within Catholic schools, and the three schools in the sample were recruited using modified snowball sampling over two years. Each school had announced that they were adopting a STEM focus and had made some initial movement toward instituting changes. In each school, a research-practice partnership developed and the University Center agreed to facilitate a discussion among stakeholders, review curricular and assessment decisions, and develop metrics for program evaluation. In return, each school agreed to participate in research about the shift. The three schools[1]—Annunciation, Prince of Peace, and St. Mark—represent diverse school sites, particularly with regard to size, location, enrollment, and choice policies (see Table 1). At the time of data collection, each of the three schools had taken initial steps toward becoming a STEM-focused school; however, none of the schools had a full understanding of the goals of STEM education or a cohesive plan for implementation and had yet to participate in any sessions with the University Center.

1 Pseudonyms are used for the schools and university center.

Table 1

School Descriptive Information

School context	Annunciation	Prince of Peace	St. Mark
Grades served	PK–8	K–8	K–8
School size	Very Small (<150)	Small (<300)	Small (<300)
Student demographics	37% White 8% Black 19% Hispanic 23% Asian	56% White 10% Black 5% Hispanic 13% Asian 10% More than one race 6% Native American	68% White 10% Black 17% Hispanic 2% Asian 2% More than one race
Location	Mid-size city	Large city	Suburb
Principal experience	Novice (<3 years)	Veteran (>10 years)	Veteran (>10 years)
Finances	Struggling	Stable	Stable
Nature of STEM shift	Reactive	Proactive	Proactive
Driver of curricular shift	Need to increase enrollment and ensure economic viability	Desire to set school apart; participate in pilot STEM accreditation	Shared interest of strong math and science teachers
School choice environment	Charters Magnets Inter- & intra-district	Charters Magnets Inter- & intra-district Private school choice	Charters Magnets Inter- & intra-district Private school choice

Data Sources and Collection

Individuals from seven stakeholder groups were interviewed from each school at the beginning of the research partnership before program participation. These baseline interviews included the pastor, school principal, diocesan superintendent, teacher in a STEM discipline, teacher in a self-contained or non-STEM discipline, community partner, and a school parent. As most Catholic elementary schools are embedded in a parish and in a diocese, understanding the viewpoints of the pastor, who is responsible for the school according to Canon Law, as well as the diocesan superintendent, the representative of the local bishop in educational matters, allows for consideration of multiple influences on the transformation. Catholic schools consider parents to be children's first teachers and value them as partners in the educational endeavour. How Catholic schools message the transformation and how parents interpret what is going on in the school offers insight from the home. STEM education also benefits from community partners. How the school interacts with local businesses and community organizations on STEM-related issues and how they perceive the changes are a valuable outside perspective. Finally, principal and teacher perspectives provide a window into the school's organization and transformation processes. Both a teacher in a STEM discipline and one non-STEM teacher were interviewed at

each school to gain multiple perspectives on the STEM integration. Interviews were limited to two teachers at each school to ensure a balanced set of voices for the larger STEM transformation project. This array of stakeholders provides an understanding of the school context from a full range of perspectives and allows for triangulation of responses and were collected to consider the transition from a holistic perspective.

Using a semi-structured protocol, stakeholders were asked a set of common questions related to the STEM transformation along with one or two role-specific questions. The common questions among stakeholders included the following:

1. From your perspective, what does success for a Catholic STEM-focused school look like 5 years from now?
2. Do you believe a STEM-focused school helps support the mission of Catholic education? Why or why not?
3. What do you think are your roles/responsibilities in the transformation process?
4. What is the level of buy-in from the following stakeholders to move toward a more STEM-focused school: [asked about each of the other six stakeholders].

Interviews were conducted over the phone during the first year of the transformation process by a team of researchers that included the author. A total of 21 interviews lasting between 20–30 minutes were conducted, audio recorded, and transcribed for analysis.

Data Analysis

Using an open coding strategy, concepts and categories were developed and refined through multiple readings of the data (Saldaña, 2012), resulting in the following categories: teacher support of STEM-focus; understanding of STEM concept; teacher role in STEM transformation; principal role in STEM transformation; principal-teacher relationship; and resources for STEM transformation (see Appendix for coding details). These emergent codes highlighted the role of resources, roles, and relationships in the data, which resonated with sociological theory on schools as organizations, specifically the theory of nested layers (Barr & Dreeben, 1983) and Gamoran and colleagues' (2000) extension of this theory. A final deductive coding pass then considered the data in light of this framework on organizational change in schools. Data were analyzed separately by school to understand the context and dynamics in each case. Next, the three cases were compared to determine the patterns and processes related to different levels of support for the shift.

