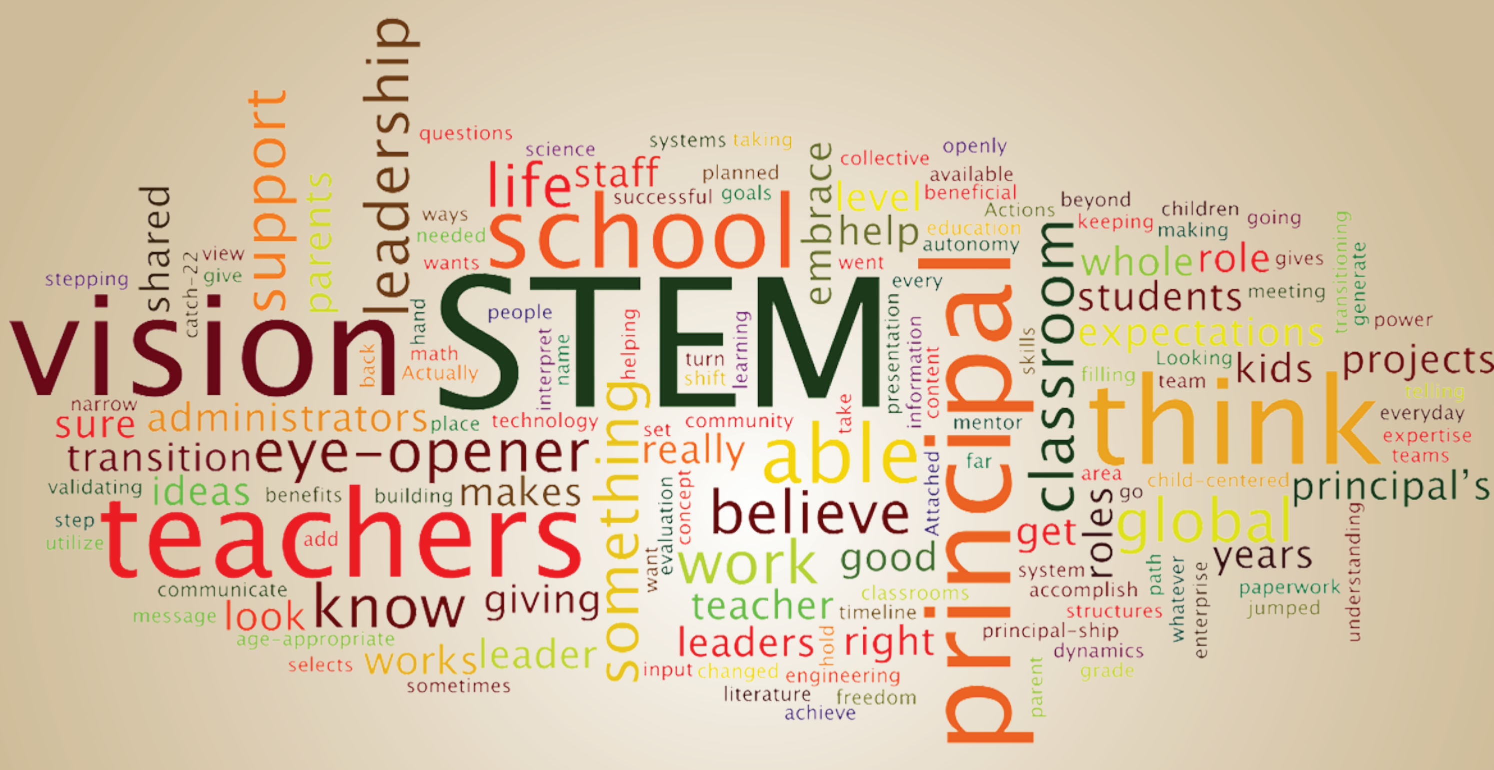
CULTIVATING LEADERSHIP IN THE STEM SCHOOLHOUSE:

ROADMAP FOR STEM TRANSFORMATION



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Cultivating Leadership in the STEM Schoolhouse: Roadmap to Community Engagement

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Forward

At PAST Foundation, we have been fortunate to have a variety of innovative, educational opportunities come our way. Our organizational story and journey is one that is rich, varied, and diverse, blending content expertise, an anthropological and systems approach, and the power of ethnographic understanding. Every opportunity to engage in the conversation associated with transformation of 21st century education has helped us refine our understanding and expand our reach across the educational landscape to accelerate change.

As anthropologists,we are deliberate in choosing what transformative work we are best suited to engage in. From an institutional stand point we have three primary core values that guide our decision making when it comes to opting in or out of projects. First, as an organization we must *believe* in the work and the underlying cause that seeks change. In short, we must be committed to being successful and willing to course correct as the project evolves in order to insure success. Second, PAST must be able to learn something from the work. It is not enough that we help others within the transformative process, but as an organization we want the opportunity to grow and learn along side our partners. Third, we must be able to pull from our full array of expertise and tools in approaching the requested assistance in transformation. Whether it's amassing capable teams, appropriate resources, meaningful partnerships or building capacity - all of these elements are critical to project success. Our work with the Columbus City Schools STEM Transformation project is one such example.

There was no model in 2009 when we began our work with Columbus City Schools (CCS). No urban district in the US had taken on STEM transformation on a feeder system scale in schools with established cultures. The CCS vision was ambitious and daunting. To place STEM opportunities within specific underserved feeder systems in every region (5) within the district so that all children would readily have access to preK-12, STEM education was unheard of. There were no protocols in place, no process, no system of gaging effectiveness outside of standardized test scores, and no established district policy to seamlessly allow for such innovation to take place.

Like many urban districts across the US, the needs of CCS students were urgent and often desperate. Politicians, Industry and community leaders openly recognized that the culture of teaching and learning, not just within the schools but across the collective community of Columbus, Ohio had to shift. The numerous initiatives associated with K-12 education and traditional instructional strategies was not impacting the educational landscape fast enough.

The CCS administration, committed to improved academic achievement and access for all students, had been looking at new approaches since 2006. The shift nationally to a STEM approach to learning and teaching was chosen as a good fit for providing access and opportunity to students within a large diverse urban population that is often in flux.

In the five years since 2009, CCS set in motion the STEM transformation in three feeder systems, Linden, West, and Africentric. This work began with the Linden Feeder System (LFS) that included four elementary schools and one 7-12. The LFS work was funded by HB119, Race to the Top (RTTT), Title 1, and an assortment of smaller grants. The second group, the West Feeder System (WFS) included seven elementary schools, two middle school and one high school. In the course of the transformation one elementary and one middle school combined to form a K-8 building. The WFS work was funded through a NASA grant, RTTT, and Straight A, as well as Title 1. Finally, Africentric (AFS) Early College K-12 began transformation. AFS work was funded through Title 1.

Over our five years working with CCS, much has changed. Building leaders have changed replaced by leaders unfamiliar with the goals of STEM transformation and thus unprepared to lead transformative change. Teachers have moved around and out of the district. In some instances this has benefited the district but not the specific school, leaving some schools in a perpetual state of having to start over with teacher professional development. Finally there has been substantial district leadership changes realigning priorities and funding. In this report we focus on what we have accomplished in the short term of the past academic year and the ever-expanding lessons learned from the whole CCS project. It is our hope that our body of work over the five year project serves as a guide for transformative shifts in teaching and learning within large urban school districts, and that both the successes and constraints that CCS encountered along the way informs others. It has been both a pleasure and a privilege to be part of this endeavor.

ROADMAP FOR STEM SCHOOL TRANSFORMATION: CULTIVATING LEADERSHIP IN THE STEM SCHOOLHOUSE

Improving the quality of preK-12 educational systems presents complex challenges that go far beyond simply raising student scores on standardized tests. Today, educational leaders are exploring ways to enhance the substance of education, advancing an approach to student learning through curriculum integration utilizing the content vehicles of science, technology, engineering, and math (STEM) in the context of transdisciplinary problem based learning (TPBL). Inherent in this approach is fundamental change, infusing new roles and relations within the schoolhouse and in each classroom, effectively opening up new leadership roles among principals, teachers and students.

Our experience in guiding STEM school transformation has generated insights on strategies for transitioning from traditional classroom instruction to TPBL, revealing identifiable program implementation benchmarks that signal effective change as it occurs. In this report, we focus on the substantive cultural factors associated with new leadership roles essential for a successful transition to STEM education, and how shifts in leadership roles support the transition in fostering an overall shift in the culture of the schoolhouse, resulting in rigorous cultural strategies. In mentoring new leadership roles for teachers, principals must also work to build and lead a structured collaborative process where teachers can explore new leadership experiences. The benefits of these changes ultimately extend to students as teachers gain in their ability to model team skills, collaboration, and communication.

Beginning with the initial launch of a well-designed STEM TPBL implementation strategy a combination of factors are critical to the early phases of school transformation. All education involves three universal pedagogical components: Instructional Strategy, Cultural Strategy and Delivery System. The principal's traditional role as the 'building' or 'instructional' leader [O1] is accepted by teachers and administrators, yet in many instances the principal and teachers have never articulated either the school strategies or delivery, assuming the pedagogical approach is a universal, common to each and every classroom. Thus the principals are often unprepared to convey a vision and willingness to restructure critical foundational elements of the STEM TPBL schoolhouse, which includes a commitment to ongoing professional development in order to operationally shift paradigms. These commitments involve implementing school "Habits of Mind," formalizing common planning time for teachers, identifying teacher leaders, and recognizing critical '"teacher support' support" factors. In other words – it is the work of the principal to lay the initial foundation for school transformation—mapping the road forward, and communicating critical actions that will occur to teachers and students, as well as to parents, and the community.

Once the process is underway and leadership roles emerge among teachers and students, the role of the principal also shifts in fundamental ways, supported by the momentum of the shared TPBL enterprise. The dynamic nature of these new roles and relations are essential to a STEM learning environment.

This report explores ethnographic data gathered from (12) elementary schools, (4) middle schools and (3) high schools during a three-year period, from 2012-2014, in our work with three feeder systems within Columbus City Schools in Columbus, Ohio. Over (300) teachers engaged in a total of (38) focus groups, (24) STEM coordinators participated in a post- training year survey (2014), and one-on-one interviews were conducted with 17 principals. In the following narrative, each study participant, cited in this report, is assigned a coded number, to preserve anonymity. For additional details on ethnographic methodology please see Appendix (X): Knowledge Capture Methods.

LAUNCHING A COMMON VISION OF STEM EDUCATION

In most instances preK-12 education, the role of instructional leader falls primarily to the principal, while leadership in cultural strategies sit with the vice principals, and the Delivery Systems with the individual teachers. However, these strategies and delivery systems are often couched and benchmarked by the expectations of the school district's administration. In this capacity, the district administration or building leaders delegate "Initiative" leadership roles buy tying salaries to grade-level or "master" teachers, or special assignment teachers tasked with implementing different school district mandates or special program initiatives. Often specialized training is provided for teachers taking on mentoring positions for initiatives. Additionally, the teachers work closely with the principal in creating and assessing effective strategies to advance progress in meeting district-mandated directives. More often than not, grant funding behind the initiative supports the Master Teacher positions within the school for a period of two to three years only. However, across multiple initiatives within the overarching strategies and delivery systems, the principal holds authority for assessing the quality of instruction and grade level success for each classroom teacher, and as such is ultimately responsible for the overall success of teachers and students, as well as the instructional and cultural health of a school.

In this report, we begin by considering the role of principals in initiating the transition of their school to STEM instruction. In looking at the experience of CCS schools over a three-year period, from 2012-2014, the first steps toward implementing STEM were initially defined and structured by the principal in his or her role as the building instructional leader (5004-46; 5006-267; 5007-54). However, to sustain the multiple-year transition to STEM TPBL the overall process must involve 1) supporting a cultural shift for the school as a whole, 2) providing professional development for teachers, and 3) engendering new forms of leadership among teachers as well as their students.

