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INVESTIGATING STEAM:

A STUDY OF FIRST YEAR MIDDLE SCHOOL CURRICULUM IMPLEMENTATION



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Project Overview

This project was a one-year investigation of the implementation of the STEAM (Science, Technology, Engineering, Arts, and Mathematics) Initiative in the Metro Nashville Public School System. Interviews with STEAM teachers, principals, and district personnel, as well as a comprehensive review of STEAM documentation, were conducted to determine the following: (a) how the initiative unfolded across the district during the 2017-18 school year; (b) how Instructional Leadership, Professional Development, School Culture and Climate, and Organizational Capacity influenced the STEAM implementation; and (c) how the implementation was perceived by teachers, principals, and district personnel. This report nests our findings within the extant research on STEAM and the relevant scholarly work on new program implementation. This report indicates that the most positive perceptions of the STEAM Initiative stemmed from the one-on-one instructional support provided by the Discovery Education consultants. Teachers and principals noted that the STEAM initiative and student learning benefitted from the district's instructional framework focused on creativity, collaboration, critical thinking, and communication. The report suggests that the initiative was weakened by a lack of vision, unspecified goals, and a lack of measurable benchmarks. Recommendations to the district include early collaboration with teachers and principals to establish the foundation for STEAM implementation, communication of a clear vision, the development of shared goals, measurable outcomes, team-based learning, and targeted support for the specific needs of students and teachers while focusing on academic growth and student care.

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I. Executive Summary

Metro Nashville Public Schools (MNPS) in Tennessee is experiencing a decrease in student enrollment just before middle school with a corresponding increase in charter school and private school enrollment. The district has determined this decrease reflects the community's perception that the public schools are not adequately preparing their children for college and careers. The decrease of student enrollment is increasingly concerning because it is linked to decreased racial and socioeconomic diversity in MNPS and potential negative impact on student achievement. Concerned with middle school enrollment, rigor, and achievement, MNPS partnered with Discovery Education to implement a STEAM (Science, Technology, Engineering, Arts, and Mathematics) initiative in 18 middle schools across the district during the 2017-2018 school year. After the implementation year, and in order to reflect strategically on the STEAM Initiative, MNPS partnered with Vanderbilt University/Peabody College doctoral students to address the following project questions:

1. How did the implementation of the STEAM Initiative unfold across the district?
2. How did Instructional Leadership, Professional Development, School Culture and Climate, and Organizational Capacity influence the implementation of the STEAM Initiative?
3. How did teachers and stakeholders perceive the STEAM Initiative?

Our report addresses the project questions by focusing qualitatively on the perceptions of teachers and principals in nine of the 18 middle schools that implemented the STEAM Initiative in 2017-18, as well as on the perceptions of district STEAM personnel. Additionally, the analysis incorporates pre-implementation survey data, state-reported achievement and demographic data, and the websites and media releases of MNPS and its STEAM partners. The findings in this report are intended to aid the district's decision making as it considers whether or not to support and expand the STEAM initiative, moving forward.

A. Key Findings

1. How did the implementation of the STEAM Initiative unfold across the district?

Implementation: The initiative was perceived to have unfolded haphazardly and to have lacked goals, objectives, and measurable outcomes. With three different STEAM directors in the first year of implementation, teachers, principals, and district personnel were generally confused about the initiative's intent from its introduction on July 31, 2017 and throughout the 2017-2018 academic year. Teachers were particularly unclear about how to incorporate STEAM into courses, such as English Language Arts and Social Studies.

2. How did Instructional Leadership, Professional Development, School Culture and Climate, and Organizational Capacity influence the implementation of the STEAM Initiative?

- a. **Instructional Leadership: Discovery Education's one-on-one consultants provided the most instructional leadership.** As a major component of the STEAM Initiative, MNPS partnered with Discovery Education to provide consulting services as teachers and administrators grappled with what it meant to be a STEAM school. Each STEAM school received its own Discovery consultant and each consultant provided one-on-one

instructional support for teachers. STEAM teachers pointed to this relationship as the most prominent form of instructional leadership for the duration of the initiative.

- b. **Professional Development:** Although interested in learning about Discovery Education’s online resources, Professional Development left teachers dissatisfied with STEAM strategies and discontented with the STEAM Initiative all together. The greatest difficulty in creating buy-in for the STEAM professional development was the lack of pre-planning. Teachers were surprised in August 2017 to find themselves selected to participate in the STEAM Initiative and disappointed to find the first professional development day widely inapplicable to their content and context. Professional development days were negatively perceived despite the effort over the course of Phase One to improve them.
- c. **School Culture and Climate:** Schools, like families and communities, are unique—but all are perfect for STEAM. Every STEAM school interviewed seemed to have a unique culture and climate. Instead of all the STEAM schools becoming more like each other as they adopted STEAM strategies, technologies, and philosophy, it was evident they all incorporated STEAM to fit their existing school cultures. Similarly, teachers and principals from every school interviewed, regardless of type, size, or achievement scores, reported that STEAM was a natural fit for their school.
- d. **Organizational Capacity:** The STEAM concept was valued, but its implementation lacked planning and resources. MNPS STEAM participants acknowledged the need to increase 21st century skills—critical thinking and problem solving in middle school classrooms. Although they believed in teaching these skills, participants were confused about how to implement STEAM with neither clear outcomes nor adequate resources.

3. How did teachers and stakeholders perceive the STEAM Initiative?

- a. **Teacher Perceptions:** Although STEAM was poorly implemented, every school found a path to becoming STEAMier. Teachers valued the concept of STEAM and enjoyed collaborating with the Discovery Education consultants, who supported the STEAM implementation in their classrooms. At the same time, teachers experienced difficulties with the professional development days and struggled to understand how to implement the initiative or where to find the resources to accomplish that goal. When comparing clusters of teachers, those who had higher student achievement and a community or academic partnership perceived STEAM more favorably.
- b. **Stakeholder Perceptions:** When comparing the perspectives of the three stakeholder groups—teachers, principals, and district personnel –teachers and principals had similar perceptions and noted greater progression in STEAM than district personnel perceived. Most teachers and principals perceived growth in STEAM-related activities throughout the district, unique to each of their schools. Several district personnel noted little faith in the general understanding of the initiative, its impact, and the district’s capacity to build up STEAM stakeholder capacity.

B. Recommendations

Recommendation 1: Collaborate early with teachers and principals in pre-planning activities to establish the foundation for STEAM implementation; communicate a clear vision of how the STEAM initiative fits with district goals and classroom-level instruction. We found strong support among participants that STEAM was needed in schools; at the same time, teachers struggled to adapt STEAM to their own classrooms. A clear vision, overarching district goals, and clearer strategies for various types of classroom implementation will support future STEAM success.

Recommendation 2: Strengthen organizational capacity and mission clarity through the development of shared goals, measurable outcomes, and team-based learning. Teachers and principals in MNPS middle schools have embraced the vision of the 4Cs (creativity, collaboration, critical thinking, and communication) and will benefit from the development of clear STEAM goals and objectives.

Recommendation 3: Target support to the specific needs of students and teachers, while focusing on academic growth and student care. Even the most promising strategies must be adapted for specific content and context. Teachers would benefit from working with grade-level or content-level teams to apply STEAM to their own classrooms.

II. The STEAM Movement

In the latter half of the 20th century, as the U.S. grew into one of the world's two great superpowers, the government's focus increasingly widened from the national to the international. Emphasis shifted to assuring our security and our economic and political competitiveness on the world stage. The Soviet Union's space launch of the Sputnik satellite in 1957 triggered a focus on science and engineering in education and an effort to regain technological superiority. Continuing to be spurred by a fear of global inadequacy, in 1984 the U.S. declared itself "A Nation at Risk", which confirmed and "signified a shift . . . toward the economic purpose of education" (Rosefsky, 2016, p.1; Coleman, 1988; Schultz, 1961). In 2002, national leaders made a commitment to "No Child Left Behind", and in 2009, a commitment to the "Race to the Top" (U.S. Department of Education, 2009) in which schools began bidding for competitively-dispersed federal funding by proving effectiveness and the ability to improve failing schools. American education was centered on economy, security, and global achievement.

For decades, to improve the national economy, increase innovation, and better prepare students for the perceived jobs of the future, American educational leaders and policy makers have attempted to infuse science, technology, engineering, and math (STEM) into K-12 curriculum (US Department of Education, 2015; U.S. Department of Education, 2018). Recently, however, some educators have noted that STEM-based teaching has been too narrowly focused, leaving out an important component of education: Art. The added "A" from STEM to STEAM represents all the arts, along with design thinking and humanities, creating a more balanced approach which emphasizes transdisciplinary teaching, critical thinking, and real-world problem solving (Quigley & Herro, 2016). The goal of this approach is "to prepare students to solve the world's pressing issues through innovation, creativity, critical thinking, effective communication, collaboration, and ultimately new knowledge" (p. 410).

Nashville News Channel 5, reporting from the Nashville Adventure Science Center where MNPS announced the launch of their STEAM initiative, informed the public of the STEAM plan: "With industries like technology and engineering growing rapidly, Metro Nashville Public Schools wants students to be prepared." Holding tight to the promise of STEAM, Metro Nashville district leaders, like educational leaders and policy makers across the United States, were attracted to STEAM Initiatives in their own schools or school districts. Kris Elliott, MNPS' first STEAM director, shared the STEAM dream with area reporters: "We're hoping to prepare students to be better adults, so if we think about our jobs as adults, we very rarely if ever say, 'I'm going to sit down for the next 10 minutes and only do math,' or the next 20 minutes and say, 'I'm only going to be doing art. Those things in our lives are integrated all the time, so when we think about ways to engage students in the classroom, we have to teach in the same way as students will interact as adults" (as cited by Denson, 2017). Although STEAM Initiatives are relatively new and limited research has been done to determine under what circumstances they could be effective, MNPS was confident in STEAM: "There is no better place for this to happen than in Nashville—where technology, the arts, and science blend together to create a vibrant and thriving economy. And now the middle school classroom will reflect that environment" (MNPS STEAM, 2017). Middle schools were selected for the STEAM Initiative, according to a district administrator, "to raise

the rigor and engagement for middle schoolers.” This administrator also noted that “the district had spent a decade redesigning high schools and years impacting reading at the elementary level, but there was no focus on middle schools. [The] middle schools needed something.” That “something” was the STEAM Initiative, and throughout the United States, STEAM offers hope for both the rigor and the relevance that schools and districts seek.

Because of the ever-increasing demands for greater American academic achievement, new strategies for increasing rigor and relevance in schools continue to emerge and school implementation strategies abound in the extant literature. Researchers cite four lenses through which to view the implementation of new initiatives in schools: Instructional Leadership (Murphy & Torre, 2014), Professional Development (Papay & Laski, 2018), School Culture and Climate (Murphy, 2013), and Organizational Capacity (Senge, 2006; Malen, Rice, & Matlach, 2015).