Results

In the results that follow, I present data from each case separately by school using a similar pattern. I provide context on the school followed by evidence from stakeholder interviews. I then

consider the case in light of the Gamoran et al. (2000) framework. Next, I present cross-case analysis, considering how the cases compare and placing the three schools on a continuum of engagement.

Annunciation School

Located in a state with charter schools and inter- and intra-district choice, Annunciation's move to a STEM-focused school was motivated by a sharp decline in enrollment threatening its stability. Working with diocesan and community partners, school stakeholders sought to fill a market niche and attract students. As a first step, the school leader was able to secure external funding to create a STEM lab. During the renovation, a new principal who shared the vision for change was hired. However, when progress on the lab stalled, the school lost momentum and the transition became overshadowed by feelings of frustration.

Across interviews, the majority of stakeholders perceived a lack of engagement with changes. The diocesan administrator stated, "I sense that maybe there's one teacher that has buy-in to this. I am not seeing it from anybody else, but there's a lot of resentment to the whole way this all came down . . . . It just feels very burdened." A parent noted sensing "resistance from teachers," and the pastor suggested "there's been some reluctance, especially on the part of some of the teachers, which has been a bit frustrating at times." The community partner characterized teacher support as "spotty," citing the exception of one teacher with strong interest in the program. Teachers referenced several major issues that fed into the level of engagement, including (a) ambiguity of the STEM concept, (b) the lack of an established curriculum, and (c) the sense that a STEM focus might be temporary.

As not many STEM-focused schools exist at the elementary level, few teachers had knowledge of what a STEM-school looked like in practice. One teacher admitted,

> It's a really fuzzy idea without any clear guidelines. If you give teachers clear guidelines, they can do anything . . . . But this is very frustrating for the teachers in my school trying to figure out what exactly we need to do.

She suggested that with greater direction, teachers would be less frustrated and more supportive. The conceptions of STEM that teachers did have were surface-level, incorporating constructivist ideas of education (e.g., hands-on learning, student-driven, and collaborative learning) or as consisting of a series of isolated STEM-related activities.

Other stakeholders noted that the not-yet-completed STEM lab, while serving as a real and tangible change, was considered the only change needed to shift the school's focus. The diocesan administrator noted,

> There is a real reliance on the lab to do the work for them and not enough on the transformation and the buy-in from the staff much less the community on what a STEM school is and how the implementation will happen.

With the initial focus on the lab, teachers and other stakeholders noted that little planning had gone into the next steps of curricular change.

The teachers felt that responsibility for the shift was placed on their shoulders with little support from the principal in the form of resources and professional development. The principal's responses confirmed this perception. He described his role as confined to building community partnerships and expressed frustration with his teachers regarding the curriculum:

> They want something that is going to be ready for them. They can open up the box, and they can take it, and they can run with it. Something that's easy. And they are not willing to put forth the extra effort to be innovative.

From the teachers' perspective, they were being asked to create a curriculum without full knowledge of the STEM concept, related goals, and without models, professional development, or resources. One teacher noted, "We're trying to create everything on our own and we're constantly having to research ideas and try to find the materials or purchase it out of our own pockets. And so I think that's been the big struggle." The disconnect between the principal and the teachers on what was needed to design and implement an integrated STEM curriculum appears to have bred mutual frustration.

Due to the stalled development of an integrated STEM curriculum and maintenance problems with the lab, some teachers initially considered whether the STEM focus would be temporary. The pastor suggested that teachers were moving past that:

> It's not just this new idea that's popped up and is going to fade away. I think that message has become clearer to the teachers now. . . . Once they realized they were having a voice, it helped to shift things a little bit.

While not without hope for a successful transition, the stakeholders recognized that engagement with the change was one of the major challenges they faced.

Considered against Gamoran et al.'s (2000) framework, the new STEM lab was an important material resource supporting Annunciation's shift to a STEM-focused school. However, without other material supports such as curricular resources, funding for professional development, and paid time for teachers to develop the integrated STEM curriculum, the teaching staff felt overwhelmed and unsupported. Neither the principal nor teachers had the necessary human

resources—prior knowledge, skills, experience, or expertise—to ensure a smooth transition. The lack of understanding around the STEM designation also hindered progress. Perhaps most importantly, the school leader was not able to fully engage with the mission he inherited. This lack of clarity and material support fostered feelings of reluctance, resistance, and resentment among the faculty when facing the burden of curriculum development without professional development. Thus, few positive norms regarding teacher effort had been established at the time of data collection, resulting in few social resources to support the shift.