THE BIG PICTURE

When asked about the role of the principal, teachers engaged in STEM school transition identified two important ways that a principal could ensure a successful launch of STEM in their school:

» **The principal should have a vision of what a STEM school will look like, and should be able to mentor teachers as they transition to STEM and TPBL in ways that will achieve a shared vision of a STEM classroom.**

» **The principal should be able to clearly communicate specific goals for the school to create a shared enterprise for teachers transitioning to STEM instruction, and should also articulate a well-crafted message for students, their parents, and the community as a whole about the planned transition and timeline for the process to take place.**

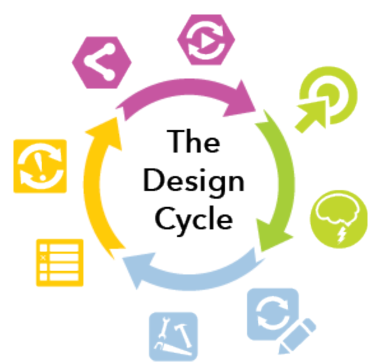
In talking with principals about their role as the instructional leader, one first-year STEM school principal described his focus on leading teachers in a process to explore what STEM TPBL "instruction will look like" for the children in their school (5002-36). Another principal in a second-year school stated that the overarching goal is to create "a way of life" within the school as a whole.

This overarching goal includes a vision for sustaining STEM TPBL instruction through a cultural shift that embraces the idea that to teach in a STEM school means you are a STEM teacher, and is an explicit, mutually held expectation shared by the building leader and the teaching staff (5009-163).

"Attached to our [school] name is STEM, so [the principal] makes sure that it is part of what we do each and every day" (210-4-64c)

Principals and teachers feel the principal must ensure that implementation strategies also build teacher "buy-in" during the early stages of the transition. From this viewpoint the principal is responsible for promoting early adopters, offering leadership and support for teachers who are hesitant adopters or apprehensive about shifting forward to STEM, and listening to the opinions of resistant adopters (6001-42). Encouraging teachers with assurances that the principal knows the transition period will require "a rollout," and communicating "we'll get through this together" (6007-30), are essential features of the process, building teacher confidence that they will be successful with support from the principal (5003-100; 6005-39; 6006-38).

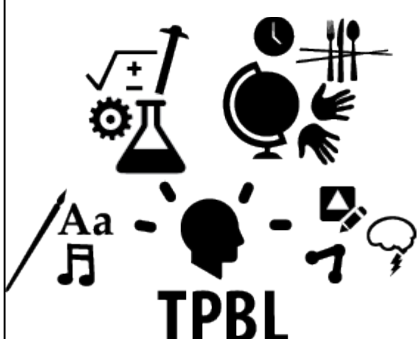
It is also important for teachers to see their principal setting clear expectations and holding teachers accountable for successful implementation over time. One teacher observed that it's not about "pushing it to the point that you feel overwhelmed," but more as a "constant reminder… that this is what our goal is" and "there is no forcing anything" (210-4-64a). For some teachers, the decision to transfer out of a STEM school may be the best path for those who are uncomfortable with a STEM approach to education. When new staff is hired, it is up to the principal to select new faculty who will be on board with the concept, and the principal's expectations for all teachers are clear to everyone in the building (5005-74; 80-1-84; 80-3-53; 110-8-211; 180-8-237; 210-4-64b; 313-320-5; 315-226-4). This point was driven home by a teacher noting that, "if we're not excited about it, if we don't buy into it, then we can't get the kids to buy into it" (210-4-64c).



Assisting teachers with envisioning what a STEM TPBL classroom will look like is essential for bridging the transition from the current practice of classic textbook-based instruction (5002-44) and "teaching to the test" (80-3-53), to creating a "problem-based approach" (5002-28). It is important for principals with a background in problem based learning to convey their prior experience to teachers, reinforcing teacher confidence that the principal understands the types of changes that will occur in the transition (5002-24; 6008-22). The principal must also instill the vocabulary of STEM TPBL environment in order to incentivize teachers and students to buy-in.

One principal noted that sitting in with teachers in their STEM professional development sessions, and visiting other STEM schools in transition are important ways to signal to teachers as well as to students that principals are fully engaged in understanding what STEM is (5004-96), and what the transition looks like in different buildings. Sharing these observations with teachers, especially if the principal hasn't had experience with TPBL, can also build teacher confidence (6004-93). One of the pivotal precepts of TPBL is to become a lifelong learner. A principal that fully admits he or she is learning alongside their teachers is modeling that ability to be "the guide on the side instead of the sage on the stage." Being responsive to evolving questions that emerge as the implementation advances to convey essential information about the transition is something one principal identified as a prominent part of the principal's role in providing guidance and support (6007-32a).

"Some people just think that STEM is really just science, technology, engineering, and math, and they don't embrace it as a whole, and as authentic. They embrace it as four silos." (5004-96)



The transformation process relies on establishing clearly stated goals and strategies for implementation, even though the pathway may not be clear to anyone, including the instructional and cultural leaders. These are the primary and crucial roles of the instructional and cultural leaders, within the school in the early stages of the transition. In the next section of this report, different aspects of communication are explored that impact the implementation structure and processes or Delivery Systems reliant on teachers. The implementation of delivery as teachers embark on the shift in strategies and delivery require new and cohort relationships with colleagues, as well as new relationships with students in the classroom. These shifts inherently define a STEM learning environment or classroom culture.

CREATING A COMMUNICATION STRATEGY ABOUT STEM EDUCATION

Initiating communication about STEM is a multi-faceted process that encompasses sharing information to convey not only what STEM is, but also the process for exploring how to design STEM instruction for the classroom. Principals can play an important part in modeling dissemination of information in ways that support sharing new ideas among the school staff and openly exploring what works and what does not work in the classroom (5003-98; 5009-54; 6003-50; 6006-36) in order to assure "every single person has a strong foundation in STEM" (6003-50). One principal noted that in the first year of this transition, "I had to have a lot more conversations and [give] a lot more feedback in terms of what they are doing in the classroom" (5001-78).

Consistent and ongoing communication of ideas is important in building effective teacher teams. Providing a structured process for teachers to build new collaborative relations with their colleagues involves communication to assure that everyone is informed and aware of what is changing, what progress is being made, and who is involved in different STEM TPBL activities going on in the school (5003-98). Giving teachers time to share ideas and their progress in implementing STEM TPBL in their classrooms can occur in different ways and extends understanding of STEM within the context of the school as a whole. One teacher noted that in the second year of their transition, the opportunity to talk about their work with their colleagues was conducted during "every staff meeting [when] we had time to just share, even just five minutes, to share where we're at with our projects, what we're looking for, and what we need" (180-5-119).

Communication to openly discuss teacher's concerns about how implementation is being conducted, and any problems or hurdles encountered can be discussed in ways that will inform everyone as to how the issue is being resolved, especially if a particular problem should be addressed as "an entire grade-level concern" (5004-42). Lack of systematic communication with teachers about problems, following-up with information, or letting teachers know when changes are occurring that will affect their classroom planning, leaves teachers with the impression that their efforts to advance STEM implementation are not valued (317-144-4; 318-183-6).

Teachers also want more frequent communication with their instructional leaders to get feedback about what needs to change, or if they are "really, completely lost," how to fix it (150-1-123a). During the initial stages of transition to STEM, some teachers have an ingrained sense that, "you're my boss, tell me what to do" (318-380-5). This is something that often comes up for teachers who regard their role to be primarily one of fulfilling the principal's goals. If the principal isn't communicating effectively during the transition, teachers express frustration that the principal isn't providing enough guidance, and isn't meeting teacher expectations of their instructional leader to keep them informed (120-7-148; 314-172-7; 314-181-8; 319-267-9; 319-281-7).

Another equally critical aspect of communication about STEM education involves the dissemination of information to parents and to others in the community about what STEM is, why the school is transitioning to STEM TPBL, and initial details about the plan for the school transition (6003-62). From the perspective of the teacher, if the principal or district leaders do not take the lead in providing information to parents and more broadly to the community, then teachers feel they are put in the position of conveying information to parents, and often feel unprepared for this role (312-72-9; 318-245-6). Bringing teachers together with administrators, and ideally inviting leadership of the school's parent teacher organization (PTO), could assure that parent and community meetings are designed to help inform parents and to begin to identify and address different needs (301-48-5).

Teachers identified three main areas in which administrative leaders could communicate information about STEM education and facilitate the transition to becoming effective STEM TPBL teachers. They include:

"Actions to support the shift to STEM was one of communicating it openly… these are our expectations, but we as a group and we as a collective have to think about the direction we want to go and how we are going to do it" (5009-44)

"We had a parent meeting, we put all the information [into] a PowerPoint presentation and went through it with the parents…we had literature available and where they had different questions… that's where we jumped into our roles as administrators" (6003-62)

- » Leading communication about the STEM TPBL transition process for parents and community
- » Creating professionally designed information, including brochures, to support clear and consistent communication about STEM TPBL education for parents and others in the community
- » Reaching out to potential community partners with information about STEM to create interest in supporting school projects

Table 1: Teacher Identified Challenges for Engaging Parents and Community Partners in Supporting STEM TPBL (2012-2013) shows that concerns about communication to parents and community continue from year one to year two of the school's transition that also has implications for building community partnerships and reaching out to parents in STEM careers, and more generally engaging parents in the school's transition to STEM TPBL.

Table 1: Teacher Identified Challenges for Engaging Parents and Community Partners in Supporting STEM TPBL (2012-2013)
PreK-12 Teacher Focus Groups: n=21 Focus Groups (FGs), 153 Teachers (Ts)

Focus Group Sub-Themes	Year One Schools (6)	Year Two Schools (3)
	n=12 FGs 104 Ts	n=9 FGs 49 Ts
Ineffective use of community partners	✔	
Lack of adequate communication to parents and community	✔	✔
Lack of parent involvement	✔	✔
Identifying parents in STEM professions		✔
Lack of community involvement		✔

Modeling Leadership in a STEM Learning Environment

Mentoring teachers in their transition to STEM TPBL education involves many steps toward attaining autonomy and building leadership skills. One principal in a year-three school observed that giving "the grade level teams the autonomy to use their expertise" to work toward meeting expectations set by the principal is a key part of supporting their development as STEM teachers (5004-46). Conveying to teachers that they have the "academic freedom…to change things around," is an important message from the principal that requires thoughtful reinforcement for teachers who are accustomed to working from textbooks and following standardized, grade-level curriculum structured by uniform pacing guides (5009-94; 6002-103). Table 2 presents three areas of critical importance identified by teachers for a successful transition for their school.

Table 2: Leading a Successful Transition to STEM TPBL

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❍	The principal should be flexible and thinking 'outside the box' to support creative ways of engaging students in STEM TPBL learning experiences, and building autonomy among the teaching staff
❍	The principal should be able to lead the process initially, and as teachers initiate STEM TPBL in the classroom, strike a balance between constructive feedback and active mentoring to help teachers identify best practices
❍	Teachers and students need to see the principal as leading the school transition to STEM TPBL including supporting integration of school HABITS for successful student learning

"I think my role as the principal is to set up the structures, or the systems, or the expectations that support our STEM education. And then ... give the teachers in the grade level teams the autonomy to use their expertise in the content area to mesh the two together." (5004-46)

The distinctive changes in one principal's experience during the second year of STEM implementation reflects fundamental shifts in the relationship between the principal and the teaching staff that offer, as noted, long-term benefits:

> *"It has been an eye-opener as far as leadership, in being able to transform how we do things as leaders, not necessarily keeping it as a power and control thing and telling [teachers] what to do, but taking a step back and saying to my staff, 'I believe in you, I believe in the ideas you can generate, and I believe in what you can accomplish with our children. Let me help you get to that point.' Looking at the dynamics of the principal-ship and how that has changed over the years, and to add this [STEM] concept in it, has been an eye-opener, you know, it's been a good eye-opener, and something that can be beneficial to us for years to come" (5009-174).*

As teachers gain in their STEM TPBL skills during the planning phase for integrating STEM curriculum into the classroom, one principal noted that teacher teams are confident in their collective ability to work through planning and curriculum design, even when they encounter problems (5009-135). Shifting from directing teachers in their daily instruction to giving teachers the freedom essential to "be as creative as your children need" allows teachers to use their professional training and experience to determine how best to meet core standards and student learning objectives (140-2-228). This is a break with past practice as reported by teachers in year-one and year-two STEM schools, and is an important step in the process of developing STEM TPBL skills (160-5-115; 170-4-41; 190-6-80; 200-4-32a; 210-10-65; 220-3-69; 306-162-1; 310-233-5; 323-91-4; 328-87-1).