This study examined the planning and implementation of the MNPS STEAM Initiative using these lenses; we investigated three specific project questions:

- 1. How did the implementation of the STEAM Initiative unfold across the district?**
- 2. How did Instructional Leadership, Professional Development, School Culture and Climate, and Organizational Capacity influence the implementation of the STEAM Initiative?**
- 3. How did teachers and stakeholders perceive the STEAM Initiative?**

To investigate the implementation of STEAM in the Metro Nashville Schools, it was necessary to understand the context of education in the district and the STEAM implementation plan, specifically (Section III). Qualitative data were gathered through interviews with 26 STEAM teachers, 7 principals, 2 assistant principals, and 5 STEAM district personnel, as well as, a thorough review of public documents and review of documents acquired from MNPS. Details of the analysis process of the interview data, site visits, and documentation review are found in Appendix A. The completed color-coded master matrix of interview data is in Appendix B.

Teachers and principals selected for interviews met two criteria: they worked for MNPS and participated in the 2017-18 STEAM Initiative. Interviewed district personnel included past and present district-appointed STEAM instructional coaches, technology coaches, and past and present directors of the STEAM Initiative.

The interview protocols, shown in Appendices C through E, were developed using a framework provided by Meyers, Durlak, and Wandersman (2012). Meyers et.al. created their Quality Implementation Framework with 4 phases and 14 critical steps for implementing a new initiative, based on the analysis and synthesis of 27 published implementation frameworks intended for human service organization like schools and hospitals. The connections between the Meyer et.al. framework and the study’s interview questions are detailed in Appendix F.

In connecting the perceptions of the MNPS STEAM implementation with its documented planning, this study investigated the role and influence of Instructional Leadership, Professional Development, School Culture and Climate, and Organizational Capacity on the initiative.

Instructional Leadership questions probed schools' and the district's level of support and supervision, as well as investigating explicit buy-in. Instructional leadership was one of the four lenses in this study because researchers agree most consistently that the instructional leader sets the primary goals for new school initiatives (Robinson, Lloyd, & Rowe, 2008; Murphy & Torre, 2014; Marzano, Waters, & McNulty, 2005), and instructional leaders are expected to participate with teachers in planning, coordinating, and evaluating the teaching and curriculum (Stoll, Bolam, McMahon, Wallace, & Thomas, 2006; Robinson, et al, 2008; Murphy & Torre, 2014).

Professional Development (PD) questions asked about the initial preparation, participants' understanding of the implementation, and overall impact of the PD experience. Professional development was included because effective professional development will result in changes to teaching practice (Darling, Hyler, & Gardener, 2017; Hiebert & Morris, 2012; Kyndt, Gijbels, & Groseman, 2016). These changes are highly supported by offering teachers a sustained duration of professional development during which time they have the opportunity to try what they should teach their students, work in collaborative teams, reflect on their practices through mentoring and feedback, be supported by a healthy school culture, and acquire materials that can be shared and improved.

School Culture and Climate questions investigated the initiative's fit for individual schools, the adaptations in individual buildings, the perception of each school's buy-in, and the school-based support structures. School Culture and Climate was included in the interview protocol because many researchers present a structured vision and a culture of learning as the route to student growth and the ultimate measure of an initiative's success. Structured vision includes clear expectations and materials like long term funding, stable participation, and evaluative systems (Goh, Cousins, & Elliott, 2006; Malen, Rice, & Matlach, 2015; Murphy, 2013). A culture of learning ensures time, information, training, and technology to support teachers in developing shared goals for student learning, meaningful collaboration, and shared inquiry into problems (Malen, Rice, & Matlach, 2015; King & Bouchard, 2011).

Organizational Capacity questions explored the initiative's fit for the district, support structures and barriers, and initiative evaluations. Organizational Capacity is a valuable lens in this study because in school systems, organizational capacity offers clear, stable structures to develop the collective power of the entire faculty to strengthen student performance (King & Bouchard, 2011; Malen, et al, 2015; Goh, et al, 2006)

Closing questions asked about lessons learned and offered an opportunity for participants to share any other STEAM-related thoughts.

III. Metro Nashville Schools: Contextual Analysis

A. School District

Metro Nashville Public Schools (MNPS) is a large, urban, underachieving K-12 public school district in the southeastern United States, comprised of 163 schools, serving 85,500 students (Tennessee Report Card, 2018). The U.S. Census Bureau (2018) indicates that the school district covers approximately 505 sq. miles and serves a community of more than 700,000 people. Of the total population in metropolitan Davidson County, 21% are school-aged. Although the district's general population is 65% white and only 15% live in poverty, 65% of the students served by MNPS are students of color and 65% are eligible for free/reduced price meals (U.S. Census Bureau, 2018; TN Report Card, 2018).

Students' academic achievement is underperforming. In 2018, while the district had a 27.4% achievement success rate overall; the state's average success rate was 39.1%. Success was measured by the percentage of students who were on track or had mastered the expected content in core-subject, state-mandated exams (TN Report Card, 2018). The lowest achieving level of schools in MNPS were middle schools. As noted in Table 1, while the district and state were 22% and 33% successful in math respectively, the MNPS middle schools had only 18.75% of students on track or mastering state math expectations. Middle schools were also the lowest achievers in science: 33% of MNPS middle schoolers were on track for state science expectations, whereas the district achieved at 39% and the state at 55%.

Table 1 clearly shows that MNPS middle school achievement lagged behind the district achievement, which lagged behind the state. However, data in Table 1 do not show the quantity of middle schools below average nor the degree to which they fall below the average achievement of the state of Tennessee. In 2017, as the STEAM Initiative began, 27 of 33 MNPS middle schools had lower than state-average science scores and 29 of 33 had lower than state-average math scores (Table 2, Table 3). The lowest achieving school in math had only 5% of students meeting state expectations. In science, the lowest achieving school had 12% meeting expectations.

Table 1. Achievement Comparisons of MNPS Middle Schools to All MNPS Schools and the State

	Average % of Students succeeding in math	Average % of Students succeeding in science	Average of success overall
MNPS Middle Schools	18.75%	32.75%	25.75%
MNPS All Schools	21.90%	37.90%	27.40%
State	33.00%	54.80%	39.10%

(TN Report Card 2018 Data: Percentage on meeting or exceeding grade-level expectations)

The MNPS Director of Curriculum indicated that lower than average achievement in the district, and especially in the middle schools, has led to a loss in confidence among community members. Responding to district probes, MNPS families noted a poor perception of the middle school experience and expressed that MNPS middle schools were failing to adequately prepare their students for college or careers. The community response to district inquiries matched district-data that showed a reduction of student enrollment just before middle school.

Table 2. Percentage of MNPS Middle School Students Reaching State Expectations in Science

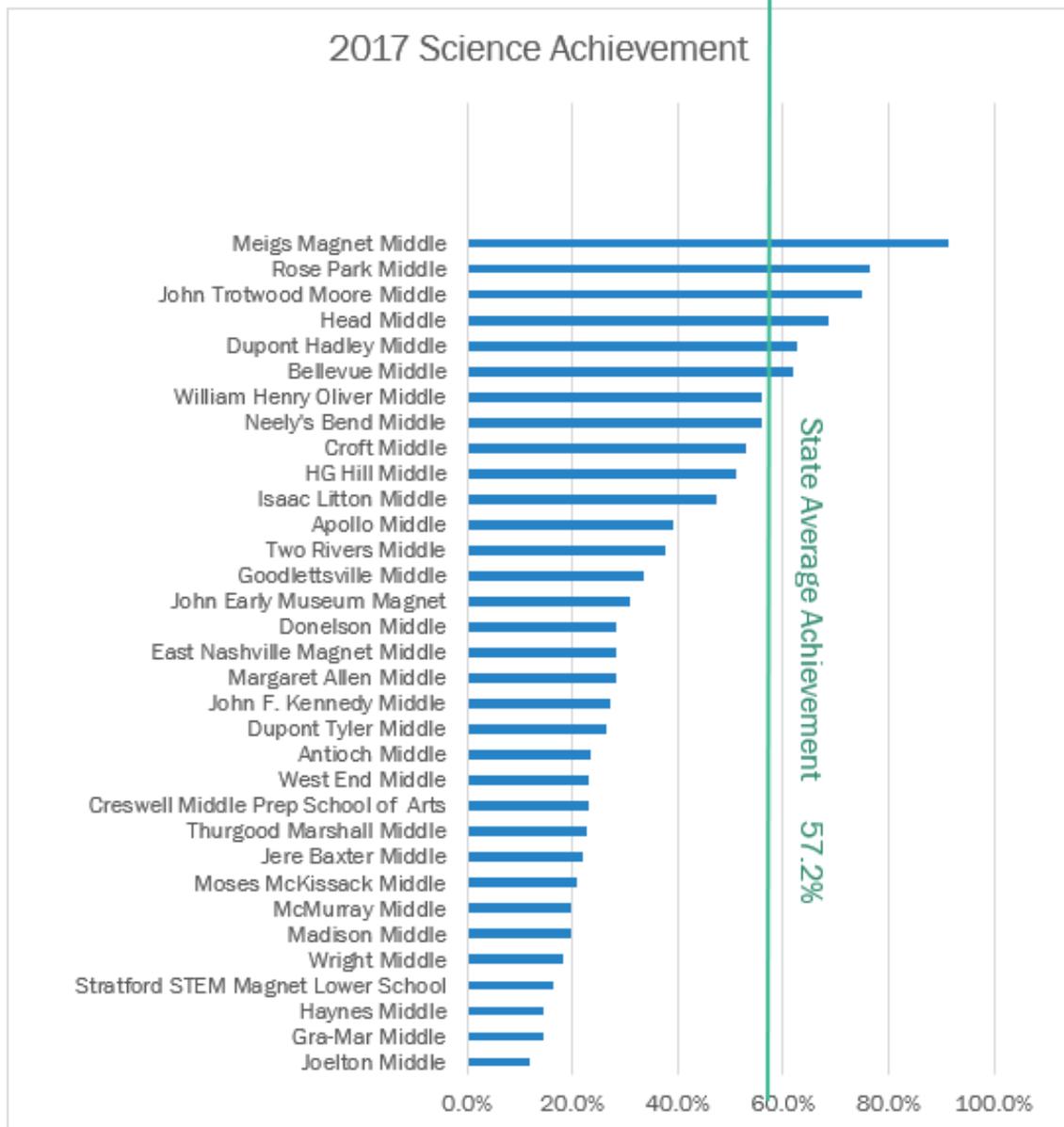
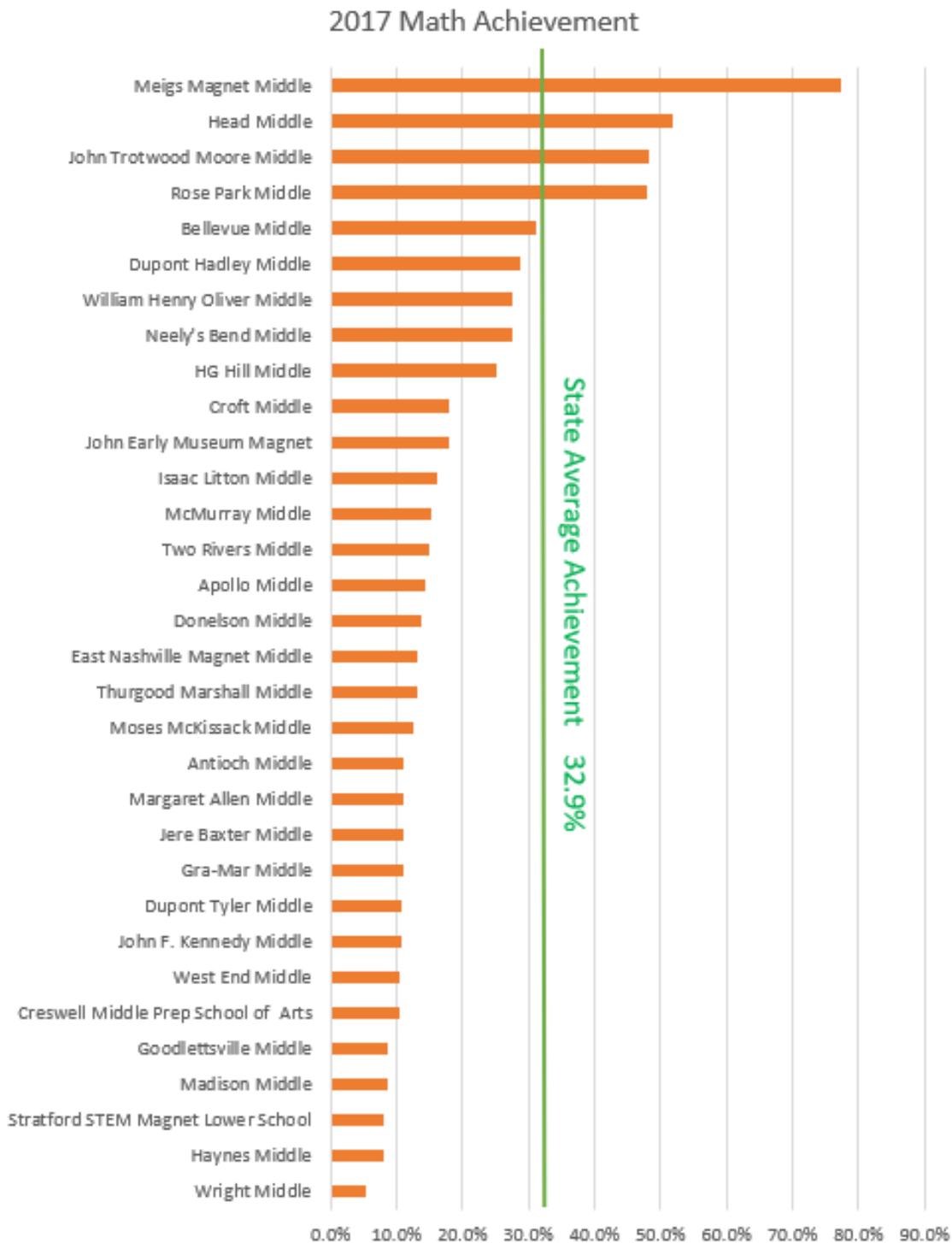