Prince of Peace School

Prince of Peace's move to a STEM-focused school, motivated by a desire to be distinctive and attract students, was part of a proactive strategy. Located in a state with charter schools and public inter- and intra-district and private school choice, the school was small but stable, and the STEM focus was an extension of small projects by individual teachers, including an outdoor learning garden and STEM activities. The principal was very involved, directing faculty, gathering resources, and forging relationships in the community. While some uncertainty existed, teachers and the principal felt confident that a plan was developing.

Engagement was less of a focus across interviews, with more discussion on product and process of the transformation. While the diocesan administrator and the pastor reported positive support for STEM, the principal portrayed it as developing and as "rudimentary" with "varying degrees of implementation." She reported a goal of "all teachers being comfortable" in the STEM environment and provided a detailed sense of teachers' difficulties, relating to instruction for non-science teachers and for integrating science in other blocks in self-contained classrooms.

The teacher interviews documented a range of acceptance among the teachers, by subject and grade level. One teacher noted differences between the junior high and elementary teachers:

> I think our junior high is really, really, really into it . . . That's her whole life is science, you know, because that's all she teaches . . . . But to be honest, in the primary grades where we teach so many different subjects, some of the teachers have jumped on board like I have, but some of the teachers have tried a few things, but they haven't found their little niche.

Another teacher noted that age and length of teaching experience also seemed to play a role: "The teachers that have been here for 20 years and have been very traditional teachers . . . . This is a huge shift and they're not real excited about it."

As at Annunciation, stakeholders at Prince of Peace raised issues related to uncertainty around the STEM concept and the need for an integrated STEM curriculum, but interestingly, no one conceived of the change as temporary. Fewer stakeholders referenced the ambiguity, but the fuzziness of the concept was evident in differing understandings of STEM. The principal had

a strong sense of STEM-focused instruction as problem-based and fully integrated across the curriculum. Asked about changes in instruction that accompany a STEM-focused curriculum, one teacher noted that "the biggest change [will be] the way we teach," referencing hands-on cooperative learning, the use of the engineering process, and a new curriculum, Building Bridges.

The roles of the principal and the teachers in the transformation also seemed to be better defined. The principal had researched the transformation and focused on instructional leadership:

> I see my role, as the principal, to facilitate them accomplishing this . . . to make transition as easy as possible for the teachers . . . .I'm giving them a step-by-step what all these projects have to include . . . .That's kind of my job as an instructional leader, to show them a different way to go about [teaching]. So, I'm not just adding another workload to an over-scheduled day.

Teachers perceived principal support on multiple levels, particularly in relation to curricular materials and time and space for teacher collaboration, "Our principal is very supportive, very. She's already gone out and gotten us programs to try to get teachers involved. . . . She's been working on schedule changing so that we'll have time for collaboration." Another teacher confirmed this sense of support, describing the principal as having "a really good vision." Teachers did not report feeling a sense of burden; they pointed out the need for increased planning and collaboration time as well as professional development, but there was confidence that these elements were in progress.

The principal felt that part of her role was to hold teachers accountable; she viewed the STEM transformation as needing a "mandate" and required teachers to sign an expectation sheet related to the STEM changes in the renewal contract. Tying expectations to the employment contract may have reduced uncertainty regarding whether the change would in fact occur.

Prince of Peace stakeholders discussed several examples of material, human, and social resources in support of the curricular shift. The principal had a strong understanding of what being a STEM school entailed and expressed a clear vision. Although teacher engagement was still in progress, the principal had a realistic sense of where teachers stood, an understanding of the difficulties, ideas for how to address them, and had acquired curricular materials. The principal, in holding teachers accountable via signed expectation sheets and in planned provision of resources of curriculum and time, was able to reduce uncertainty around the shift, fostering social resources related to collaboration and cooperation for teachers and administration. While professional development was not directly discussed, the principal appeared to be filling these needs as an instructional leader.

St. Mark School

St. Mark School, located in a state with private school choice as well as charters and open enrollment in the public schools, was more stable than Annunciation but less stable than Prince of

Peace. The school also benefitted from the support of the diocese and local benefactors. School and diocesan leaders encouraged the move to a STEM-school, but interestingly, a subset of teachers seemed to be driving the change. These teachers were highly engaged, identifying professional development opportunities and sharing experiences with their teacher colleagues, and the principal was enthusiastic and supportive. The circumstances at St. Mark's provided a glimpse into transition with a proactive faculty.