Some teachers report that once they have the skills to develop curriculum and project plans, they prefer working autonomously as a team with minimal guidance from the principal during the planning stages of preparation for the classroom. Some teachers observed that when the principal occasionally sits in on their team meetings, communication within the team changes, conversation is less open, and progress is impeded (160-4-93; 160-5-108; 160-5-115; 220-9-75). When principals aren't shifting in their approach to allow teachers the autonomy essential to STEM TPBL, teachers can lose their enthusiasm and initiative in creating curriculum and project plans. One teacher expressed frustration at the loss of the "sense of ownership of our project [plan]" when the principal stepped in and changed the project design the team had created, noting that the teachers would have preferred to have feedback in order to work out the instructional plan on their own (150[MH2] -7-127).

When teachers move from planning to classroom implementation of STEM TPBL, the process involves striking a balance between giving teachers freedom to explore new approaches to student learning, and proactive mentoring provided by the principal. Engaging in classroom observation and offering teachers constructive feedback can convey both the principal's understanding of effective progress toward integrating standards in a TPBL context, as well as identifying best practices for STEM classrooms. Teachers and principals agree that this type of creative engagement is essential for teachers during the early stages of transition to STEM (5004-26; 5005-175; 90-2-69; 150-3-112; 210-10-67; 220-3-69; 314-179-8; 318-376-4; 319-273-7; 321-173-3; 341-165-6a).

One principal noted that the process is one of talking with the teacher about the changes the principal sees taking place, and helping teachers to define those observed differences that are clearly leading to "results oriented learning" for students (5006-227). This was echoed by a year-one STEM teacher who observed the importance of the principal in "coaching the teachers through opening up creativity of students because a lot of this has been taken away, and with problem-based learning, it has come back into the room" (310-232-8). Equally important is the message that this is not about getting "written up," but rather in "setting expectations" and clearly conveying that as the principal, "I [am] going to support you" (6006-38a).

On the other hand, if a principal isn't actively leading the transformation, and in effect lacking in attention to setting as well as meeting goals for transitioning to STEM TPBL, teachers find themselves leaderless in having to make the most of a minimal situation (321-168-2). One teacher stated that the key role of the principal is to be supportive of the transition to STEM TPBL, commenting that, "if they're not on board, then it's not going to work" (320-457-1). This is particularly important in supporting teachers who find it difficult to make the transition. Principals who can mentor teachers through the stress of shifting into unfamiliar roles, demonstrate interest in understanding the specific nature of the challenge facing each teacher, and in so doing, model qualities of good leadership that includes showing patience with different approaches, and recognizing progress in ways that can support teacher success (305-108-5; 305-141-4; 306-162-1; 320-458-2; 323-96-3). One teacher made the observation that the principal has to both provide support as well as show understanding "that there's going to be a certain level of growing pains that teachers are going to have…and they will need [the principal's] assistance" (317-125-2).

Supporting integration of student Habits of Mind can be reinforced in the way the principal interacts with both teachers and students in the classroom. Asking questions directly of students in their classrooms, and engaging in discussion about what they are learning signals to both students and their teachers that learning is about a process in which particular steps are performed in pursuing new knowledge and

"So it's a catch-22, you look for your leader to kind of, not hold your hand, but sometimes I think, can we get some more input on this? What's [the principal's] view? What is [the principal's] perception of what we think is good work here?" (220-3-69)

"I would like to have more administrators in my classroom. Actually, not just filling out paperwork because it's needed for whatever evaluation system, but actually understanding what we're doing and giving me more ideas." (321-173-3)

understanding. Through interaction in the classroom, principals can give students an opportunity to discover and express a valued sense of "owning their learning" (6004-95; 317-396-1). As students advance in their skills to self-evaluate, effectively using the same skills that teachers and principals use to assess skill building and learning strategies, students are given the tools for using "a project rubric for a type of reporting, a daily reporting system, just as engineers do" (5004-46e). Teachers also want support from the building leader in managing student behavior in ways that signal students themselves are accountable for creating a positive learning environment (317-131-6) Teachers see the value in this type of interaction between students and the principal, observing that students are always enthusiastic in sharing their learning experiences with the principal, in displaying their project work, and generally feel encouraged to stay on track with STEM TPBL learning through sharing important learning experiences with the building leader (309-123-4; 314-165-6b).

A second-year STEM teacher noted the similarities between the teacher's learning processes led by the principal, and those of their students:

> "It's just like our students in our classrooms. We're giving them some freedom when they're doing their projects, and we have to support them by helping them [to find] the right path, and by validating their work and the work that their families do to help them complete their projects. It's the same as [what] a teacher wants from their principal, you know, because we're like her classroom" (220-9-75).

In the next chapter, issues associated with building teacher leadership skills are explored in the context of collaborative teamwork among peers. Teachers who gain in their understanding of effective teamwork through direct experience report increased ability to foster collaborative skills in their students. This incorporates new leadership roles for students in surprising ways that contribute to successful learning.

FOSTERING COLLABORATION AND LEADERSHIP AMONG PEERS

> "The role of the teachers is to move it forward with the kids, and making sure it's child-centered, age-appropriate, something that our kids will be able to utilize not only here in school, but in everyday life. I think that's one of the real true benefits of problem based learning because if you do it right, it is something that is applicable to life skills and life beyond school. You know, the teachers [are] just stepping into their roles of leadership" (5009-50).

Becoming a STEM TPBL teacher involves building a range of skills to support essential teamwork required to create coordinated, grade-level integrated curriculum. Within individual schools, the initial stages of the transition involves not only professional development for all teachers, but also requires that teachers continue to work collaboratively together, throughout the school year. For most schools the initial plan for teachers to work together, on a regular basis, must be organized by the principal (5004-6a; 6000-39; 6001-36; 100-8-120; 100-10-118; 130-9-49; 200-9-37; 200-10-100; 210-1-10; 318-192-4; 318-197-1). However, principals report that options to create 'common planning time' during the school day is a goal that is not easily accomplished.

In some cases, principals must be creative in finding opportunities for teachers to communicate about their work and collaborate with fellow teachers as they advance their STEM TPBL skills, including setting aside time within the building-wide staff meeting time, or working with teachers one-on-one (5006-77; 6002-41). Teachers are also creative in finding other ways to build time into their weekly or monthly schedules, in some cases meeting before or after school, or on weekends. Making a commitment to building a fully integrated plan for the academic year using formally structured meeting time or other informal means of communicating to coordinate grade-level projects reflects an investment by all to meet the challenge of transitioning to STEM TPBL (6002-37).

Teachers working in grade-level teams, which in some cases overlapped with the existing CCS 'professional learning community' (PLC) process, were able to initiate a productive form of interaction, enjoying varying degrees of 'common planning time.' Teachers reported that they used this opportunity to foster ongoing collaboration, communicate ideas, advance planning and project design, and learn to share in leading the process (110-2-89; 130-9-49; 200-10-100).

A review of nine schools within two K-12 feeder systems in Columbus City Schools (CCS) shows a wide variation of program design to support STEM TPBL implementation. In Table 3: Comparison of Program Design Variables for Transition to STEM TPBL (2012-13), note that seven of the nine schools are organized by grade-level groups to enhance transdisciplinary content integration, and four schools ranged from scheduling 'common planning time' for teachers from 1 time/week to 5 times/week, with two schools meeting 2 times/month. Additionally, six schools reported meeting quarterly during the academic year for district-wide STEM TPBL professional development (PD). Four of the nine schools also conducted STEM leadership meetings as part of their program implementation design.

Table 3: Comparison of Program Design Variables for Transition to STEM TPBL (2012-2013)

(Administrator Interviews 2012; Total Schools n=9)

Program Implementation Year	Interview Timeframe	School Code #	Common STEM TPBL Planning Time							Teacher STEM TPBL Teams		STEM Leadership Meetings*		STEM TPBL at Staff Meetings		District-wide STEM TPBL PD	
			None during the school day n=2	1 x Week n=1	2 x Week n=1	5 x Week n=2	2 x Month n=1	2 x Month after the school day n=1	3 x Year n=1	By Grade Level n=7	By Content Area n=2	Yes n=4	No n=5	Yes n=4	No n=5	Yes n=6	No n=3
End of Year 1 Schools	Spring 2012	5001		✓						✓			⊘		⊘	✓	
	Spring 2012	5002	⊘							✓			⊘		⊘		⊘
	Spring 2012	5003				✓					✓		⊘	✓		✓	
End of Year 2 Schools	Spring 2012	5006			✓					✓			⊘	✓		✓	
	Spring 2012	5007	⊘							✓		✓			⊘		⊘
	Spring 2012	5008							✓	✓		✓		✓		✓	
	Spring 2012	5009					✓			✓			⊘	✓		✓	
End of Year 3 Schools	Spring 2012	5004				✓				✓		✓			⊘		⊘
	Spring 2012	5005						✓			✓	✓			⊘	✓	

Key: ✓ = school program design includes this component; ⊘ = school program design does not include this component

* These are meetings described by administrators where STEM TPBL is discussed with a range of participants that may include teachers, STEM coordinators, department chairs, administration staff, and engaged community members.

The range of STEM TPBL program design components implemented during the 2011-2012 academic year varied considerably across (9) schools in two CCS feeder systems. Note that (3) of the schools (5002, 5005, and 5007) did not schedule common planning time during the school day, reporting that teachers were meeting before or after school, lunch time, or on weekends (offsite) to work collaboratively to plan coordination of projects across content areas and/or grade levels. Principals cited the main reason for not providing common planning time was due to scheduling issues, including lack of substitute time. Of the two schools that had neither regular common planning time nor district-wide STEM TPBL PD (5002 and 5007), only one school (5007) did not provide regular opportunities for administrators and staff to communicate about planning and progress on the transition to STEM TPBL.

STEM COORDINATORS: TEACHER LEADERS IN ACTION

As part of the CCS STEM implementation strategy, in-house lead teachers were selected from among the teaching staff at each school to serve as STEM coordinators. During the 2013-14 academic year, STEM coordinators attended monthly, half-day PD sessions. Within CCS, principal responsibilities include many administrative aspects that can sometimes keep them from being consistently engaged with day-to-day classroom learning. Therefore, the general role of STEM coordinators has been to provide leadership and ongoing support for classroom teachers across grade levels. STEM coordinators are able to help fill that gap and provide support for teachers as an in-house resource, including bringing issues forward to the monthly PD sessions where STEM coordinators can share ideas with other STEM Coordinators from different schools, as well as bring information back to the teachers at their home school (80-3-14; 302-3-116).

In a survey conducted in spring of 2014, 24 STEM coordinators representing schools from across all three of the CCS STEM feeder systems responded to (13) questions offering an opportunity for self-reporting on a range of issues related to communication and skill development as STEM coordinators (Appendix X: CCS STEM Coordinator Survey Questions). Of the 24 STEM Coordinators, 62% reported communicating with other school STEM Coordinators outside of the monthly PD session to share information and ideas about STEM TPBL. Twenty of the 24, or 83%, described their level of involvement as 'mostly involved' to 'somewhat involved' in their work with teachers at their school.