Table 3. Percentage of MNPS Middle School Students Reaching State Expectations in Math



District leaders felt it necessary to respond and intentionally sought ways to increase student achievement and develop a more positive community perception. This led to the STEAM Initiative. District administrators investigated the implementation of a STEAM Initiative. The district's STEAM goals were to: impact curriculum and instruction through project-based learning techniques, create interdisciplinary connections, emphasize the district's 4Cs (critical thinking, creativity, collaboration, and communication), integrate

technology, develop social-emotional learning strategies, and emphasize equity. To foster community partnerships and offer unique STEAM experiences, the plan called for project-based learning support, work-based learning, family nights, Saturday events, summer camps and other extracurricular activities. STEAM was supposed to shift the middle schools' culture in a positive direction. The STEAM plan included school-wide implementation of the Discovery Education curricula, increased interdisciplinary teacher collaboration, new honors courses, a refreshed growth mindset, and accessible and well-equipped STEAM physical space. Assessment was planned to ensure authentic performance-based assessments that applied to real-world situations, and based on those assessments, an enhanced ability to make data-driven decisions, which would inform the development of lesson plans for increased student learning. The STEAM resources, in the planning stages, included one computer for every two students, five district Learning Technology Specialists, three district-employed STEAM coaches, a STEAM advisory council, a STEAM A-team fostering community partnerships, and finally an online site providing curriculum materials (David Williams, personal communication, June 11, 2018).

Dedicated to the STEAM Initiative, new district positions were generated to include five Learning Technology Specialists, each to serve two to four schools, to lead the STEAM team, to coordinate professional development, and to collect data. Monthly professional development, initiated by the Technology Specialist, would be guided by his or her data collection, visits to classrooms, and through BrightBytes data-management system. Three district-employed STEAM instructional coaches were added for support as well.

To accomplish the district's STEAM goals, however, Metro Nashville also sought expert partners: the Buck Institute for Education, from which the 4Cs instructional framework was drawn (Figure 1); AdvancED, an organization offering STEM certification; SpringBoard, a College Board product offering honors level English reading and writing resources; and Microsoft's Imagine Academy, which had curricula and certifications needed for a tech-driven society. Its primary partner in the STEAM Initiative, however, was Discovery Education. The MNPS partners and their specific contributions are detailed in Figure 2, and this media release was shared with teachers, principals, district personnel, and the community at large.



Figure 1. MNPS Instructional Framework

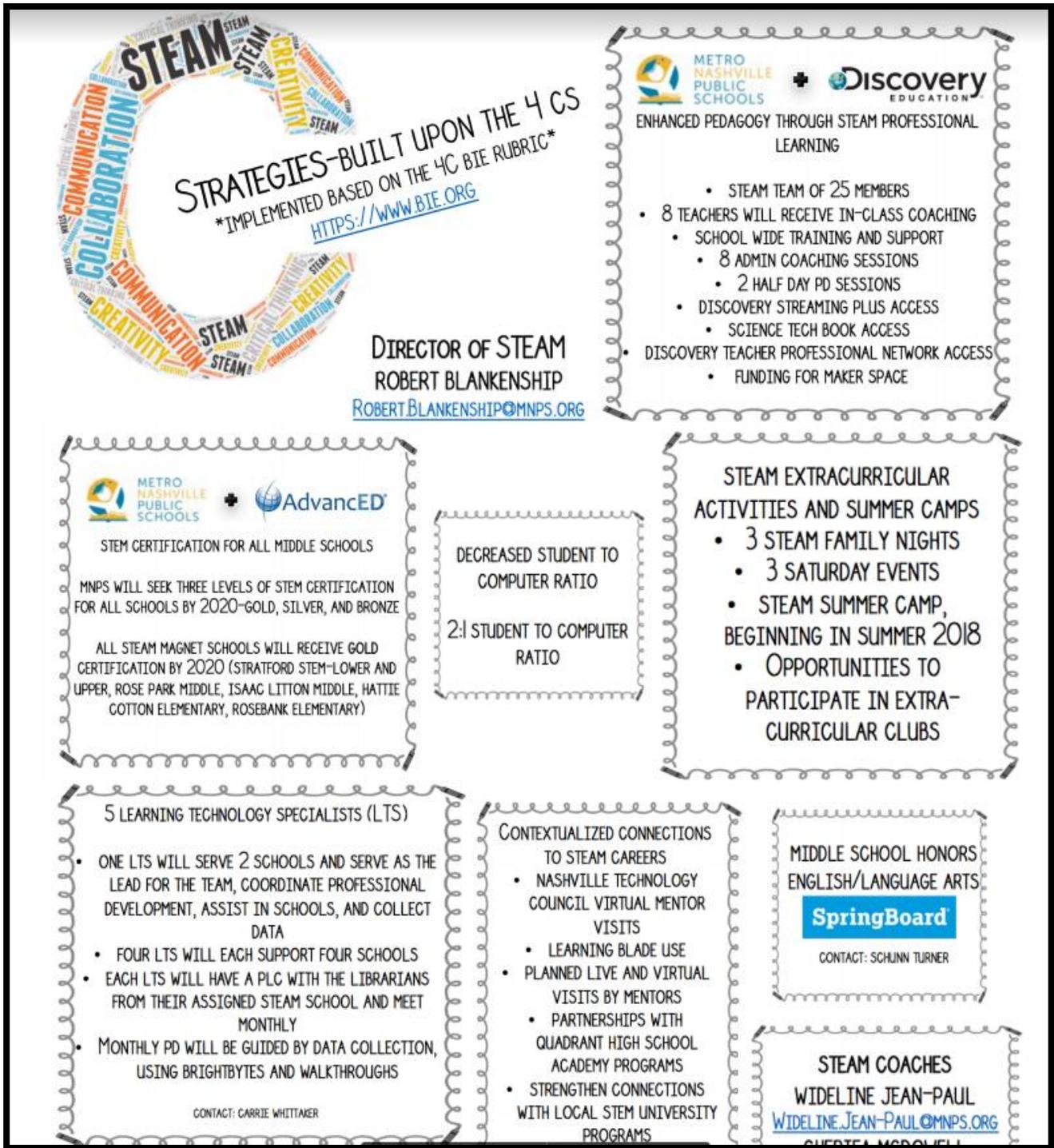


Figure 2. Strategies Built on the 4 Cs: Plans and Partnerships for STEAM

B. Discovery Education

Metro Nashville Public Schools' leaders knew that they were insufficiently prepared to implement the cross-curricular STEAM content or pedagogy. Therefore, the district sought external expert support. Using experts would allow teacher teams to focus on their strengths, eliminate outdated structures, and increase student outcomes (King & Bouchard, 2015). After gathering multiple bids from STEAM expert implementation companies, MNPS selected Discovery Education as its primary STEAM partner.

Discovery Education's website offered dazzling science, social studies, and math Techbooks - digital textbooks (Figure 3). For science, the online resource was advertised as a breakthrough K-12 digital textbook "that changes the way students and teachers experience real-world science phenomena, boosting achievement and igniting interest in the exploration of cross-cutting science concepts" (Discovery Education, 2018). The Discovery social studies Techbook boasted "a comprehensive, standards-aligned, core curricular resource that uses an inquiry-based approach to enhance literacy and critical thinking skills. . . in U.S. History, World History, Civics and Government, and World Geography" (2018). Finally, the Discovery digital math Techbook presented math concepts through real-world problems. It balanced conceptual understanding, procedural fluency, and application, and offered digital interactives, complex problems with videos, data manipulation using digital tools, and game like activities.