Across stakeholder perceptions, engagement was strong and positive. A parent described the teachers as highly involved:

> Their desire to learn is amazing . . . . They're taking all sorts of seminars on all sorts of things, particularly how to do all of this. How do you get engineering into the second grade? They are just constantly finding ways to do this.

The pastor reported the presence of enthusiastic teachers and the diocesan administrator noted that "there's a number of long-time traditional teachers who are buying in or retiring. They are rising to the occasion or exploring other options."

From the principal's perspective, engagement had been present "since day one," suggesting that teachers may have been the main impetus behind the transformation: "I've had teachers who were definitely of the opinion, "We have to do this." We started talking and brainstorming and saying, "Well how do we do this, and how can we take it to the next level?" The principal considered herself fortunate that the "faculty recognize that this will separate us from other schools," noting that teachers "want that for our school."

Teacher perceptions of the shift were mostly positive, although one teacher acknowledged a range of support among her colleagues: "Some of the younger teachers and those who lean towards independent or open thinking are there, but some of the older teachers are a little resistant to the idea." Another teacher confirmed this sense:

> The faculty, I think, for the most part are all for it. We do have some new faculty this year, so this is their first time you know being part of a STEM program, what we want to do. And they seem excited. They seem interested and they want to do it, and they've been implementing it as we're going.

Although there was some suggestion that teachers did not have complete knowledge of the STEM-concept, this seemed less of an issue. For the principal and teachers, securing time and resources to make changes were of greater interest and considered solvable problems. Curriculum changes were teacher-driven and one middle school teacher described attending professional development on the engineering process:

> They taught us the basic design concept of how to create the process, the five steps from beginning a unit to working all the way through it. They showed us how to take a unit from the starting point, like starting with lecture and research, into the problems all the way through different elements of how we could take it from a kindergarten lesson and then manipulate it into a middle school lesson.

An elementary teacher referenced professional development through a national program, Project Lead the Way, in which she was becoming a teacher trainer for grades K–5. St. Mark was unique in matters of curriculum; teachers accepted responsibility for designing and enacting curriculum, but they also had the benefit of multiple supports.

Beyond providing professional development, the principal saw it as her responsibility to support her teachers, noting:

> I'm walking through this process with them . . . . I don't just put it onto them. I'm learning and responding. I'm having dialogue about these ideas coming up with pros and cons and things that will work and things that won't work . . . .They come in, and they say, "I have an idea. What do you think?" So, we work through it, brainstorm through it, and then, when they're doing it, I make sure that I try to be there to support them with that and then follow up with "What was good? What wasn't good? What do you want to change? Where do you want to go?"

Teachers were behind the changes, with important support from a school leader who saw her role as being an "advocate" and assisting with opportunities for training.

St. Mark had access to the most external resources. The diocesan administrator discussed support for the transformation through provision of classroom resources, professional development funding, and funding for substitute teachers to allow teachers to visit other science classrooms and schools. As a result, the teachers at St. Mark had the most sophisticated understanding of what a STEM school should be. One teacher described the problem-based learning model of STEM as:

> When we can see that the students are starting to think of possibilities or think of how to solve problems in more than just a linear way, where they can look at something and they can attack it in different types of view and be okay with not completely finding the answer right away.

In sum, while the principal and diocese were providing material resources in the form of professional development and personal support for the transition, a subset of the teachers appeared to be guiding the transition, particularly through their interest and engagement. These teachers

had basic knowledge of creating a STEM school and actively sought professional development to achieve that goal. While the principal had less concrete knowledge regarding the STEM transition, she had embraced the concept and assumed an active role. In doing so, she and the teachers were building social resources, creating an environment of teamwork and support, actively brainstorming and problem-solving as new issues arose. St. Mark's material resources were complemented by individual human resources and the social resources of collaboration. Professional development served as the connection point between teachers and the principal and brought ideas and knowledge necessary for the shift into the school community.

Cross-Case Analysis

The three schools provide examples of engagement with the curricular shift along a continuum, ranging from low (Annunciation) to developing (Prince of Peace) to high (St. Mark). Considering the presence and interplay of resources and professional development according to Gamoran et al.'s (2000) framework of school organization, I mapped the different levels and combinations of resources in each school in comparison to each other and did an additional round of coding considering levels of progress and resources based on the framework. This allowed for better recognition of trends and patterns by school (see Table 2).