When asked to identify common achievements during the year, across all responses the following five areas reflect ways in which STEM Coordinators played a leading role in sustaining STEM education in their schools:

- » Providing project ideas
- » Creating STEM projects
- » Creating and maintaining effective communication with teachers and others in the building
- » Modeling STEM/TPBL in their classrooms
- » Fostering teacher collaboration

OBSERVED CHANGES IN STUDENT CLASSROOM PERFORMANCE

In a multiple-year STEM transformation, our understanding grew during each successive year of research. As teachers became more comfortable with the participating in the Knowledge Capture process, we continually heard from teachers about their experiences in establishing STEM classrooms within their schools. Among second- and third-year STEM schools, it became apparent that as teachers increased their skills and confidence level in conducting TPBL, awareness of changes in student classroom performance also began to emerge as a significant topic of teacher focus group discussion. From 2012 to 2013, the Knowledge Capture Program staff conducted (38) focus groups with just over 300 teachers. In this research, the observations shared by teachers from year-one through year-three STEM schools affirmed gains for teachers as well as students in surprising ways. Note that each school experience must be viewed in terms of the unique differences as well as the common elements of the transition design, including regular PD sessions throughout the school year, as well as differences in the process led by the principals and STEM coordinators. However, it is valuable to consider the informed observations of veteran public school teachers who enthusiastically described shifts in student learning in the classroom that were significantly different from their classroom experiences in prior years. In Table 4: CCS Teacher Reported Observations of STEM TPBL Student Skills, three main categories were identified by teachers who observed positive shifts in student engagement in the classroom that included unexpected changes in low-performing or under-performing students, second-language students, and special education students. In these groups in particular, teachers noted that these students participated in learning, as well as leading their group in hands-on project work in ways that teachers had not experienced prior to implementing STEM TPBL.

Table 4: CCS Teacher Reported Observations of STEM TPBL Student Skills

2012-2013 PreK-12 Teacher Focus Groups; n = 38 Focus Groups (FGs), 304 Teachers (Ts)

Themes	Sub-themes	Year 1 Schools (n=163 Ts)	Year 2 Schools (n=110 Ts)	Year 3 Schools (n=31 Ts)
Student Advances in STEM TPBL Skills	Increase in student led projects/classwork	✔	✔	✔
	Students connecting projects to problem		✔	
	Students understand they will present to an audience/showcase work		✔	✔
Changes in Classroom Culture	Students demonstrate maturity, independence/initiative, accountability	✔	✔	✔
	Increased student engagement	✔	✔	✔
	Students are able to collaborate in their classwork/projects	✔	✔	✔
	Students recognize and utilize habits/standards		✔	✔
Changes in Student Achievement	Increased student creativity	✔		
	Students use the design cycle to guide project phases of work	✔		
	Second language learners improve performance through group work	✔		
	Critical thinking and demonstration of "real world" problem-solving skills	✔	✔	
	Building confidence and leadership skills	✔	✔	
	Special Education students perform better in a TPBL learning environment	✔	✔	
	Students connecting ideas across content areas	✔	✔	✔
	Students with low academic skills perform better	✔	✔	✔
	Students take pride in learning and understand that gaining new skills is not just about being an "A" student		✔	
	Students are prepared for grade level work at the beginning of the school year		✔	
	Students reach a higher achievement level based on setting personal goals		✔	✔

Teachers reported that growth observed in their students involved unexpected changes in a range of low performing students including those with below grade level skills, second language students as well as special education students. In these groups in particular, teachers noted that these students engaged in new ways in learning through hands-on TPBL projects.

"What makes us so successful here is because we have vision and leadership… that's simply it." (5007-74)

"I would say here's how the vision works: the principal or the building leader gives a global vision. He or she selects leaders that can interpret that global vision and narrow it a bit. And that team, in turn, works with the staff and each individual teacher narrows it down to the student level to really satisfy the global vision" (5007-112)

SUSTAINING LEADERSHIP IN THE STEM SCHOOLHOUSE

This report incorporates the views and experiences of CCS principals and teachers gained over a three-year period, from 2012 to 2014, within three preK-12 feeder systems. In total, interviews and focus groups were conducted with staff from (12) elementary schools, (4) middle schools, and (3) high schools. Many of their insights on the route undertaken to transition from traditional textbook instruction to STEM TPBL education suggests that a viable process to provide a 21st century approach to learning, while challenging on many levels, is attainable. The principals and their teachers, students and families in these neighborhood public schools are a testament to a joint commitment to our youth to prepare them for STEM careers, including advancing to higher education or entering the workforce upon graduation from high school.

The experience of the CCS STEM program implementation process offers the opportunity to consider the subtle but critical changes in leadership that occur in the course of developing a cultural shift in the way teachers work together to cultivate a shared vision of STEM TPBL, and to lead an effective implementation process. One principal eloquently noted that the mission of a principal in transitioning to STEM TPBL is to "develop a way of life, and then no matter who comes here, this is what we do, and you are going to be a part of something – and this is the expectation" (5009-163). Empowering new forms of leadership, including building leadership teams within the school community, is another important facet that some principals view as inherent in gaining buy-in from the school staff as a whole (5005-141; 5007-104).

The process of engendering a cultural transition to STEM TPBL involves integration across all levels of the school that, while initially may be led by the principal, can only succeed when teachers and their students grow in their mutual understanding of the school's goals for sustaining a successful learning environment. As one second-year STEM school principal described it:

Among teachers who participated in 2013 focus groups, discussion of essential supporting factors identified a range of issues that include both actions achieved during the first three years of the transition to STEM TPBL, as well as actions yet to occur. Table 5: Essential Components of Administrative Support for a Successful STEM TPBL Transition presents five categories identified by teachers as necessary changes to ensure continued efforts to build and sustain STEM TPBL programs. These factors represent system-wide challenges that require coordination between individual schools and the school district administration of these schools, including shifting formal policies to align with the needs of STEM TPBL schools.

Table 5: Essential Components of Administrative Support for a Successful STEM TPBL Transition

2013 PreK-12 Teacher Focus Groups, n = 23 Focus Groups (FGs); 165 teachers (Ts)

Main Theme	Issue
Integrate Building Goals as they Relate to District Goals	1. Principal conveys a clear plan that integrates what teachers must do to achieve both school-level and district-wide goals and priorities (inform teachers and coordinate initiative implementation)
	2. Organize staff meetings more effectively to direct how the different priorities/initiatives are to be implemented
Engage with Teachers to Guide/Resolve STEM Transition Issues	1. Teachers believe that because the principal is often out of the building, and also has many responsibilities, it is difficult or not possible for them to be engaged in the transition to STEM TPBL; principal should delegate certain responsibilities to non-teaching support staff to assure success
	2. Principal should be knowledegable about the design cycle process to inform their expectations and understanding of classroom work reflecting design cycle phases of project completion
	3. Teachers need guidance/direction on how to issue a grade for student work that may not align with the district grade-level reporting period (STEM TPBL content/skills may be out of synch with traditional grading cycle)
Create a Collaborative Planning Environment	1. Schedule common planning time and/or adequate planning time
	2. Principal is responsible for creating a collaborative environment for teachers (decompartmentalize grade levels, keep teams informed building wide)
Recognize New Dimensions of Teacher Evaluation	1. Allow teachers flexibility to make the shift to STEM TPBL at their own pace; encourage teachers in their transition process, and explicitly affirm progress
	2. Teachers need to know that the principal will be flexible with evaluating teacher performance during the transition to STEM TPBL
	3. Teachers need flexibility to teach content out of synch with grade level pacing guide in ways that respond to student readiness associated with STEM TPBL
Assure Funding for STEM TPBL Project Materials	1. Principal needs to assure funds and materials are available to support STEM TPBL project success (national average for unfunded classroom supplies was $485 expended annually in personal funds by teachers, reported in the 2013 NSSEA Retail Market Awareness Study)

Teachers expressed their ideas to systematically advance the transition to STEM TPBL district-wide. Many of the issues concern institutional constraints that will need broad-based shifts in policy and/or program practices to better align with the needs of STEM TPBL schools. Additionally, teachers see the necessity for district-wide communication to increase effective coordination of multiple initiatives and programs in context of the transition to STEM education.

Conclusions & Recommendations

LESSONS LEARNED

PAST is committed to lifelong learning, real time course correction, and regular modification. Thus we regularly evaluate, and where needed modify our process in an effort to engage and inspire teachers and to agilely respond to the dynamic landscape of today's educational needs. This reflection and modification continually consider the nature and learning styles of digital natives, the gap between non-digital teachers and the students they teach, the need for evidence of teacher effectiveness, and the importance of well articulated, Student Learning Objectives. Beyond understanding the process and practice there is also the importance of understanding the mechanisms for generating momentum in change, the agents that accelerate change, and those that constrain or stall change. The study of scaling good educational practice has been and remains the driver of many research questions including the Harvard School of Education (Elmore 1996). Our first step at PAST has been to understand who is most likely to lead change in terms of building administration and teachers.

As in all professions, practitioners consistently group themselves by their willingness to try new ideas, problem-solve, and adopt changing strategies. Recent studies by Gallop, at Johns Hopkins University, and at the Air Force Academy in Colorado have all studied the three categories generally recognized as Early Adopters, Hesitant Adopters and Resistant Adopters (Harter et al 2003, Wertheimer 2014, Rosen 2014). The Gallop study noted that while Early and Hesitant Adopters will change, Resistant Adopters rarely do. The Air Force Academy study found that putting Early Adopters with Resistant Adopters actually lowered the scores of all students and thus were able to understand and establish the value of the Hesitant Adopter as a bridge between the two divergent spectrums. The work at Johns Hopkins is analyzing the economy of targeting the various adopters in terms of effectively and efficiently promoting change.

In the teaching profession, and in the new federal initiative on Teacher Effectiveness, Early Adopters most often fall into the category of Distinguished Teacher. The STEM TPBL instructional strategy helps teachers consistently reach the distinguished status, for both Early and Hesitant Adopters. Evidence of completed and implemented TPBL modules or PD deliverables also indicates that the Early Adopters and even Hesitant Adopters are more likely to produce evidence of effective teaching that can be benchmarked. This is a crucial factor in raising the bar for teacher professionalism in the near future. Administrators, parents, and community stakeholders want to see evidence of planning and implementation beyond a post-it with Chapter 2 scribbled across it. The PAST PD forms associated with the STEM TPBL approach provide evidence of effective planning, alignment to Common Core, Next Generation Science, and Ohio standards, concise smart goals, gap assessment, and visualization of project implementation.

Applying this research to CCS teachers across the STEM feeder system, each faculty is roughly divided into thirds among the three categories of adopters. In every instance the principal could easily determine Early Adopters, and more often than not, assign these teaches to the role of Lead STEM Coordinator. In some instances, principals promoted Hesitant Adopters to the role of Lead STEM Coordinator with the intention of helping them attain the drive and give them the tools to become an Early Adopter.

In the early years of STEM transformation within the CCS feeder systems, the approach was to provide all teachers PD, without consideration of the adopter category an individual fell into. Depending on the mix of Resistant Adopters in any PD, the progress toward transformation could be constrained or stalled, simply by the negative attitude toward change. In the best scenarios, the Resistant Adopters self-selected out of the schools, recognizing that the STEM approach did not match their skill set. In the worst case scenarios Resistant Adopters hijacked the transformation either at the leadership level or through organizing a strong clique of resistant teachers. Recognizing Resistant Adopters and the role they play in transformation was very important in evaluating how precious funding resources were allocated.

As the transformation progressed, the schools began to target PD for the Early and Hesitant Adopters making the STEM TPBL transition process self-selective. This has proven more cost effective and more sustainable. After several years of PD support, both Early and Hesitant Adopters in the West Feeder System consistently plan and implement TPBL modules, whereas in the first year only the Early Adopters willingly tried the new instructional strategy and delivery.

As PAST continues to modify and agilely respond to the changing landscape of education, being more cognizant of the three types of adopters and how they affect and drive change enables us to modify how and when PD is delivered. This approach is both cost effective and responsive to using grant funding as a stimulus. Often grant funding and labor costs are directly tied together. The unintentional consequence of this approach is a 2-3 year cycling of initiatives that cannot be sustained without continued grant funding. This type of cycle creates short-term solutions to labor but has no effect on long-term transformation to a 21st century approach to education.

FIDELITY

Fidelity to an instructional strategy and approach is essential to transformation. A recent study on teacher effectiveness ranked systems for benchmarking fidelity as integral to moving today's education forward (NRP story 7/16). By combining PD with ethnographic evaluation the PAST STEM Coordinators and Knowledge Capture teams were able scrutinize and benchmark each PD workshop and bootcamp to ascertain where the teachers stood in terms of comfort quotients with regard to motivation, engagement, problem relevance, and rigor in planning and implementation of TPBL in the classroom. Continually evolving PD forms within the Problems, Projects, Products Workbook (third edition) along with new avenues of research for mining information provided through Knowledge Capture, and TPBL modules enable the PAST team to continue exploring the educational landscape in the quest for providing useful and important tools for this century's educational transformation.