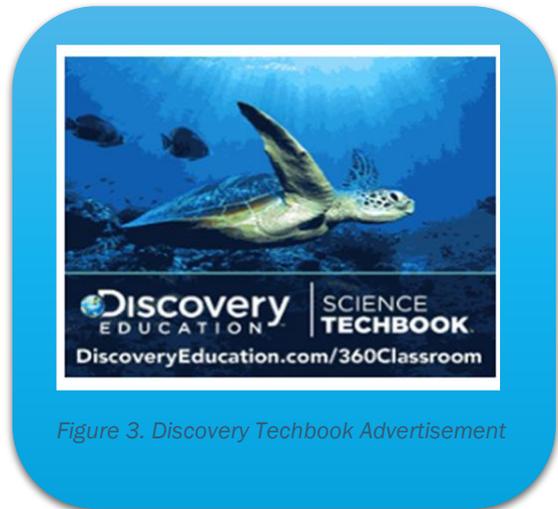


Figure 3. Discovery Techbook Advertisement

In addition to the Discovery Techbooks, Discovery offered Streaming Plus, which gave teachers access to 180,000 vetted resources that meet every state standard. In advertising their Streaming Plus, Discovery Education claimed that "Discovery Education Streaming is linked to higher academic gains for African American and Hispanic learners, English learners, and students impacted by poverty" (2018), indicating a perfect fit for MNPS. Achievement results in Rock Hills, South Carolina, a district of 17,000 students, showed an increase of nine scale score points overall, and 17 scaled score points for African American students on their state-mandated exams, helping to close their achievement gap (2018).

Most applicable to the needs of Metro Nashville Public Schools was Discovery Education's STEM Connect that taught children that "for every real-world problem, there is a real possibility to solve it." STEM Connect was purchased to be an "interdisciplinary K-8 resource designed to enhance core curriculum and bring STEM to life in classrooms" (2018). STEM Connect offered model lessons, interdisciplinary connections, interactive tools, and class activities (Figure 4).



Figure 4. Discovery STEM Advertisement

In addition to products, Discovery Education also offered in-person and online professional development for teachers and principals, using the Discovery Educator Network. This professional development included new Discovery content, best practices, the development of a community of practice and possibly even a SENSI Principal Summit, four days of professional development and networking (2018). For teachers, Discovery Education had professional development in-person, at conferences, online, and through job-embedded instructional and leadership coaching. Discovery boasted: “In an average month, 130+ Discovery Education learning consultants will deliver more than 600 days of professional development to over 15,000 educators—and the numbers are growing” (2018).

School district testimonials from across the United States and positive press announcing impressive growing partnerships created an image of success, which led the Metro Nashville Public Schools to dedicate \$2.3 million to a first-year partnership with Discovery Education to implement Phase One of the STEAM Initiative in 2017-18, the first phase of a three-phase, three-year project.

MNPS published the Phase One STEAM plan and Discovery Education’s role in it to enhance MNPS’ pedagogy through STEAM professional learning (Figure 2). The 18 middle schools selected by the district for STEAM were each required to assign 25 teachers to the STEAM team; the district’s STEAM team would be comprised of 450 middle school teachers. The STEAM teachers would benefit from Discovery Education’s school and district-based professional development. They would have access to Streaming Plus, the Science Techbook, and the Discovery Educator network. Schools would receive funding for a Makerspace, which is a “DIY social space where students meet to create, design, share ideas, and learn, containing a variety of resources - crafts, hardware supplies, 3D printers, electronics, etc.” (Shark, 2017). Last, but crucially important, was that eight of the 25 teachers in each school would be deemed *innovators* and would receive in-class instructional coaching from a Discovery Education consultant. For the purpose of clarity, the 25 STEAM teachers will be noted either as innovators, if they were among the eight in each school who worked with a one-on-one Discovery Education consultant, or non-innovators, if they were among the 17 in each school who had professional development and online access, but no individual consultant support.

Aside from teacher and principal support, Discovery Education committed to supporting three STEAM family nights, three Saturday events, a STEAM summer camp, and student opportunities to participate in STEAM-based extra-curricular clubs.

C. STEAM and Non-STEAM Middle Schools

With a partnership established, MNPS gathered survey data from middle school principals to measure each middle school's STEAM readiness. Based primarily on the readiness survey, 18 of 33 middle schools were selected to participate in Phase One of the STEAM implementation. The 18 are called STEAM schools. The remaining 15 MNPS middle schools are called non-STEAM schools for the sake of comparison. Although the district reported that the STEAM schools were selected primarily using the aforementioned survey results, it is notable that the STEAM middle schools are remarkably similar as a group compared to the whole of the metro middle schools academically, demographically, in terms of community or academic partnerships, student enrollment size, and when comparing years of experience among principals as seen in Tables 4-8. Full comparative details for each of the 33 middle schools can be found in Appendix G.

Academically, the average math and science achievement levels across STEAM and non-STEAM middle schools were remarkably similar (Table 4): 21% for STEAM schools, and 19% for non-STEAM schools in math, and in science, 39% for STEAM schools, and 35% for non-STEAM. The academic comparison, averaged across each category, represents the percentage of students who were on track or had mastered the content expected in 2017 on the state's core-subject exams (Tennessee Data of Accountability, 2017).

Demographically, as seen in Table 5, STEAM and non-STEAM schools show a slight variance in the average percentage of African American and Hispanic students, with a difference of five percent and six percent respectively, but identical percentages of White and Asian students (Tennessee's School Profile Data, 2017).

In terms of community or academic partnerships (Table 6), just over half of STEAM and non-STEAM middle schools have partnerships like a zoo partnership, the Cambridge academic program, or a science magnet program (MNPS STEAM Readiness Survey, Private Communication, June 2018). Table 7 showed an equivalence between STEAM and non-STEAM schools in terms of size. The average STEAM school had 551 students, whereas the average for non-STEAM schools had 560. Lastly, in terms of educational leadership, STEAM and non-STEAM schools showed almost no difference in the average years of principals' experience at the current school as seen in Table 8, which shows an average of 3 years for STEAM schools and 3.5 for non-STEAM schools, and just a year and a half gap in overall administrative experience, 6.7 years for STEAM and 8.2 for non-STEAM. This mirror imaging seemingly indicated that if STEAM were to be successful in the first 18 schools, it would be reasonable to assume future success across the district. Three years of implementation were planned. Phase One's implementation, beginning in 2017, included the following 18 schools: Antioch, Bellevue, Creswell Prep School of the Arts, Croft, Dupont Hadley, Gra-Mar, Haynes, Head, Isaac Littleton, Jere Baxter, John F. Kennedy, J.T. Moore, Madison, McMurray, Moses McKissack, Oliver, Rose Park, and Stratford STEM Magnet middle schools.

Phase Two, anticipated to be implemented in the 2018-19 school year, planned to incorporate 10 more middle schools: Apollo, Donelson, Goodlettsville, H.G. Hill, Joelton, Marshall, Martin Luther King Jr., Two Rivers, West End, and Wright. And finally, Phase 3, intended to begin in the 2019-20 school year, of the STEAM Initiative included the final five

schools: Dupont-Tyler, East, John Early, Margaret Allen, and Meigs Magnet schools (MNPS STEAM Sheet-Updated, Personal Communication, June 2018).

Table 4. Comparison of Achievement on 2017 State Exams

	2017 Math Achievement	2017 Science Achievement
STEAM Schools	21%	39%
Non-STEAM Schools	19%	35%

Table 5. Comparison of Demographics 2017

	White	African American	Hispanic	Asian
STEAM Schools	28%	51%	16%	4%
Non-STEAM Schools	28%	46%	22%	4%

Table 6. Comparison of Community or Academic Partnerships

	# of Schools with Special Programs	# of Schools with No Special Programs
STEAM Schools	10 (56%)	8 (44%)
Non-STEAM Schools	8 (53%)	7 (46%)

Table 7. Comparison of Average School Size

	Student Enrollment
STEAM Schools	551 students
Non-STEAM Schools	560 students

Table 8. Comparison of Principal Experience

	# Years in Current School	# Years Admin Experience
STEAM Schools	3.0	6.7
Non-STEAM Schools	3.5	8.2

At the culmination of Phase One in the summer of 2018, budget cuts forced a hiatus for the STEAM Initiative. This hiatus allowed district leaders the opportunity to reflect on the first year of implementation of the STEAM Initiative before deciding whether to invest in a future

Phase Two. These events helped launch this STEAM Implementation study. Details of the study's inception and methodologies are in Appendix H.

D. STEAM Schools' Selected for this Study

Contextually, this study and the MNPS STEAM Initiative itself utilized strategic sampling. The Vanderbilt research team chose the best possible representation of STEAM schools for the qualitative interview process in terms of size, achievement, and specialty. Balancing time and interest, nine of the 18 participating STEAM schools were included in the study as a representative sample of a set of key characteristics across the 18 STEAM schools: larger and smaller schools; very low, average, and high achieving schools; and traditional and specialty schools like those with academic or community partnerships. Full comparative data for all of the 18 STEAM middle schools can be found in Appendix I. The MNPS district strategically selected the 18 STEAM schools that represented the district's 33 middle schools overall in achievement levels in math and science, in demographics, in specialty and traditional schools, in school size, as well as in years of experience of its principals. Therefore, the data gathered by this project can reasonably be expected to represent the general perceptions of the district as a whole.

Size. We wanted to include schools that reflected the average STEAM school size of 550 students. Five large STEAM schools were interviewed; four were not. Four small STEAM schools were interviewed; five were not. Schools included in this study are highlighted in yellow in Table 9.

Achievement. Data from the 18 STEAM schools produced three distinctive achievement groups, which this study identifies as *very low*, *average*, and *high* achieving. Cut scores for each group were determined by natural breaks in the data of more than 10%. For example, the 2016-17 school profile data from the Tennessee Department of Education presented the 10 *very low* achieving STEAM schools with averages between 11% and 19% of their students being on track or mastering state standards in math and science. A natural gap of 13% occurred between the *very low* and the *average* achieving schools, into which no school fell. Then, the five *average* achieving schools were presented as having 32% to 47% of their students as on track or mastering standards. A second natural gap of 13% occurred between *average* and *high* achieving schools. The *high* achieving schools had reported scores of 60% to 62% of their students on track or mastering state standards.

Consistent with the 18 STEAM schools that vary in terms of student achievement levels in math and science, the nine in our sample include four *very low achieving*, three *average* achieving, and two, *high* achieving. Their non-selected or excluded counterparts were six *very low* achieving, two *average*, and one *high* achieving STEAM schools. Schools included in this study are highlighted in Table 10.