Across the three schools, ambiguity surrounding the STEM-focused school concept contributed to how teachers perceived change at their school, similar to previous case study research (Sikma & Osborne, 2014). At Annunciation, few if any school personnel, including the principal, seemed to have a working knowledge of what a STEM-focused school entailed, and teachers and personnel attributed what was "STEM" about the school to the STEM lab, which came to symbolize the transformation. When pressure to implement a school-wide integrated STEM curriculum was placed on the teachers without scaffolding, professional development, or support, teachers felt they did not have sufficient knowledge or experience to design a curriculum.

At Prince of Peace and St. Mark, a subset of school personnel had deeper knowledge of the concept and the steps needed for transformation. The principal at Prince of Peace had completed extensive research on the STEM concept, transition process, and curricular materials. She had plans for longitudinal class projects, professional development for teachers, changes in scheduling for collaboration, and had acquired curricular resources. Yet, the principal and teachers felt that engagement was developing. In this case, the principal seemed to be in the process of sharing her knowledge of the concept with her faculty. Conversely, teacher leaders at St. Mark seemed to have a better handle on the STEM concept than the principal. They actively sought professional development, gathered materials, and were designing a curriculum based on multiple programs. While not yet experts, the teachers were empowered to learn and bring ideas to the school.

Table 2

Resources Related to Curricular Change by School

Resource type	Annunciation	Prince of Peace	St. Mark
Material resources			
Curricular materials, equipment, supplies	Limited to new STEM lab	Purchased for coming school year	Available
Time for planning and preparation	Limited	Being worked into schedule	Developing
Funds for professional development	Limited	Available	Available
Human resources			
Teacher knowledge and skills	Limited	Developing	High
Principal knowledge and skills	Limited	High	Developing
Principal leadership	Focused on community relationships	Clear vision; leading changes	Role of support and encouragement for change
Social resources			
Professional community	Some conflict	Developing	Strong
Environment conducive to change	Resistance	Developing	Developing
Professional development	No mention	Principal directed	Multiple external programs; Teacher initiated
Teacher engagement	Low	Developing	High

Across the three cases, ownership of the shift emerged as a key difference. At Annunciation, the lack of ownership was evident. The principal wanted the teachers to design the curriculum, but the teachers did not feel prepared. As a result, teachers felt frustrated. The principal at Prince of Peace clearly owned the curriculum changes and while she held teachers responsible in a regulative fashion, she seemed to be behind the school transformation. At St. Mark, the teachers were in full control of the shift, accepting responsibility for design and implementation. The STEM transformation appeared to have begun in a normative fashion and had been embraced by a growing subset of teachers.

Principal support also differed across contexts, with Annunciation teachers receiving the least support and Prince of Peace and St. Mark teachers receiving a great deal of support from their principals, albeit of different styles and methods. At Annunciation, teachers felt on their own to figure out what a STEM-focused school and curriculum looked like without support for research and development. There was no mention of resources or professional development in these early data, and both the principal and teachers expressed frustration with the other, suggesting a lack of interpersonal support.

Both principals at Prince of Peace and St. Mark discussed and provided examples related to how they were supporting their teachers, but this support took different forms. The principal at Prince

of Peace had acquired pre-packaged curriculum that could be introduced without extended effort on the part of teachers. This support, however, came with clear mandates and expectations. The principal at St. Mark, while not an expert on STEM herself, saw her role as providing professional development that would allow the teachers to become experts.

Discussion and Conclusion

This paper considers the dynamic interplay between types of resources—material, human, and social in combination with professional development—within a school community undergoing the early stages of a shift in curricular focus and finds that the degree to which these resources are present or absent impacts engagement with curricular change. Interview data from a range of stakeholders in three schools lend support to Gamoran and colleagues' (2000) theory of school organization consisting of reciprocal flows between teachers and principals regarding changes in classroom instruction.

The school environment of St. Mark's, with resources flowing in both directions between principals and teachers and informed by professional development, provided the strongest example of engagement. Prince of Peace exhibited more of a one directional flow of resources from principal to teachers, but additional planned supports of time, curricular resources, and professional development, suggest the potential for reciprocal flows from teacher to principal in future. The case of Annunciation, however, points to the importance of the broad range of resources discussed in Gamoran and colleagues' (2000) model. With only limited material resources invested in the new STEM lab and few human and social resources flowing between principal and teachers, the curricular shift at the time of data collection appeared to have paused. Together these cases point to the important role of a broad conception of resources in securing engagement for the adoption of a specialty curricular focus.