Thus the process that PAST promotes through the process outlined in the P3 workbook provides a guide for teachers just coming into the profession or transitioning from one instructional strategy to another. By maintaining continuity and consistency in an approach to STEM TPBL, PAST provides a fluid system for brainstorming, designing or planning, building, evaluating, modifying and sharing. The workbook templates provide teachers and administrators with a process that enables them to create benchmarking evidence that moves from theory to planning, and planning to practice (Appendix G.6). The power of the TPBL process partially lays in the ability to easily crosswalk various theories of good practice with the implementation of the design cycle delivery. Recently PAST was asked to crosswalk the aspects of Charlotte Danielson's four domains with the delivery aspects using the TPBL process and forms to plan and implement STEM TPBL curricula. Appendix G reveals how teachers using the process with fidelity can provide evidence of effective teaching that places them in the category of distinguished teachers.

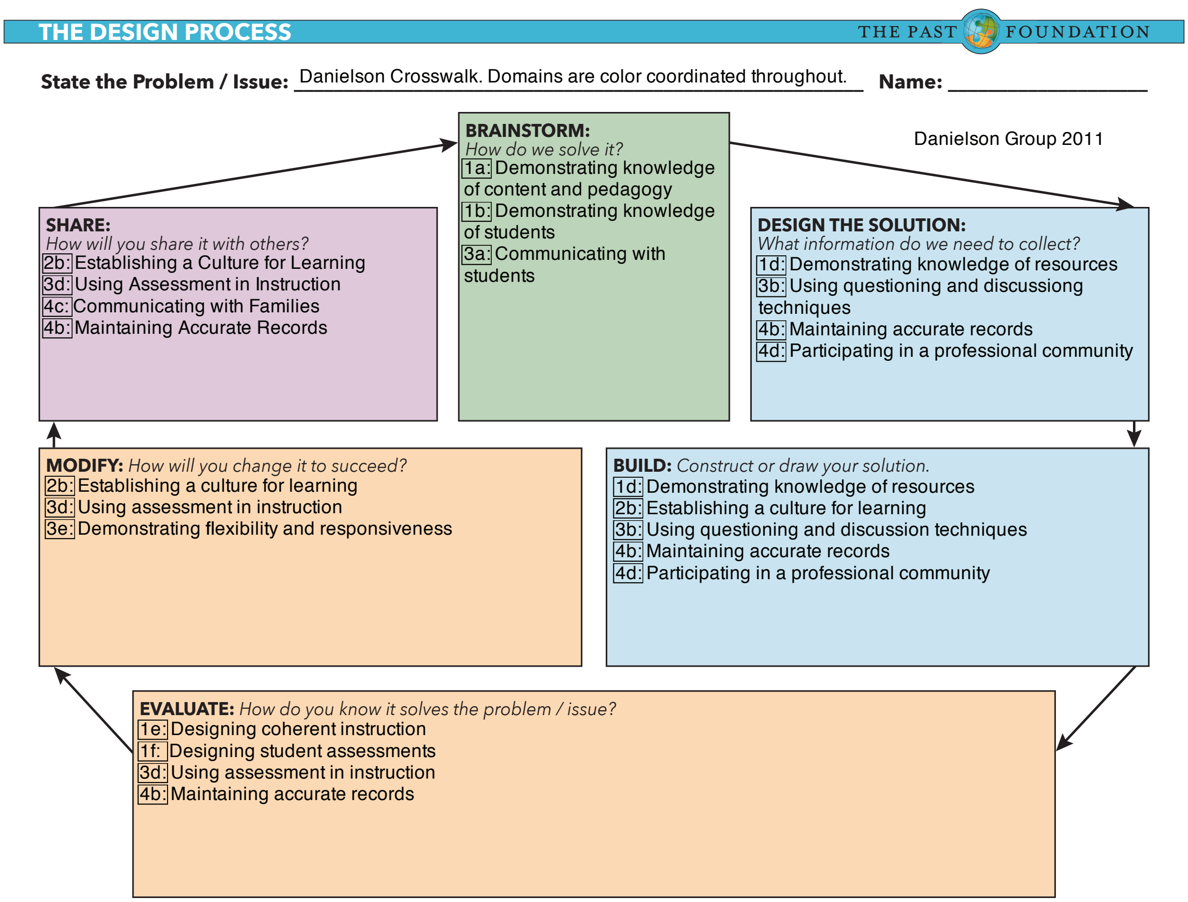

Figure 12: Evidence of Learning

Recommendations

This year's recommendations fall within four categories that we at PAST have consistently promoted as agents of change. Considering the dynamic nature of American educational transformation in the first quarter of the 21st century, and PAST's experience in both facilitating PD and continuously studying the emergence of STEM through knowledge capture, we have narrowed our recommendations to focus on acceleration of change.

WHERE DO WE PUT THE MOST EMPHASIS ON PROFESSIONAL DEVELOPMENT TO EMPOWER CHANGE?

emphasis must be placed with building leadership PD and Early and Hesitant Adopters. If after preliminary PD, a building leader exhibits no or little interest in transformative change toward a STEM TPBL instructional strategy then the District must closely examine the school's faculty for the presence of Early Adopter, lead teachers. At this juncture it is important to make STEM TPBL PD available to those who self-select to participate in transformative PD. This is cost effective and continues the preparation of teachers toward applied learning systems. In many instances both school leaders and teachers who self-select for this PD will also search out opportunities to teach in schools that promote STEM TPBL from the leadership down.What are the factors constraining accelerated change?

One of the most apparent factors constraining accelerated change is the lack of STEM understanding and training available to building administrators. Teachers look to administrators, particularly principals to provide a unified vision of instructional strategy and curriculum delivery in the school community. Teachers who become proficient and distinguished in STEM TPBL instructional strategies need an administrator who shares a vocabulary, vision, and understanding of the strategy and delivery system. Thus it is important in setting the pace and scope that the principal and other building administrators also undertake professional development regarding STEM TPBL.

HOW DO WE ACCELERATE CHANGE?

The "how" of accelerating change has evolved as much as the look of PD over the five years of transformation in the CCS STEM feeder systems. Although planning has always been considered a pivotal factor in sustaining transformation, understanding the levels of planning has evolved. The most successful schools are those that creatively open up the traditional school day and reconstruct it to accommodate regular and structured common planning time for teachers. The two levels of planning that have percolated up and are the most widely adopted, consist of regular grade level cohort planning that focuses on modifying existing modules for the current quarter, coupled with quarterly intensive planning that maps out the upcoming quarter with P3 workbook, backmaps, planners, and snapshots. These combined approaches to planning emphasize the importance of real time course correction and facilitate the development of relevant TPBL module curricula responsive to the current needs of the school and community.

WHEN DO WE INSERT ACCELERANTS FOR CHANGE?

Amplifying and enhancing change can and should occur with regularity that provides impetus to stay dynamic and receptive to the changing cultural landscape surrounding all communities. Creating opportunities that empower teachers to learn new skill sets, experience STEM TPBL instructional strategies in a modeled environment, and expand the concept of learning centers provide the accelerants for change. Bootcamps, Hybrid Bridge Programs, SOILabs all provide invaluable experiences for teachers and students that model the process of taking theory to planning, planning to practice, and knowledge to understanding.

APPENDIX A:

Knowledge Capture Research Methodology

Ethnographic Case Study Research

The PAST Foundation ***Knowledge Capture Program*** **(KC)** produced this report, *Roadmap for STEM School Transformation: Cultivating Leadership in the STEM Schoolhouse*. This study presents data gathered during a 3-year period, Spring 2012 through Spring 2014, through research conducted with PreK-12 school administrators, STEM coordinators and teachers in Columbus City Schools.

The KC research team relies on ethnographic methods to conduct field research, working collaboratively and school staff engaged in STEM TPBL program implementation. The KC program observes ethnographic research protocols that require anonymity of study participants. Therefore, each individual participant was assigned a code number. Interview participants were assigned a four-digit code number identity. These code numbers appear in the report narrative as a reference to interview data. The second number in the citation indicates a specific response in the interview transcript (e.g., 3001-25). Focus group participants are identified by a series of numbers that represent the focus group number, identity code and transcript response number (e.g., 210-8-85).

Case study citations are incorporated into the narrative discussion presented in this report to underscore information based upon "insider" knowledge of the actions underway and direct experience with the STEM program implementation process in Columbus City Schools. Documenting implementation strategies has the potential for creating a model for public school transformation to STEM education, offering the reader the opportunity to gain strategic insights on effective approaches for implementation design.

A detailed overview of all research activities by feeder system is presented in *Appendix Table A: Research Study Participants by CCS Feeder System*. In the three-year research period (2012-2014), the Knowledge Capture team gathered ethnographic data from 372 participants, including a total of (17) interviews with school principals; (38) focus groups (including STEM Coordinators, Encore and Special Education staff) with 304 teachers; and (51) surveys with STEM Leaders.

Appendix B: Knowledge Capture Research Documents, presents a sample set of interview questions, a sample set of focus group questions, and a copy of the online STEM Coordinator Survey conducted in 2014.

Roadmap Table A: Cultivating Leadership in the STEM Schoolhouse
Research Study Participants by CCS Feeder System (Total Participants, n=372)

Year	Feeder System	Number of Schools	Field Work Dates	Interviews (n=17)	Focus Groups (n=304 Ts)		Surveys (n=51)
				Principals	Total FGs	Teachers	STEM Leaders
2012	LFS	1 HS	May 2012	1			
		1 MS		1			
		1 ES		4	1	3	
	WFS	1 HS	May 2012	1			
		2 MS		2			
		1 ES					
	LFS	1 HS	June 2012		1	13	
		1 MS			1	6	
		1 ES					
	WFS	1 HS	June 2012		2	20	
		2 MS			4	39	
		1 ES					
	LFS	1 HS	August 2012				
		1 MS					
		4 ES			6	58	
	LFS	1 HS 1 MS 4 ES	Oct-Dec 2012				10
	WFS	1 HS 2 MS 6 ES	Oct-Dec 2012				17
2012 Subtotals:				9	15	139	27
2013	WFS	1 HS	April-June 2013		3	16	
		2 MS			6	33	
		7 ES		5	12	104	
	AFS	1 HS	May 2013	1			
		1 MS		1			
		1 ES		1			
	LFS	1 HS	June 2013		1	8	
		1 MS			1	4	
		1 ES					
2013 Subtotals:				8	23	165	
2014	LFS	4 ES	March 2014				6
	WFS	1 HS 2 MS 6 ES					14
	AFS	1 HS 1 MS 1 ES					4
2014 Subtotals:							24
Total Participants by Research Activity				17	38	304	51

LFS=Linden Feeder System; WFS=West Feeder System; AFS=Africentric K-12

In the period 2012-2014, the Knowledge Capture team conducted a total of (17) interviews with school principals; (38) Focus Groups (including STEM Leaders, Encore and Special Education staff); and, (51) surveys with STEM Leaders. This table shows a breakdown for each of the three feeder systems engaged in transformation to STEM education in Columbus City Schools.

APPENDIX B:

Knowledge Capture Research Documents

Knowledge Capture Sample Interview Questions
Knowledge Capture Sample Focus Group Questions
CCS STEM Coordinator Survey Questions
CCS STEM Coordinator Survey Report

APPENDIX B: Knowledge Capture Sample Interview Questions

1. How long have you been principal at your school?
    a. How many teachers are in your school?
    b. Have all the teachers in your school participated in the STEM/PBL PD?
    c. How many teachers do you anticipate potentially leaving this spring (2013)?
    d.
2. Tell us briefly if there were any preparations or actions were implemented to support the shift to STEM education at your school.
    a. If there were actions taken, what did you perceive your role to be in that process?