Specialty Status. Of the 18 STEAM selected middle schools, 10 had specialty status due to a formal community or academic partnership as seen in Table 9. Of those, exactly half of the specialty schools were interviewed. Eight of the 18 STEAM schools were traditional, non-specialty schools; four of those eight were interviewed.

Table 9. STEAM Schools by Population and Specialty

School	Total Students	Special Programs
Haynes Middle	282	Health and Medical Science Magnet
Jere Baxter Middle	297	
Moses McKissack Middle	344	
Gra-Mar Middle	358	
Stratford STEM Magnet Lower School	388	STEM Magnet School
Creswell Middle Prep School of the Arts	428	Arts School
Rose Park Middle	446	Math and Science Magnet School
Isaac Litton Middle	471	STEM Magnet School
Madison Middle	543	
Head Middle	561	Math and Science Magnet School
Dupont Hadley Middle	610	
Croft Middle	652	Partnership with Nashville Zoo
John Trotwood Moore Middle	670	IB School
Bellevue Middle	692	IB School
Antioch Middle	723	
John F. Kennedy Middle	770	
William Henry Oliver Middle	834	Cambridge School
McMurray Middle	851	

Note: Source: TDOE 2016-17 School Profile Data and the MNPS District STEAM Readiness Survey

Table 10. STEAM Schools' Math and Science State-Mandated Exam Achievement

School	Math Scores (On Track or Mastered in 6-8)	Science Scores (On Track or Mastered in 6-8)	Average
Haynes Middle	8.0%	14.7%	11.4%
Stratford STEM Magnet Lower School	8.1%	16.4%	12.3%
Gra-Mar Middle	11.0%	14.4%	12.7%
Madison Middle	8.6%	20.0%	14.2%
Jere Baxter Middle	11.0%	22.0%	16.5%
Moses McKissack Middle	12.5%	21.0%	16.8%
Creswell Middle Prep School of the Arts	10.6%	23.1%	16.9%
Antioch Middle	11.2%	23.4%	17.3%
McMurray Middle	15.4%	19.7%	17.6%
John F. Kennedy Middle	10.8%	27.1%	19.0%
Isaac Litton Middle	16.3%	47.3%	31.8%
Croft Middle	18.1%	52.8%	35.5%
William Henry Oliver Middle	27.7%	56.0%	41.9%
Dupont Hadley Middle	28.9%	62.6%	45.8%
Bellevue Middle	31.2%	61.8%	46.5%
Head Middle	51.9%	68.6%	60.3%
John Trotwood Moore Middle	48.3%	75.1%	61.7%
Rose Park Middle	48.1%	76.4%	62.3%

Note: Source: TDOE 2016-17 School Profile Data

After taking all three factors of achievement, size, and specialty into consideration, the following selection was made (Table 11):

Table 11: Schools Selected to Interview

School	Achievement	Size	Specialty
Croft Middle	average	large	specialty
William Henry Oliver Middle	average	large	specialty
Dupont Hadley Middle	average	large	traditional
John Trotwood Moore Middle	high	large	specialty
Rose Park Middle	high	small	specialty
McMurray Middle	low	large	traditional
Haynes Middle	low	small	specialty
Madison Middle	low	small	traditional
Jere Baxter Middle	low	small	traditional

In sum, the team selected nine schools, five with a specialty, four without; five with average or high achievement scores, four with low achievement scores; five large and four small schools, including the largest and smallest, two schools with fewer than 300 students and two with more than 800.

The research team interviewed a total of 38 STEAM participants from across the nine middle schools and at the district-level: 26 teachers, seven school-level principals, two school-level assistant principals, three STEAM district coaches, and both the past and current STEAM directors. Details of the interviewed participants including job position and subjects taught are in Appendix J.

IV. Findings

A. Finding 1: Unfolding the Initiative

Research Question 1:

How did the implementation of the STEAM Initiative unfold across the district?

Haphazard Unfolding

When measuring the need for STEAM, it was commonly accepted that the MNPS middle schools needed an increase in rigorous content that promoted thinking and problem solving.

The Need for STEAM

“The biggest problem that our district was trying to solve with STEM for middle schools was to raise the rigor and engagement for our middle schools. There were we spent 10 to 12 years redesigning our high schools, we spent a lot of years impacting reading at the elementary during that time, we had no focus on what was happening in our middle schools. And then when we start looking at data, it's like, ooh, our high school kids are graduating more, they're engaged in more they're getting all these, you know, industry certifications are right kids are growing, but our middle schoolers, we're losing a lot of our middle schoolers to charter schools or private schools or why right? Well, it's because we're not engaging our middle schools and their developmental level for things that connect them to what's happening at the high school. And then building on what's happening in elementary. Our middle schools needed something.” - Principal

The idea of preparing students with 21st century skills inspired teachers and principals. One teacher from a school with a strong community partner said, “It was time, probably overdue, respectfully, to get on board.” Although many did not find a way to incorporate the STEAM subject areas of Science, Technology, Engineering, Arts, and Mathematics into their existing curriculum, participants perceived STEAM as necessary, using it as an opportunity to “engage students’ active minds” through the MNPS’ instructional framework of collaboration, creativity, communication, and critical thinking.

The STEAM Initiative was chosen to combat declining enrollment, increase academic rigor, and reinforce 21st century skills and careers. MNPS introduced STEAM on July 31, 2017 and implemented Phase One in the 2017-18 school year in 18 of their 33 middle schools. Discovery Education partnered with the district to provide online classroom resources, to organize professional development days intended for 450 middle school STEAM teachers, and to implement one-on-one coaching for approximately 150 teachers.

The research team found that over the course of Phase One there were three different district STEAM directors, which created tremendous confusion for all STEAM

stakeholders. With the fluctuation of primary STEAM leaders, the initiative unfolded with much less focus than expected.

Anticipating tremendous professional development and individualized support from district personnel and Discovery Education consultants, school leaders were excited to support the STEAM initiative at its inception. In terms of scope and frequency, Professional Development (PD) for STEAM seemed ample and applicable at first. By contract, for principals during the 2017-18 school year, Discovery Education was to provide a STEAM Leadership Event, two days of principal STEAM PD, and four full days of in-house consulting. For STEAM teachers, Discovery Education was contracted to implement eight days of in-house training before gathering all the STEAM teachers in the district at the culminating professional development day called the STEAM Immersion Experience, which occurred on November 9, 2017. The topics for the eight days were to include: how to get started, centers-based teaching and learning, maximizing student engagement, building the foundation for integrated STEAM instruction, STEAM immersive experiences, incorporating STEAM in high-quality lessons, assessing student progress, and STEAM instructional planning.

District records, however, do not match the Discovery Education plan. There were only two scheduled or actual PD days associated with STEAM. According to the district, *Building the Foundation for STEAM* was scheduled for September 13, and it was not listed in the Discovery Education contract, as well as, the aforementioned *STEAM Immersion Experience* scheduled for November 9.

Aside from actual PD days, STEAM innovators could contractually expect one-on-one consulting 15 times per year for an hour and a half per visit. Following this contractual obligation, PD would have likely occupied the five professional development days built into the district calendar, plus require four additional days in which 25 teachers per school would miss instructional time for PD before November. Principals sent their teachers to the opening PD sessions with high hopes for meeting a real need in the middle schools through STEAM.

However, from the very beginning, teacher buy-in was difficult to achieve as the initial PD sessions never reached the expected participants. The first district-recorded STEAM Initiative PD, *Building the Foundation for Integrated STEAM Instruction*, was a two-day session on September 13 and 14, 2017, attended by 241 teachers on the first day and 90 teachers on the second. The next large PD day, *Full STEAM Ahead*, occurred November 9, 2017 with 317 MNPS STEAM teachers. Two other STEAM-based PD days, which involved 7 and 27 MNPS employees, occurred in October 2017 and February 2018.

If, in fact, the district data reflects the professional development days as they unfolded, the \$2.3 million-dollar initiative began unfolding with just 53% of STEAM teachers in attendance, which dropped to 20% in one day. The initiative desperately needed stronger initial planning and continual leadership. Despite contractual obligations and district expectations, many of the initiative's stakeholders (teachers, principals, and district personnel) were confused about how to implement the initiative. That confusion permeated teacher, principal, and district levels.

One STEAM teacher said, “[I didn’t understand it;] Not the way they wanted it. The reason I didn’t like going to the training was because I didn’t understand what they were doing. They were so advanced, so we just fluffed what we already had.” Others conveyed that they did not understand “the big picture” or “understand what they were doing in PDs.”

At the beginning, many innovators were also unclear as to how the initiative connected specifically with their content areas like English Language Arts and Social Studies. One innovator stated that she understood the ideas and concepts behind the initiative, but said, “We needed to know how to use the strategies for social studies. I had no idea how STEAM even was supposed to look in the social studies classroom.” After attending required professional development days at the start of the school year, innovators still felt unsure as to how the initiative fit into specific subject areas. The same innovator went on to say that, “Even after we had the two days of the district workshop, and then we had other days that we had to come out of the classroom during the school year, nobody ever addressed it until the [Discovery consultant] came.”

Theoretical, not Practical

“Well, that’s the problem. I’m not sure anybody knows how it was supposed to happen. You know, theoretically, it was going to be a nice integration of science, technology, engineering and math into every classroom in the building. But teachers were never taught how, or what that looks like. . . or how to make that happen.”

School principals noted that they were unclear about how to implement the initiative and were confused about how to achieve the end goals. One principal said, “Well, that’s the problem. I’m not sure anybody knows how it was supposed to happen. You know, theoretically, it was going to be a nice integration of science, technology, engineering and math into every classroom in the building. But teachers were never taught how, or what that looks like...or how to make that happen.”

Progress toward implementing STEAM strategies was made over the course of the Phase One year. Many teachers valued the contributions of the one-on-one Discovery Education consultants in tying STEAM to their specific curriculum. One school

praised the district technology coach for helping organize collaboration and STEAM planning within the one school itself. Some highly enthusiastic teachers independently investigated STEAM strategies and gathered their own resources to make STEAM work. Yet the overall implementation lacked planning, vision, and resources.

Resources were more available to some schools than others. One school indicated receiving \$7,000 for a MakerSpace, but it was the only one that reported that level of resourcing. Another principal mentioned that “the only resource we were given was two robotic balls. They were toys and expensive toys, but that was it... [We also had] the Discovery online book, which some teachers still use.” Still more varied were the teachers’ perceptions when they said that even if they wanted to do STEAM projects, there was no indication of one computer being provided for every two students as was promised, not even supplies like “cotton balls or popsicle sticks”.