While some research points to the limited impact of financial and material resources on student achievement (Hanushek, 1994), other evidence suggests that having at least average resources does have a modest effect (Greenwald et al., 1996; Ludwig & Bassi, 1999). Thus, the lack of resources can impact success. The U.S. Catholic school sector, operating without the benefit of full public funding, has a history of principals and teachers stretching and supplementing material resources with a heavy reliance on human and social resources (Bryk et al., 1993). While simply adding material resources may not guarantee a successful curricular shift, evidence here suggests that too few material resources, specifically resources for providing professional development, can inhibit efforts to develop the human and social resources needed for curricular change. This finding echoes other research in the STEM-focus adoption research related to the importance of professional development (Nadelson et al., 2013; Trott, 2021).

Findings suggest that whether change is driven from a reactive or a proactive financial position may contribute to the success of the curricular shift. Schools on the brink of closure due to

enrollment and financial difficulties may not be the best schools to consider such a course of action. Without the necessary financial flexibility to invest in materials and personnel, these schools may have a lower probability for success, particularly as individuals within these communities are subject to greater levels of stress and anxiety that accompany the threat of closure. Schools with a modest level of resources that can invest in professional development for teachers and additional curricular materials may be best suited for considering such curricular specialization.

Some research suggests that social resources, specifically relational trust, are also critical to the success of school improvement efforts (Bryk & Schneider, 2002). Both teachers and principals are dependent on each other as principals trust teachers to enact the school mission and vision in the advancement of student learning in the classroom and teachers must trust principals' leadership and provision of supports for instruction. Assessing the strength of relationships and the level of trust among a school faculty are necessary when considering such a shift as human and financial resources flow through these relationships as a form of social capital (Coleman, 1988).

Similar to other studies, these three cases underscore the importance of professional development, as Gamoran and colleagues (2000) refer to it, as the "engine of change" (p. 52). Participation in professional development as part of the STEM-focused school transition has been found to be a critical factor (Nadelson et al., 2013) and the presence of or lack of professional development appears in stark contrast among the cases in this study. Without professional development as a support, research suggests the likelihood of success for such a transition is low.

These data were collected early in the shift to a STEM-focused school and thus provide only a snapshot of the beginning of a larger process in a limited number of school contexts and thus are not able to speak to outcomes at later stages. As with any institutional change there will be high and low points within the change process informed by internal and external dynamics. Future research may allow for a fuller sense of these ebbs and flows and a clearer understanding of the role of resources in this process over time. Data are also limited to stakeholder perceptions in three school contexts and may not be generalizable to other curricular shifts and schools. Further, despite attempts at triangulation, the perspectives of the participants may not be fully representative of the school. Finally, because each school differs in culture and context there may be additional contributing factors that help or hinder the process that may not be considered in light of the Gamoran et al. (2000) framework.

As the U.S. educational field continues to adapt to the addition of state-funded choice initiatives and the growth of public charter schools, curricular specialization is likely to continue to be one way private and religious schools seek to differentiate themselves within the educational market. Further attention to whether and how schools are able to make specialized changes to the curriculum will contribute to the ways in which educators seek to encourage and foster innovation in Catholic schools.

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Appendix

Codebook

1.0	**Teacher "Buy-in": Engagement and/or Support for Transformation**
	1.1 Absent
	1.2 In-Progress
	1.3 Present
2.0	**Understanding of STEM-focused Concept**
	2.1 Ambiguous
	2.2 Symbolic
	2.3 Gimmick or fad
	2.4 Surface level understanding
	2.5 Deeper level understanding
3.0	**Teacher Role/Responsibility in STEM Transformation**
	3.1 Design Integrated STEM Curriculum
	3.2 Enact Integrated STEM Curriculum
	3.3 Collaborate with Teachers and School leaders
4.0	**Principal Role/Responsibility in STEM Transformation**
	4.1 Support Teachers
	4.2 Hold Teachers Accountable
	4.3 Acquire STEM Resources and Professional Development
	4.4 Acquire STEM Curricular Resources for school
	4.5 Connect school to community partners related to STEM
5.0	**Principal-Teacher Relationship**
	5.1 Trust absent
	5.2 Trust in-progress
	5.3 Trust evident