3. When did your school initiate teacher PD in STEM transdisciplinary problem based learning [TPBL]?
    a. In your view, what are the essential steps that have been taken to support the transition to STEM/TPBL?
    b. What is the role of the principals?
    c. What is the role of the teachers [e.g. did your school establish a STEM coordinator or Lead STEM Teacher]?
    d. What is the role of the parents?
    e. Are there others who are playing a role from within the district/outside the district or from the community?

4. In addition to the days of professional development required annually for Columbus City School teachers, were there other types of professional development offered to your teachers during the school year to support STEM/TPBL?
    a. In your view, what is the ideal type of PD that would best suit your teachers and fit well with the way your teachers have approached PD in the past?
    b. How often have your teachers had STEM/TPBL PD?
    c. In your view what are the main changes you have observed that you would characterize as “milestones” in the transition to STEM/TPBL as a result of the ongoing PD?

5. Did you implement any changes in the way you interact with the teachers, parents or others involved with STEM/TPBL over the course of the year?

6. What challenges did you anticipate would occur during the 2012-13 school year?
    a. Were you able to address those challenges?
    b. If yes, how? If no, please describe the situation and what you think could help support a good solution?

7. Do you plan to change any part of the way in which the transition to STEM/TPBL is supported in the coming year (2013-14)?

8. Has there been any outreach to the parents about the transition to STEM/TPBL at your school?
    a. If so, has there been any response from parents, residents, or others in the community? If so, what was their response?
    b. Were there meetings or community outreach conducted during the school year?
    c. If not, do you have plans to conduct outreach prior to, or during the 2013-14 school year?

APPENDIX B: Knowledge Capture Sample Focus Group Questions

1. How long have you been a teacher at your school?
    a. What do you teach?
    b. How many teachers do you work with?

2. Do you work in a grade level cohort?
    a. Do you work with a curriculum specialist, and if so, how often?
    b. Who else do you work with during the school year?
    c. Have you had the opportunity to work with teachers from other schools in your feeder system?
    d. Have you had the opportunity to work with teachers from other schools in other feeder systems?

3. When did you first learn that your school was going to shift to STEM education and transdisciplinary problem based learning (TPBL)?
    a. Had you been introduced in the past to TPBL in your training and experience as a teacher, or is this a completely new concept for you?
    b. In your understanding of STEM TPBL, what are the essential changes that you think are important goals for student engagement in learning?

4. Beginning with the 2012 school year, your district initiated training in TPBL in your school. In your view, what are the essential steps that need to be taken to support a successful transition to STEM TPBL?
    a. What is the role of the teachers?
    b. What is the role of the principal?
    c. What is the role of parents?
    d. Are there others who need to play a role?

5. Have there been any changes in the way you work with other teachers?
    a. How do you communicate within your team about STEM TPBL planning and implementation?
    b. Is there communication about STEM and TPBL outside the team, for example, is there discussion of STEM TPBL in your staff meetings? At other times?

6. Did you experience any challenges during the year and if so, how did you address those challenges?

7. In your view, are there particular things that are important for the successful transition to STEM?
    a. Leadership?
    b. Good communication?
    c. Effective team collaboration?
    d. Increased parental involvement in the classroom?
    e. Building partnerships in the community to support the school and student projects (provide resources, supplies, other)?
    f. Other?

PAST InnovationLab
access through education

CCS STEM Coordinator Survey

* 1. **This is an anonymous survey. The PAST Foundation uses survey data to assess professional development needs in the transition to STEM TPBL education. Completing this survey will give you the opportunity to share your insights and concerns anonymously.**

Your participation in this research is voluntary. You may choose not to participate. By checking the response below that states you agree to participate in this survey, you confirm that you have read and understand the PAST Foundation Consent to Participate in Research provided for your review prior to taking this survey.

- ❍ I agree to participate in this anonymous survey

2. **How long have you been an educator?**
- ❍ Student teacher
- ❍ Less than 1 year
- ❍ 1 to 5 years
- ❍ 6 to 10 years
- ❍ 11-15 years
- ❍ 16-20 years
- ❍ More than 20 years
- ❍ If other, please describe

____

3. **How long have you been a STEM TPBL educator?**
- ❍ Less than 1 year
- ❍ 1 to 2 years
- ❍ 3 to 4 years
- ❍ 5 to 6 years
- ❍ 6 to 10 years
- ❍ More than 10 years
- ❍ If other, please describe

____

4. **How effective are the following methods of communication with staff *in your building* for sharing the ideas and information you bring back from the monthly STEM Coordinator meetings. Please note that you may assign the same rating to different ways of communicating.**

	Most effective	Somewhat effective	Less effective	Not effective	Not available or not applicable
Email	❍	❍	❍	❍	❍
Telephone	❍	❍	❍	❍	❍
Paper handouts	❍	❍	❍	❍	❍
Facebook, twitter					

or other social media	❍	❍	❍	❍	❍
Texting	❍	❍	❍	❍	❍
Basecamp	❍	❍	❍	❍	❍
In-person [informal]	❍	❍	❍	❍	❍
Staff meetings	❍	❍	❍	❍	❍
Common Planning Time	❍	❍	❍	❍	❍

5. **Have you communicated with other CCS STEM Coordinators this year outside the monthly meetings with the PAST Foundation?**

❍ Yes ❍ No

6. **If the answer to question 5 was "yes," please rate the effectiveness of the following methods for communicating with other CCS STEM Coordinators. Please note that you may assign the same rating to different ways of communicating.**

	Most effective	Somewhat effective	Less effective	Not effective	Not available or not applicable
Email	❍	❍	❍	❍	❍
Telephone	❍	❍	❍	❍	❍
Facebook, twitter or other social media	❍	❍	❍	❍	❍
Texting	❍	❍	❍	❍	❍
Basecamp	❍	❍	❍	❍	❍
In-person [informal]	❍	❍	❍	❍	❍

7. **What are the top three things teachers *in your building* ask you about to improve their TPBL skills to be more effective in the classroom (please describe each in 1 to 5 sentences)?**

1 ______________________________

2 ______________________________

3 ______________________________

8. **How would you describe the level of involvement in STEM TPBL *in your building*?**

❍ Extremely involved
❍ Mostly involved
❍ Somewhat involved
❍ Very little involvement
❍ No involvement
❍ If other, please describe

____

9. **How would you describe the level of curriculum integration with STEM TPBL *in your building*?**

❍ Extremely integrated
❍ Mostly integrated
❍ Somewhat integrated
❍ Very little integration
❍ No integration
❍ If other, please describe

____

10. **Please describe your top three achievements as a STEM Coordinator *in your building* this year (please describe each in 1 to 5 sentences).**

    1 _______________________________________

    2 _______________________________________

    3 _______________________________________

11. **Please describe the top three challenges you have experienced in working with teachers and others in your building in making the shift to STEM TPBL this year (please describe each in 1 to 5 sentences).**

    1 _______________________________________

    2 _______________________________________

    3 _______________________________________

12. **Please describe up to three areas where you feel you need additional support in your role as STEM Coordinator (please describe each in 1 to 5 sentences).**

    1 _______________________________________

    2 _______________________________________

    3 _______________________________________

13. **Are there any additional factors you feel are important for successful STEM TPBL implementation *at your school*? If so, please list below.**

    ____

    ____

    ____

    ____

14. **Would you be likely to take online classes to further your TPBL knowledge base?**

    ❍ Yes ❍ No

    Additional Comments

    ____

Knowledge Capture

Columbus City Schools and its transformation to STEM has been a subject of national interest and anthropological study since 2010. The only school district in the nation to attempt to flip or transform whole feeder systems simultaneously, CCS provides the nation with an important insight into the process, momentum, and constraints facing urban schools across the nation. Each year the PAST Knowledge Capture team of anthropologists has observed and documented the changing face of STEM in CCS and its STEM feeder systems. The first section in this report documents the voice and views of the STEM Coordinators from the 2013/2014, academic year.

In 2013, PAST published the first Roadmap in a series of case studies chronicling and analyzing an urban system's vision, planning and implementation of transformative education. This year we present the second publication in the Roadmap series that is focused on the role of leadership and draws from four years of ongoing ethnographic study.

ANALYSIS: COLUMBUS CITY SCHOOLS (CCS) STEM COORDINATOR SURVEY, SPRING 2014

Overview

An online survey was conducted with Columbus City School STEM Coordinators from Linden Feeder System (LFS), West Feeder System (WFS) and Africentric Feeder System (AFS) in Spring 2014. The survey was launched on March 19th 2014 and administered via Survey Methods© to STEM Coordinators during the final STEM Coordinator professional development session on March 21st at the PAST Foundation. Of the STEM Coordinators 24/25 participated in the survey. These 24 represented 13 different preK-12 Columbus City Schools. The survey was administered through an online link available on desktop and laptop computers provided by the PAST Foundation.

The survey design was initially developed using data gathered in prior KC focus groups, surveys and interviews conducted from 2010 to the present with preK-12 educators. Earlier versions of the CCS STEM Coordinator survey were circulated among PAST Foundation Professional Development (PD) STEM Coordinators and staff, providing input to the final survey design. The final survey consists of (14) questions (see Appendix A). Note that Question 1 required mandatory confirmation of review of informed consent protocols. Participants could not proceed with completing the survey until affirming consent in response to this question.

The following survey analysis is organized into three groups:

GROUP 1: Questions 2, 3, 5, 8, and 9 are presented in bar chart format. These questions address teaching experience, collaboration, as well as building-wide STEM involvement and integration.

GROUP 2: Questions 4, and 6 are presented as grouped bar charts. These questions address communication issues. Each method of communication (Email, telephone, etc.) was grouped together, and each 'rating' (most effective, somewhat effective, etc.) was given its own column within that group. In this approach we are able to quantify effective methods of communication for teachers.

GROUP 3: Questions 7 (top priorities), 10 (top achievements), 11 (top challenges), 12 (areas for additional support), and 13 (additional factors important for STEM TPBL implementation) were exported to Excel and analyzed by KC research staff. The survey questions for this set are in an open-ended extended response format; questions 7, 10, 11 and 12 allow the respondent to write three statements per question. The data is organized into thematic table presentations. Each table has a column that indicates the number of teachers who included that particular theme in their response. In this way, we can quantify the relative importance of certain themes by the number of teachers who included it their survey responses

CCS STEM COORDINATOR SURVEY BP REPORT

Q1: Participant confirmation and agreement on informed consent protocols regarding confidentiality.

Q2: How long have you been an educator?

- Only one STEM Coordinator has been an educator for less than one year (1/24)
- Four respondents have 1-5 years of experience (4/24)
- CCS STEM Coordinators are predominantly more experienced teachers, with 19/24 having anywhere from 6 years to more than 20 years of teaching experience
  - 6-10 years (6/24)
  - 11-15 years (4/24)
  - 16-20 years (5/24)
  - More than 20 years (4/24)

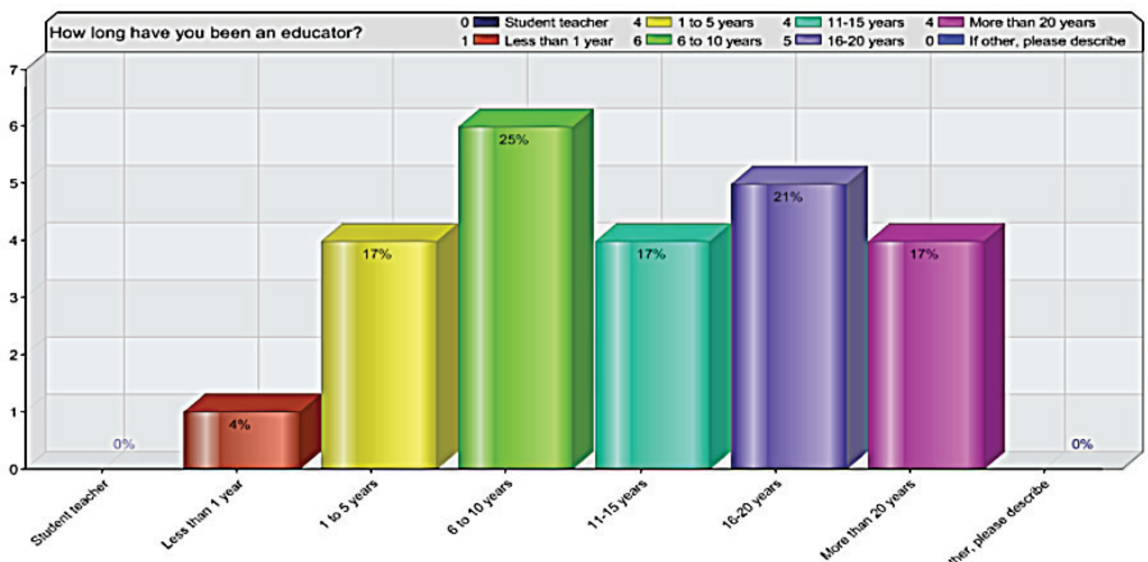

Chart 1: Q2: How Long Have You Been An Educator?