Finally, when reviewing all of the STEAM plans, it was notable that there was little to no mention of the promised expectations. New personnel to support STEAM were employed, but only one school commented on the value of the district learning technical specialist; no

one mentioned the district STEAM coaches. There was no mention of the STEAM Advisory Council nor STEAM A-team. One mention of summer camp and one mention of a STEAM family night indicated Discovery Education complied with those expectations. No principal mentioned the Discovery Education network, online professional development, or the SENSI Principals' Summit. Professional development was the most difficult to track. Based on interviews, it seemed there was a large-scale district PD on the first day of teacher preparation time in August 2017, but there is no record of it, nor does it appear in the Discovery-MNPS contract. The contract spells out several in-school pre-trainings to support the September district training, but no teacher makes clear mention of how those occurred, if they did, and there is no record of them.

The promise of STEAM never quite became a reality. The haphazard beginning created a negative perception among stakeholders, and the initiative's goals, objectives, and measurable outcomes were the most noted deficiency in the unfolding of the initiative.

Research Question 2:

How did Instructional Leadership, Professional Development, School Culture and Climate, and Organizational Capacity influence the implementation of the STEAM Initiative?

B. Finding 21: Instructional Leadership

Confusion, Supported Learning, and Progress

As a major component of the STEAM Initiative, MNPS partnered with Discovery Education to provide consulting services as teachers and administrators grappled with what it meant to be a STEAM school. Each STEAM school received their own Discovery Education consultant, and each consultant provided one-on-one development opportunities for teachers. STEAM participants pointed to this relationship as the most prominent and helpful form of instructional leadership support for the duration of the initiative. We examined the influence of Instructional Leadership in terms of staffing decisions, explicit buy-in, and support and supervision. These three leadership items were considered because researchers agree most consistently that the instructional leader sets the primary goals for new school initiatives (Robinson, et al, 2008; Murphy & Torre, 2014; Marzano, et al, 2005). Instructional leaders participate with teachers in planning, coordinating, and evaluating the teaching and curriculum (Stoll, et al, 2006; Robinson, et al, 2008; Murphy & Torre, 2014). Last, outstanding instructional leadership does not necessarily have to stem from the appointed leader of the school. Reciprocal instructional leadership relationships can be developed among teaching colleagues (DuFour, DuFour, Eaker, & Many, 2006). Therefore, staffing, buy-in, and support and supervision all lead to successful initiative implementation.

Explicit Buy-In

An important component of Instructional Leadership for a new initiative is earning buy-in from the participants. Principals and district personnel were quite interested in buying-in initially to the STEAM Initiative. One principal said that the administrative team experienced "a great roll-out day." Principals believed in STEAM's potential to help them acquire STEAM national certification, to move them out of *priority* status, to better integrate their courses,

and to increase student achievement. In general, they were optimistic at the beginning and expressed explicit buy-in. The tone of initial buy-in soured when teachers were introduced to the initiative, however. The same principal who experienced “a great roll-out day” reported that his teachers reported their roll-out day as disorganized and uninspiring.

Many STEAM teachers did not explicitly buy-in to the initiative at the beginning, nor did they perceive buy-in from their colleagues. The only teachers who seemed to be eagerly interested were those who already taught STEM through middle school related arts. One STEM teacher, in particular, said for teachers like him, buy-in was easy because his personal perception was that “for me, STEM is engaging, a passion...As a biology teacher, I know the lesson plans and the standards.”

For the less enthusiastic STEAM teachers, the root issue seemed to be that there was little effort made through communication or expectations to earn explicit buy-in early in the process. One district coach explained: “There was not a consistent message when the thing rolled out. That was confusing for a lot of teachers as to what the expectation was or how this actually works.” One teacher agreed, remembering the initial introduction to the initiative, saying, “We just looked at each other, like, what is this?”

Without clear communication at the beginning, teachers felt stuck with STEAM and unable to focus on their higher priorities. One teacher from a very low achieving school noted, “For schools like [mine], the focus should be on academics instead of throwing in an extra, extra thing. STEAM is a great idea, but some schools on the priority list, teachers already have a lot on their plates and STEAM just overloads an overloaded circuit.” Even for schools not on the priority list, the time given to STEAM at the beginning of the school year was not added to professional development days; it was substituted. One STEAM participant said, “Everyone missed one training for another.” A STEAM librarian missed specialized training on the new library circulation system because she was mandated to attend STEAM meetings.

STEAM Overload

“For schools like [mine], the focus should be on academics instead of throwing in an extra, extra thing. STEAM is a great idea, but some schools on the priority list, teachers already have a lot on their plates and STEAM just overloads an overloaded circuit.”

Perceiving STEAM as initially insurmountable, both active resistance and apathy burgeoned. Principals stopped requiring teachers to attend STEAM professional developments; one even planned time-conflicting events. The feeling of apathy was notable in this teacher’s comment: “And we all know in a school system, anytime a new initiative is introduced, it will be gone very soon, so, you just ride the wave with it and when it’s done, it’s done.”

The STEAM Initiative, however, did not fade with the initial lack of buy-in. Adaptations were made to ensure progress. One principal shared the way the initiative changed to better meet the needs of different school settings. She commented, “At the mid-year point, schools were allowed to do training on site where they didn’t have to come and go. They were allowed to send four people instead of eight. They were able to tailor make that

training for the size of the school and the demands of the school. And had that been an option at the very beginning, I think the buy-in would have been a lot better.”

Staffing Decisions

An important component of Instructional Leadership involves making the appropriate staffing decisions, getting the right people in the right place. At the district level, MNPS created a STEAM director position, as well as, three STEAM coach positions. Turnover in these positions has been a persistent, chronic problem for this initiative in MNPS. Midway through the second year of Phase One, the district is now on its fourth director and all three district STEAM instructional coaches from 2017-18 have left for new positions. Of those interviewed, no one specifically noted the reason for their departure from the STEAM Initiative except to say they were interested in pursuing other opportunities.

At the school level, at the beginning of the initiative, each principal chose eight teachers to be STEAM *innovators* and an additional 17 *non-innovators*, who would participate in the school’s STEAM professional development during the 2017-2018 school year. STEAM innovators were to lead the STEAM change at the school level, supported by professional development (PD) and one-on-one consulting. The additional 17 non-innovators would also partake in PD, but would not receive one-on-one support. All interviewed innovators reported that they had not actually done anything to be STEAM leaders in their schools. Though the district required eight STEAM innovators from each school, the principals selected the teachers or staff members who would become innovators. A pattern of who was chosen did not emerge in the interviews, except to note that principals in larger schools had more choices. Principals logically selected primarily core subject teachers and teachers who were most interested, but the smallest schools were required to produce the same 25 participants as the largest schools, leading principals of small schools to include more atypical staff like music and PE teachers. Interviewed teachers communicated a wide range of reasons they personally became innovators, such as “He chooses me for everything,” or because they were young and energetic, or experienced, or had a previous connection to STEAM. One teacher, who had just moved from out-of-state, was told she would be an innovator on her first day at her new school. Some teachers used the word “volun-told” to describe how they became innovators.

The staffing decision that had the most profound and positive impact, however, was the addition of Discovery Education consultants. As part of the partnership with Discovery Education, each school was assigned a consultant who provided one-on-one STEAM instructional support to the STEAM innovators and provided general help to the school.

Though a few teachers had complaints, the majority of interviewed innovators from all subject areas found the one-on-one investment rewarding. One teacher with English Language Learner students summed up her experience with her school’s consultant: “She was really helpful, and she was really good about getting me strategies I could apply with kids who have low levels of academic language...she did a

Discovery Partnerships

“Oh my God, [the Discovery consultant and I] developed some great, great lessons together. I really hate, hate, hate, hate, hate. . . I cried when the district did not renew their contract. In 21 years, it was the best thing that I feel like Metro has ever done.”

good job of getting people excited about STEAM, and really making ways...to connect with us.” At another school, a science teacher said the consultant “always went above and beyond” to help the STEAM innovators and at another school, a math and social studies teacher described the consultant as “very supportive,” as she “would sit in...and chime in on lessons.” Teachers appreciated the immediate feedback, advice, and suggestions the consultant made. Even teachers who were well-experienced with high-achieving students valued the consultant relationship, like the social studies teacher who gushed: “Oh my God, we developed some great, great lessons together. I really hate hate, hate, hate, hate...I cried when the district did not renew their contract. In 21 years, it was the best thing that I feel like Metro has ever done.”

This positive perception regarding the role and impact of the Discovery Education consultants was repeated across the interviews with teachers; one calling her consultant her “number 1 supporter” and another saying that the consultant “helped specifically with implementing reflective practices in [her] classroom.” Other teachers noted the easy and reliable communication channels with Discovery Education consultants, the consultants’ availability by phone or email, that they provided quality feedback, came to their classrooms, were good collaborators, and helped innovators better understand STEAM. One school technology coach expressed, “[The district] made it a top priority as far as finding an outside source for coaching, they were visibly committed to the work.”

Of course, the teacher-consultant experience varied across schools and teachers, but within a school, the consultant was typically universally appreciated or in one notable situation, universally disliked. In that school where teachers were most dissatisfied, Discovery Education replaced that consultant halfway through the year. When that school’s teachers talked about their second semester consultant, one said: “Our mid-year [consultant] from Discovery Ed was very helpful, like brainstorming what that could look like in an ELA classroom. We had to get very creative because the other coach did not know.” This experience with the second consultant was more aligned with the experiences of other schools.

Overall, STEAM teachers described a positive and meaningful experience with their consultants, and some were disappointed and frustrated when they learned the consultants would not be returning the following school year.

Support/Supervision

A third component of Instructional Leadership is providing support and supervision when teachers need care and guidance. In addition to the support received by the aforementioned Discovery Education consultants, some teachers also appreciated STEAM support from their principals whether they perceived the initiative as progressing well or not. One teacher said, “My best supporter—my principal! Definitely my principal and assistant principal. They were both fully on board and saw the value in it and they knew that it would help out students excel.” In schools with less perceived progress through STEAM, one teacher appreciated her principal’s support by saying, “Our administration was very good about listening to our concerns, and I believe our principal actually met with the organizers to voice our concerns.”

Now, in Year Two of Phase One, without the Discovery Education consultants, principals have primarily taken on the role of instructional leader to continue the STEAM initiative. One

principal interviewed was excited by the collaboration in her school and called it “a culture of STEAM.” She gave examples of STEAM collaboration happening currently: “I am working with the 6th grade teacher because the urban green lab is going to come in. We are working on a plan to get a grant together. I stay after school to work with a particular teacher because she wants a makerspace in her classroom. The natural collaboration of the people [is now] embedded in the way we work.”

C. Finding 2.2: Professional Development

Promise, Disappointment, and a lot of Science for Everyone.