Q3: How long have you been a STEM TPBL educator?

- Only one STEM Coordinator has been a STEM TPBL educator for less than 1 year (1/24
- Most respondents have been STEM TPBL educators for 1-2 years (15/24)
- Two respondents have 3-4 years experience as STEM TPBL educators (2/24), 2 have 5-6 years (2/24), and 1 has been a STEM educator for 6-10 years (1/24)

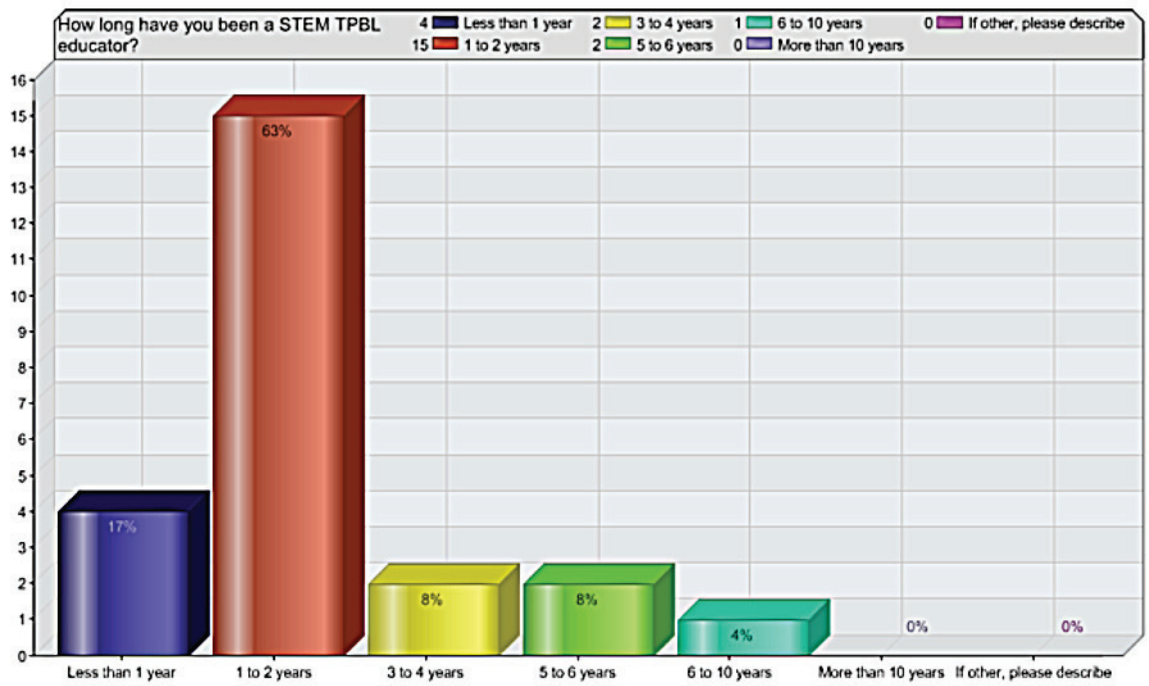

Chart 2: Q3: How Long Have You Been A STEM TPBL Educator?

Q4: How effective are the following methods of communication with staff in your building for sharing the ideas and information you bring back from the monthly STEM Coordinator meetings.

- Staff Meetings were found to be the most effective method of communicating with staff in the building with 13 citations of "most effective" and 11 rating it "somewhat effective" [n=24]
- Facebook, twitter or other social media were seen as the "least effective method" of communicating with staff with a single rating of "somewhat effective "(1/24), 6 responses of "less effective" (6/24), 5 of "not effective" (5/24), and half responding "not applicable or not available" (12/2)

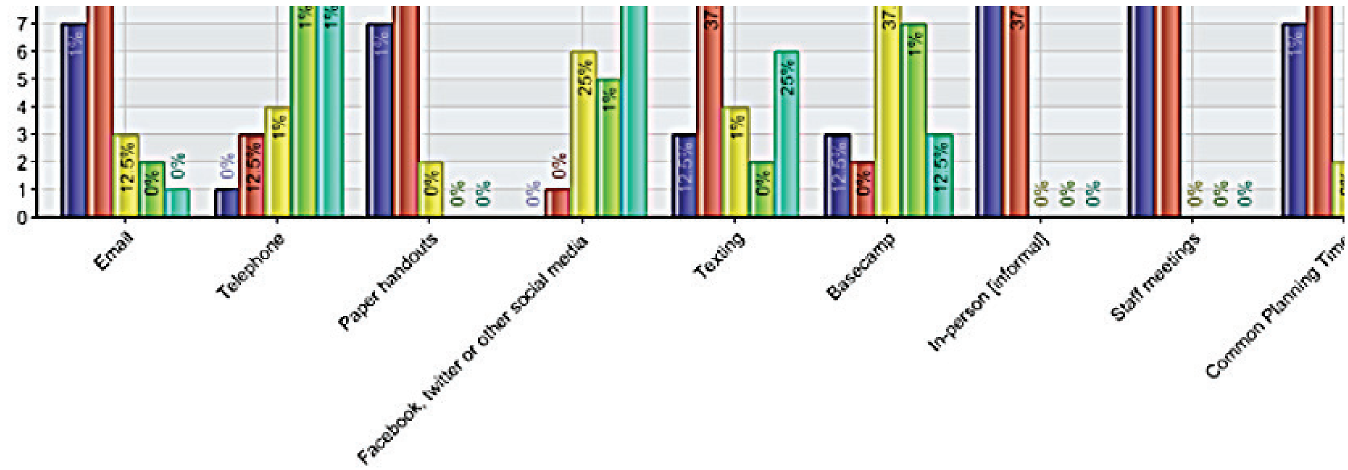

Chart 3: Q4: How effective are the following methods of communication with staff in your building for sharing the ideas and information you bring back from the monthly STEM Coordinator meetings?

Q5: Have you communicated with other CCS STEM Coordinators this year outside the monthly meetings with the PAST Foundation?

- More than half of the STEM Coordinators have communicated with other STEM Leaders in CCS outside of monthly meetings (15/24)
- 9/24 respondents have not communicated other STEM Coordinators

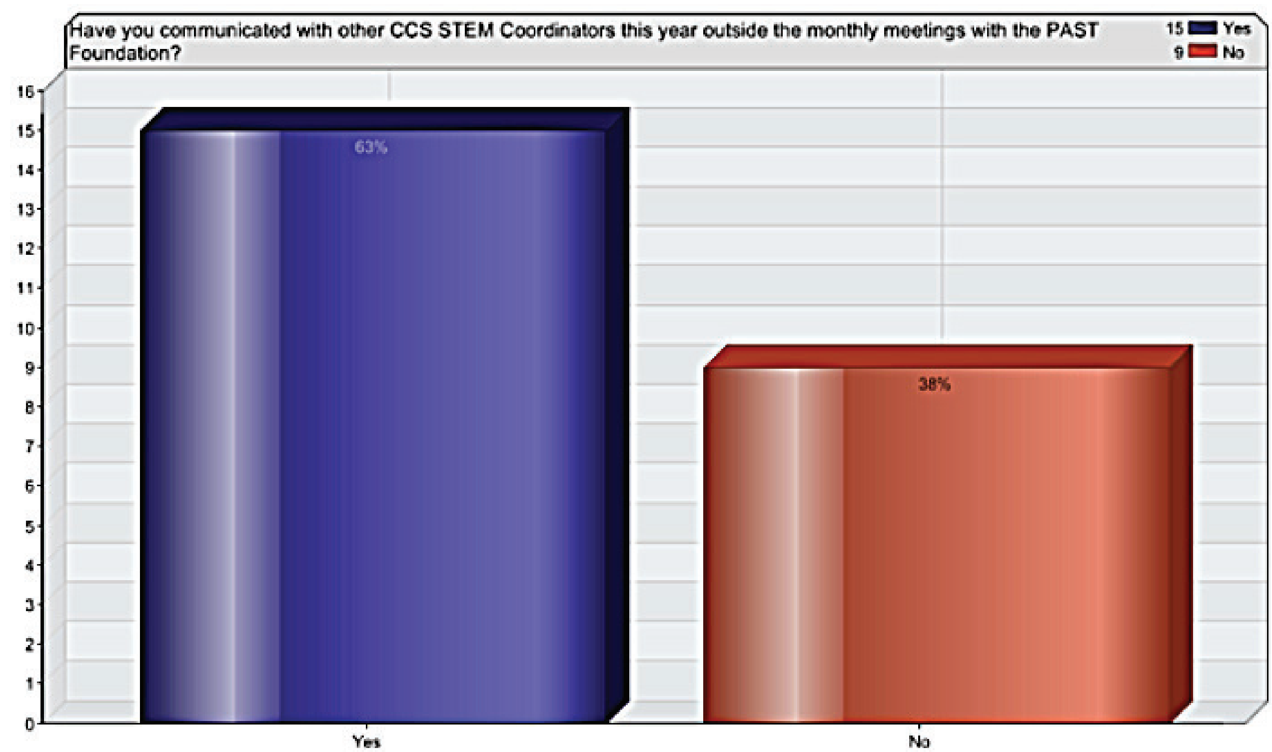

Chart 4: Q5: Have you communicated with other CCS STEM Coordinators this year outside the monthly meetings with the PAST Foundation?

Q6: If the answer to question 5 was 'yes' please rate the effectiveness of the following methods for communicating with other CCS STEM Coordinators.

- » The majority of STEM Coordinators (13/16*) responded that in-person was the "most effective" means of communicating with other CCS STEM coordinators, with 3 rating in-person as "somewhat effective"
- » Facebook, twitter, or social media was "not available or not applicable" to many STEM Coordinators (10/16*)

[Note: One teacher who did not answer question 5 responded to question 6]

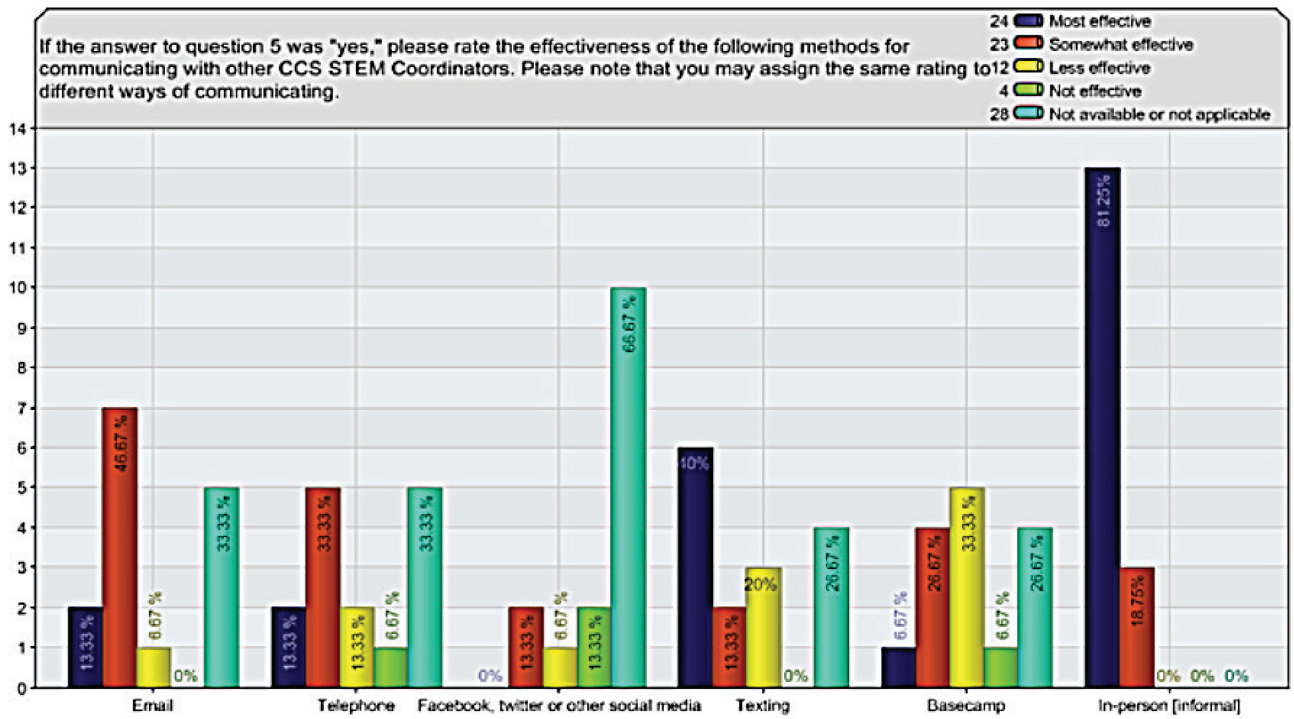

Chart 5: Q6: If the answer to question 5 was 'yes' please rate the effectiveness of the following methods for communicating with other CCS STEM Coordinators.

Q7: What are the top three things teachers in your building ask you about to improve their TPBL skills to be more effective in the classroom?

Top Three Skills	Number of Teachers
Themes	**(n=24)**
Developing project ideas	11
Time management	6
Integrating standards	5
Obtaining supplies	5
Project logistics	3
Project implementation	3
Student engagement	2
Classroom management	2
Planning time	2
Staff buy-in	2
Using available technology	2
Teacher collaboration	2
Best practices	2
Working across curriculum	2
Working with the design cycle	2
Additional PD	1
Understanding STEM/TPBL	1
Project/problem development	1
Developing rubrics	1
Supporting students	1
Creating projects to engage parents	1
Instructional delivery	1
Processing skills	1
Administrative support	1

Chart 6: Q7: What are the top three things teachers in your building ask you about to improve their TPBL skills to be more effective in the classroom?

Q8: How would you describe the level of involvement in STEM TPBL in your building?

- 6/14 STEM Coordinators described themselves as "mostly involved," while the majority of teachers (14/24) described their involvement as "somewhat involved"
- 4/24 cited "very little involvement"

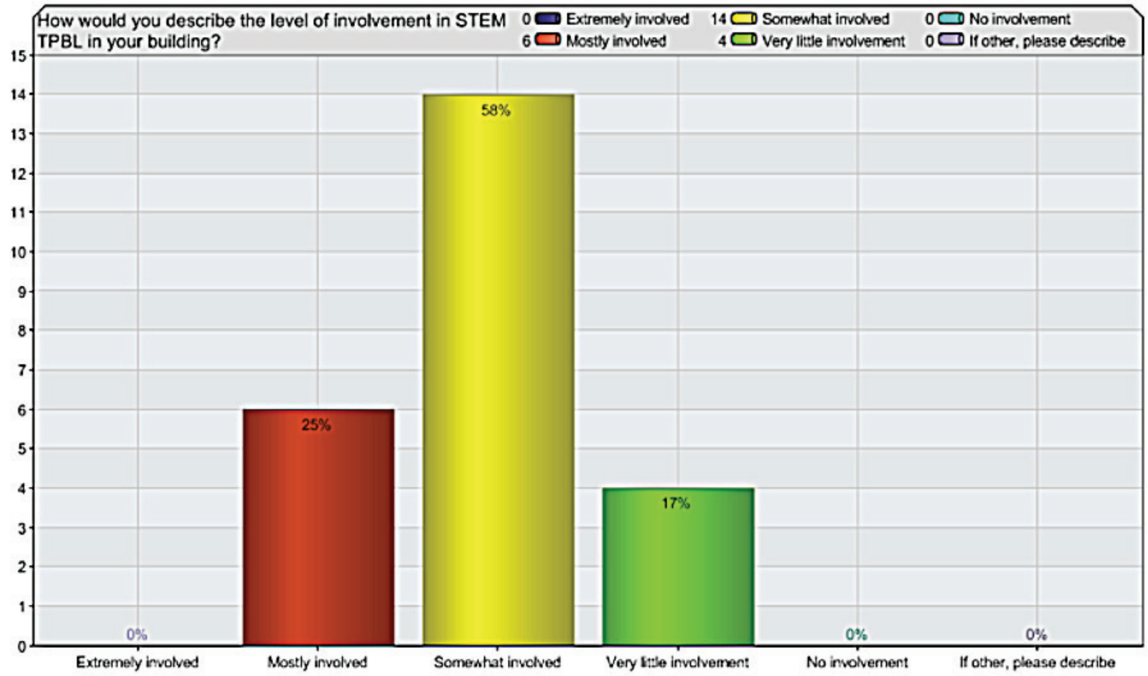

Chart 7: Q8: How would you describe the level of involvement in STEM TPBL in your building?

Q9: How would you describe the level of STEM TPBL curriculum integration in your building?

- The majority of STEM Coordinators found their buildings to be "somewhat integrated" (14/24) with one third reporting "very little integration" (8/24), and only two responding "mostly integrated" (2/24)

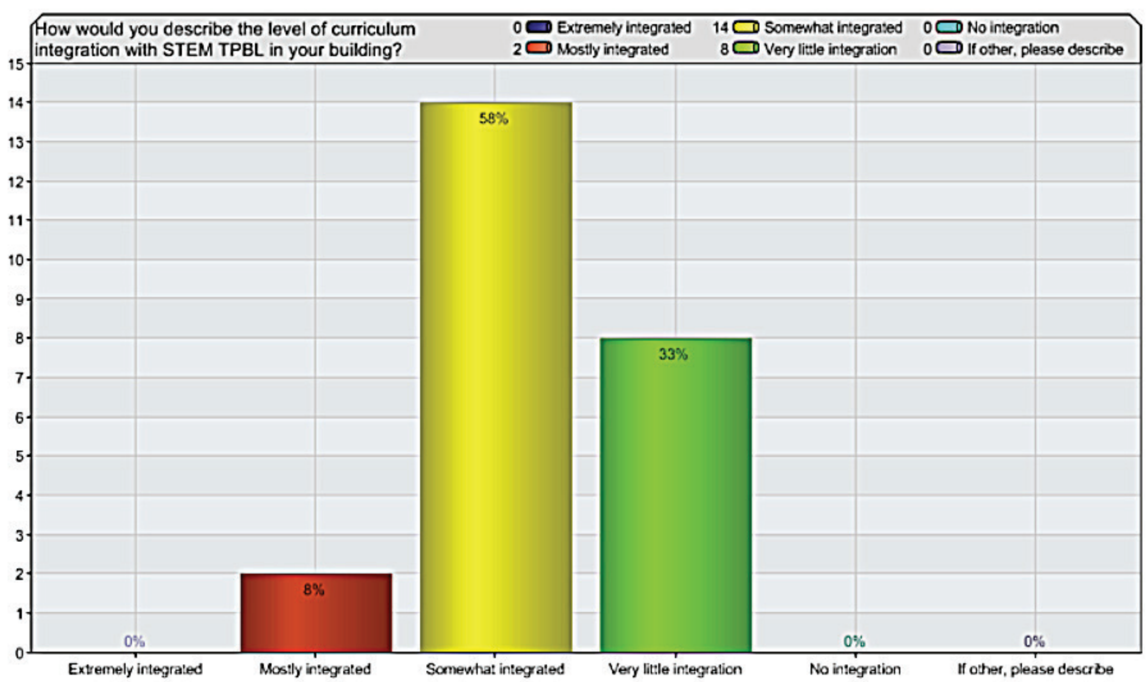

Chart 8: Q9: How would you describe the level of curriculum integration with STEM TBL in your building?

Q10: Please describe your top three achievements as a STEM Coordinator in your building this year.

Top Three Achievements	Number of Teachers
Themes	(n=24)
Providing project ideas	8
Creating specific STEM projects	5
Effective communication	5
Modeling STEM/TPBL	4
Teacher collaboration	4
Fostering student engagement	4
Sharing resources	3
Planning/hosting a STEM event	3
Fostering understanding and use of STEM/TPBL	3
Building/establishing partnerships	3
Creating a STEM space	2
Developing STEM mini-challenges	2
Displaying student work	2
Outdoor learning	2
Providing teacher support	2
Creating take home projects to engage parents	2
Professional development	1
Common planning time	1
Working with the design cycle	1
Developing STEM theme for the school	1
Engaging each grade level	1
Fostering teacher buy-in	1
Integrating standards	1
Making STEM/TPBL a priority	1
Trying new practices	1
Increasing relevance and rigor building wide	1

Chart 9: Q10: Please describe your top three achievements as a STEM Coordinator in your building this year.

Q12: Please describe up to three areas where you feel you need additional support in your role as STEM Coordinator.

Three Areas of Additional Support	Number of Teachers
Themes	(n=24)
Time to work with staff	9
Resources	6
Project ideas	5
Implementation strategies	4
Additional PD	3
Teacher buy-in	4
Planning time	3
Lack of understanding of STEM	2
Time management	1
Packed project ideas	1
Low student skills	1
Student buy-in	1
Teacher collaboration	1
Space	1
Developing partnerships	1
Meeting with other STEM schools	1
Seeing examples	1
Competing initiatives	1
Lack of administrative support	1
Creating online interactive student activities	1
Staff buy-in	1
Using assessment data to address student needs	1

Chart 11: Q12: Please describe up to three areas where you feel you need additional support in your role as STEM Coordinator.

Q13: Are there any additional factors you feel are important for successful STEM TPBL implementation at your school?

Additional Factors Important for Success	Number of Teachers
Themes	(n=24)
Fostering teacher buy-in	2
Finding time to work with staff	2
Full staff and administrative buy-in	2
Assistance implementing STEM	2
Competing initiatives	2
Developing STEM Coordinator leadership skills	1
Teacher understands STEM as a method	1
Integrating standards	1
Finding resources and funding	1
Utilizing STEM to incorporate basic reading skills	1
Administrative support	1
Additional and continuous PD	1

Chart 12: Q13: Are there any additional factors you feel are important for successful STEM TPBL implementation at your school?

Q14: Would you be liked to take online classes to further your TPBL knowledge base?

- This question was split evenly between yes and no.
  - 12/24 yes
  - 12/24 no

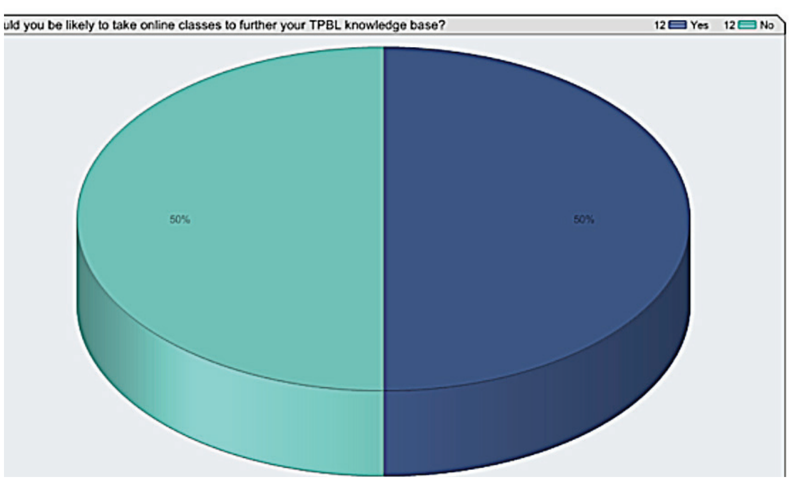

Chart 13: Q14: Would you be liked to take online classes to further your TPBL knowledge base?