Initial Preparation

Teachers were surprised in August 2017 to find out they were selected as participants in the STEAM Initiative and disappointed to find the first professional development session widely irrelevant to their content and context. When asked specifically about the initial preparation for the STEAM Initiative, several teachers responded saying there was none, even though the contract from Discovery Education called for three pre-STEAM PD days. A STEAM librarian recalled the inception of the initiative: “Our introduction to STEAM was an email; not the best way to present a new initiative.” One newly hired teacher openly admitted to deleting the emails about STEAM at the beginning of the school year. She was new to the district and having heard nothing about the initiative in the hiring process or from her school colleagues, assumed it was a mistake that she was on the STEAM distribution list. She believed that she missed the first days of professional development.

Impact of Professional Development

When STEAM began, principals and teachers had their initial PD separately. According to STEAM teachers, during the first PD day, Discovery Education showed teachers how to access their online resources and demonstrated science experiments. The initial PD was unsuccessful. According to the interviews, when the day ended, teachers returned to their schools with generally negative perceptions of the STEAM Initiative. One principal reenacted his teachers’ responses to the initial PD, saying, “Oh my God, that was so awful, so boring. So not put together, so disorganized, and so uninspiring: We dread having to do this.” The principal found himself surprised by the degree of negative response because at the principals’ PD that same week, STEAM seemed exciting.

The perception that the first PD was “a big waste of time, [after which] everyone was coming back to school and having venting sessions,” stemmed from the poor fit and irrelevance of the PD lessons. Science teachers perceived nothing new. Math teachers thought STEAM must be more applicable to science than math. Language arts, social studies, and related-arts teachers also thought that PD must have applied to someone other than them. The shared perceptions among teachers was that the PD was off-target, lacked the initial buy-in period, and was largely insufficient and irrelevant.

Over the course of the school year, Discovery Education continued to provide resource-heavy PD to the district’s teachers. Unfortunately, as one teacher put it, “I learned about a lot of resources, but not how to implement those

Impact of Professional Development

“I learned about a lot of resources, but not how to implement those in my classroom with the constraints that I have.”

in my classroom with the constraints that I have.” Many teachers were genuinely appreciative of the new resources, which made up a significant portion of the positive PD experiences, but few teachers interviewed could articulate how the PD had a positive influence on the STEAM initiative. Most of the praise for PD was only as deep as the one tool or activity that the teacher was able to utilize. For example, one teacher who routinely used the Discovery Education videos for her class was pleased that she learned how to access those videos during one of the PD sessions, but she also acknowledged that she was not sure how they made her class more STEAM-oriented. Like many others, her only appreciation for the PD seemed to be more directly tied to accessing the resource rather than any development of teaching approaches. Very few teachers indicated learning how to implement the strategies in their classrooms.

The professional development provided by Discovery Education in collaboration with the district seemed to nudge people toward using specific terminology in attempts to unify the efforts. This led to responses like the one from a science teacher who reported that several of the PD sessions were “beneficial” to her classroom because they helped her know how to incorporate the important STEAM terminology into her lesson plans. Likewise, a math teacher remembered learning how to incorporate “math discourse” into her curriculum. The teachers who seemed to get the most out of the STEAM PD were generally math and science teachers, although there were a couple, conveying a growth mindset, who were determined to “get something” out of every PD, regardless of its ineffectiveness.

For each one who found positive takeaways from professional development, there were many more who felt they had “suffered” through or simply had their time “wasted.” The aforementioned science teacher who felt positive impact on her lesson plans had a science-teaching colleague in the same school, who said STEAM PD was a “waste of time;” her reasoning stemmed from a belief that the people teaching the PD did not actually teach STEAM in a classroom and, therefore, had no contextual reference for how to reach actual students. This perception was brought up a few times in various interviews as some of the teachers questioned the authoritativeness of the presenters.

PD was most challenging for non-math and non-science teachers. Part of the difficulty was that “[they] spent like 5 or 6 PDs on explaining what STEAM meant. And every activity or anything they modeled was for math and science.” The PD had nothing to do with their content areas. The physical education, health, and music teachers from one school all expressed their frustration because of the lack of opportunity to work with anyone from their own content area on implementing STEAM in their respective classrooms. They reported that the PD presenters ensured them that STEAM principles could be applied to any classroom, but no teacher in that school bought-in. A music teacher admitted that about an hour into the PD sessions, he usually gave up trying to mix science and music. Likewise, ELA teachers were frustrated that nothing presented at the PD sessions fit into the scope and sequence of their curriculum, which was already ample, leaving little leeway to make adjustments or additions.

Lacking goals and implementation strategies after PD sessions led schools to devise their own paths to implementing STEAM. One school decided that implementing STEAM would be all about the 4Cs; given that definition of STEAM, one teacher quipped, “STEAM is something that most of us are already doing.” With the support of the Discovery Education consultants, other schools decided, just like the aforementioned school, that STEAM would be just the implementation of the 4Cs in a classroom. Many teachers were content with that understanding.

In summary, the PD informed teachers of available resources through Discovery Education and offered some specific activities seemingly relevant to math and science, but it did little to help teachers implement the broader instructional aims of the STEAM Initiative in their schools.

Teachers are Content with STEAM Being Just the 4Cs.

- It all flows together for me, the 4Cs made sense to me, but really incorporating "STEAM" is something that most of us were already doing.
- I made sure I included the 4Cs into my curriculum. We had to teach the students and the community what STEAM was. I have changed my approach; my students are now "problem-solvers" and this filters through all my lessons and units.
- From the PD, we are now applying the 4Cs and monthly STEAM Fridays.

D. Finding 2.3: School Culture and Climate

Different by Design, Disconnect, and Context

Fit Assessment

Fit assessment for a new initiative is pertinent because a school’s culture is difficult to change as schools are characterized by deep patterns of how they do business (Murphy & Torre, 2014). A well perceived cultural fit of an initiative supports the explicit buy-in needed to adapt deep cultural patterns into new strategies. The STEAM initiative resulted remarkably well in terms of its fit assessment. Every school participating in this study reported STEAM as being a *good fit* for their culture, even when the reasons for the *good fit* were completely opposite. For example, one school principal, claiming prestigious ranking, stated, “We were really ideal to go through this process,” while at the same time a priority school stated that STEAM fit their low-achieving student needs: “It was a good fit for us...to improve test scores; we do everything with this in mind.” In cultures of both high and low achievement, teachers and administrators believed students would benefit from STEAM.

Similarly, in singularly-focused and “super diverse” school cultures, STEAM seemed a good fit. The singularly-focused school indicated it was already a STEAM school; it was “a natural fit for us” and “we are the second in the nation with a zoology class.” Though vastly different culturally, the super diverse school perceived a natural cultural fit with STEAM, saying, “[With our] super diverse population, we were a really good guinea pig in that way.” The super diverse school’s teacher thought the community would say, “Look! It worked there—with all of that!”

The last unique comparison was from schools with plenty of technological resources and those with none. STEAM was a good fit for one school's culture, noted by a teacher saying, "We are a 1:1 computer school, which is probably why we were chosen." Conversely, having no resources, one teacher welcomed STEAM saying, "Our kids don't have the technology; they don't have the resources or support at home."

Very few teachers or administrators felt STEAM would be a poor fit, only expressing the worry that other priorities might be more important than STEAM like basic academic skills or English language learning.

Implementation Teams

Implementation teams are valuable during new initiatives because "collective inquiry enables team members to develop new skills and capabilities that in turn lead to new experiences and awareness" (DuFour, et al, 2006, p.5). Working together builds shared knowledge on the best way to meet the needs of student learning. In the case of the STEAM initiative, the "implementation team" at each school - the team that would theoretically be responsible for the STEAM implementation - was comprised of the administration and the eight STEAM Innovators. Based on the interviews, however, most STEAM innovators did not see themselves as part of a STEAM implementation team, but rather as individual teachers being trained to incorporate STEAM in *their own classrooms*. One principal summarized the general trend, "Last year the teachers did not feel part of a STEAM team, they felt mandated to participate. Teachers weren't even sure if they held innovator roles or not, nor did they know who did."

Implementation teams or collaboration, however, did impact teacher learning. Many, teachers, in spite of lacking a sense of belonging to a STEAM innovator team, did perceive themselves as part of other types of implementation teams like the 6th grade science team or the 7th grade ELA team. In one school, the 6th grade science team worked together on a daily basis to incorporate STEAM into their curriculum, and they worked across content areas with other 6th grade subject-area teachers, and with the resident scientist. A 7th grade ELA team-leader shared that she experimented with STEAM activities in her classes last year, and this year, everyone on her team is trying them. One STEAM librarian gathered her STEAM teachers in a weekly lunch group and she reported, "It made great ties among colleagues." In the same school with the librarian, the principal values collaboration deeply and appreciated the opportunity to try Phase One of STEAM because "to me [the principal], the cultural changes are more important than the programmatic changes, because, like in this situation, funding goes, and then the resources go, but if you haven't made it part of your culture, you stop, it stops. So, I'm excited to see that there are a handful of teachers here that are like, 'No, we got to keep going with it.'"

Teachers with no collaborative ties in their schools lamented the STEAM initiative. One STEM related-arts teacher with tremendous expertise in many aspects of STEAM, regretfully shared, "I was not a big part of the teacher community. The school was horrible. I tried to share with other teachers, but the environment was not conducive to sharing." He has since changed schools and is enjoying collaborative efforts with the new school's gifted teacher. Another teacher reported that she participated in the STEAM initiative during her first year at her school. She was assigned a portable classroom and did not even realize she was supposed to be a participant in the STEAM initiative until after she had missed the opening

PD sessions. During the interview for this study, she was not sure if she was an innovator, but she was sure she had no team. In fact, she said, “To be honest, I didn’t see a lot of other people.”

Schools with a strong culture of collaboration, built up over time and pre-dating the STEAM Initiative, perceived greater value in the initiative. A principal shared that the value of STEAM was in creating collaborative partnerships, regardless of the particular program or the funding.

Adaptation Decisions

Adaptation decisions are considered in this study because “even the most promising strategies must be customized for the specific context of each district and school,” and the most effective improvement models stem from teachers who adapt their learning to their classroom situations (DuFour, et.al, 2006, p.5).

The STEAM Initiative had several standardized, planned components: strategies built upon the 4Cs; STEM certification; Discovery Streaming Plus; Science TechBook access; funding for MakerSpace; honors programs for ELA; a 2:1 computer ratio; and partnerships with high schools and colleges. No school seemed to have benefitted from all the components, and no particular patterns of adaptation emerged, but each school adapted the components that were offered to their specific context, interests, and goals.

One middle school used STEAM to gain national recognition. A high-achieving magnet school actually achieved a National STEM Certification. This school’s principal indicated that an outside organization, AnalyzeEd, created the goal structure and measurable outcomes for them to acquire the national certificate. The school utilized the district’s STEAM initiative for its one-on-one classroom consulting and online resources, which supported the goals and outcomes expected by AnalyzeEd.

Another school increased its technological resources and its affection for both STEAM and collaboration due to the initiative. This school was very excited to receive its MakerSpace in the fall semester and perceived much more progress with STEAM this year compared with last. A technology coach said that “This year, it was reiterated that [last year] was just a year to get our feet wet. We are more comfortable [now] implementing STEAM.” Although the funding of the initiative is not currently available, the school spent local funds to hire a STEM related-arts teacher. His class focuses on the engineering design process and according to his principal, “He's fabulous because he makes connections to the standards that are being taught in each of the grade levels and incorporates his projects to reinforce what they're talking about [in the core curriculum].” This school’s STEAM lunch group now includes their newly-hired STEAM expert.

A third adaptation was to focus school-wide on the 4Cs strategies: communication, critical thinking, collaboration, and creativity. Teachers wrote weekly lesson plans that highlighted the 4Cs. They described the details of how to incorporate them into each classroom's lessons.

One final example of adaptation was STEAM Friday. School-based funds were used to purchase STEAM kits. Every teacher in the building became a "STEAM" teacher on every other Friday afternoon during the STEAM period. Students enjoyed hands-on, cross-curricular experiments.

All the teachers and principals recognized the need to adapt the initiative to their own contexts. Even if the implementation had been perfect, one principal remarked, "We have different parents, we have a different community, we have different teachers. And [STEAM] can't be something that's just crammed down the throats of teachers. It's got to be something we live, instead of something that we do...That's going to mean the district needs to define the outcome. How we get there needs to be allowed to be determined by the school."

STEAM Adaptations

"It's got to be something we live, instead of something that we do. . . The district needs to define the outcome. How we get there needs to be determined by the school."

E. Finding 2.4: Organizational Capacity

Seeking Structure and Requesting Resources

Through the lens of organizational capacity, we considered structural capacities, resource allocation, and the support of learning communities. In school systems, organizational capacity offers clear, stable structures to develop the collective power of the entire faculty to strengthen student performance (King & Bouchard, 2011; Malen, et.al, 2015; Goh, et.al, 2006). In broad terms, organizational capacity is comprised of bureaucratic systems that support teacher learning communities. Successful organizational capacity is supported by stability and clarity. Stability stems from stable funding, consistent participation, organized and shareable information management, and supportive leadership resources. Clarity is defined by a shared vision, understandable goals, benchmarking, and the sharing of feedback, which provides an evaluative learning cycle (Malen, et.al, 2015).

Structural Capacity Support

Undefined Vision

"This year we accomplished an undefined blob of goo. Because it just could have gone anywhere...borders were so undefined. No one really knew."

Although the concept of STEAM was valued, the implementation offered few clear, stable structures to develop the collective power of the faculty. Funding lasted one year and was perceived as unevenly dispersed. Participation diminished when professional development seemed irrelevant to teachers' classrooms and contexts. A system of personal feedback emerged between innovators and their Discovery Education consultants, but there was no organized, shareable information management system. Most schools did not

perceive success in increasing organization capacity and noted that the district provided a STEAM idea, but never truly developed a clearly defined vision or goals.

One principal pointed out the hollowness of the initiative's structures: "It was too fast, too fast. I don't think we spent enough time really making sure that people understood what we were trying to do as opposed to putting the stamp on top of the middle school, so that we can say that we have something." Another principal, with a similar sentiment, indicated that there was "a big difference between filling out the STEAM application for the district and going through an actual process that transforms you into a STEAM school – [it was] more than just a label." A third school leader shared that "this year we accomplished an undefined blob of goo. Because it just could have gone anywhere...borders were so undefined. No one really knew."

Only one school found an external source to develop a STEAM standards-based implementation plan. This high achieving science magnet school had a second national partner who provided them with a goal structure, measurable outcomes, and evaluated them, giving regular feedback on their progress toward the goals. That school experienced an empowerment of their organizational capacity through their new collaborative grade level planning time and weekly vertical teaming. The administration surveyed teachers, collaborated with the Discovery Education consultants to gather information about STEAM progress in the classrooms, and met with their teacher collaborative planning teams to create a consistent feedback loop.

Only one other school touted growth in organizational capacity. Their capacity building, however, was home-grown. This school's district-assigned technology coach took it upon himself to establish measurable steps to implement STEAM and worked with teachers to hesitantly try them. That school acknowledged that they had increased their STEAM capacity and that they were proud to have used last year "to get our feet wet."

Resources

The \$2.3 million initiative provided some valued resources like the online Discovery Education video materials and activities, and one-on-one consulting for many innovators in their classrooms. In fact, one school delighted in their \$7,000 of STEAM resources. In that school, the STEAM participants used their STEAM money to buy technology: Makerspace, Raspberry Pi, a Green Screen, a tripod, and cameras. In November 2018 (the following school year), their STEAM technology finally arrived on the day of the STEAM study's interview. Teachers saw these resources as a positive result of the STEAM Initiative, in spite of the fact that they arrived a year late. This school's personnel believed that all the schools received the same funding. Yet, no other school acknowledged the influx of physical resources; contrarily, resource access was noted frequently as a stumbling block for STEAM success. Many schools asserted that the lack of resources significantly impeded STEAM implementation. One teacher noted, "Some of the more hands on learning things we wanted to do, we just didn't have money to do it. We don't have a supply closet." More specifically, another teacher voiced her resource needs:

"I guess if you try STEAM activities, it is nice to have just whatever it is, whether it was clothes pins, ping pong balls, or popsicle sticks. A Discovery [consultant] came in and set up an Escape Room, but I didn't get to keep the locks, so it couldn't be repeated.

And that's something that really could have grabbed them and put the STEAM in the puzzle.”

Resources, organizational or physical, like a computer for every two students, shared data collection, high school partnerships, college partnerships, and honors-level course materials were promised as resources, but seemingly rarely materialized as they were rarely mentioned by STEAM participants.

Learning Communities

“Leaders who call upon others to engage in new work, achieve new standards, and accomplish new goals have a responsibility to develop the capacity of those they lead to be successful in meeting those challenges” (DuFour et.al., 2006, p.1). This gathering to build human capacities is a learning community. A learning community is enhanced when a teaching team collaborates in support of a shared vision, trusts teammates enough to expose their own thinking, seeks others’ feedback, is reflective of their own practices, and works through interrelated actions with his or her teammates (Senge, 2006).

Many STEAM innovators appreciated the support of the Discovery Education consultants and their schools’ internal collaborative teams to increase their personal teaching capacity as noted in previous findings, yet here and there, teachers were actually insulted to participate in STEAM’s learning community, citing years of experience implementing STEAM-like activities. One teacher, in particular, said:

“I feel like many of our initiatives are pushed onto teachers, instead of inviting teachers to share what they need, and then giving them what they need. There is kind of an assumption. We're gonna do STEAM. We assume you don't know how to do this, so we're going to send you somebody to tell you how. And then you have a natural resentment. It's like, but I've been doing this for 10 years.”

One STEM related-arts teacher told a similar story: “I met with the Discovery Ed [consultant], but he didn’t have anything to offer that was different than the way I already teach. I have always used STEAM ideas. For me, it was just another person who wanted to watch [me] in my classroom.”

Research Question 3:

How did teachers and stakeholders perceive the STEAM Initiative?

F. Finding 3: Stakeholder Perceptions

Becoming STEAMier Schools

Teachers’ and Principals’ Perceptions

Unique themes emerged when considering stakeholders’ perceptions in three categories: teachers, school administrators, and district personnel. Teachers and principals generally valued the true need for STEAM, felt the concept was a good fit for almost every school, and held an appreciation for the STEAM instructional support. The theme of *needing STEAM* was noted when teachers referenced a zest for collaboration, critical thinking, problem solving, cross-curricular planning, and making their content relevant to their students’ lives. One

teacher shared that with STEAM, she intended to teach 21st century skills, get Nashville aligned with the rest of the country, and make national leaders. Another teacher expressed heartfelt hope for the impact of STEAM on students, saying “Through IB and STEAM, we promote college and careers. Our students can be more...more than their parents expect them to be.” Progress was made toward the teachers’ STEAM aspirations, especially with the individualized support of the Discovery consultants. One teacher, who had worked with a Discovery Education consultant suggested this: “Make sure that...there's an instructional coach who's not just working with the innovators, but [with everyone] because when one worked with me, I got excited about it, and was able to become an innovator. Whereas if she hadn't really worked with me, I don't know that I would have ever done anything about [STEAM], honestly.”

Although excited by the idea of STEAM, teachers expressed mixed feelings about the district’s organizational capacity and their opportunities to learn as teachers. Some teachers and principals indicated growing as educators using Discovery Education’s online texts, increasing their focus on the 4Cs, and implementing more hands-on, student centered activities. Others noted that the teacher and principal learning opportunities were disorganized, offered resources but few applicable skills, and were too generic to apply in individual classrooms. For some teachers, the STEAM initiative left them feeling unsure about their teaching. One innovator suggested that “there needs to be a way [in the future] for new teachers, in particular, to understand the who, what, when, where, and why, and for it to be explicitly communicated—their involvement and their role in the initiative.”

Given the perception of a need for STEAM and the concerns about the district’s organizational capacity to implement across the schools, principals agreed that the district should determine outcomes, but schools determine the path. “We have different parents, we have a different community, we have different teachers. And it can't be something that's just crammed down the throats of teachers. It's got to be something we live instead of something that we do. And we can't get to that point as long as they're forced feeding. I think that's the key. So, I think we're gonna have to let schools design how they're going to implement STEAM, whatever, that's going to mean the district needs to define the outcome. How we get there needs to be allowed to be determined by the school.”

Comparison of Schools’ Perceptions by Achievement Level

Disorganized Across the Board

“It's a worldwide company or whatever, but you would have never thought anybody had ever done anything like this.”

From the lowest achieving to the highest achieving schools, teachers perceived the initiative as disorganized in general. One principal said, “That was a key. It was never inspiring. It was also so haphazardly done through Discovery: it seemed very disorganized for [that] group [and] they're supposed to have it all together.” However, a noted difference in perception between the lower achieving schools and the higher achieving schools was that higher achieving schools perceived more beneficial structural support.

In higher achieving schools, structures to support shared-thinking seemed stronger. One teacher with higher achieving students talked about the value of the support she received from her principal and her Discovery Education consultant. One teacher shared, “Our principal was all into STEAM because it all starts in the building!” Another noted that the Discovery consultant helped to keep them accountable, was very cooperative, and offered feedback regularly after visiting classrooms. There was a sense that “in order to be a good teacher, I have to implement STEAM.” These teachers mentioned having the resources to buy computers and cameras for their students. Teachers in higher achieving schools seemed to foster higher expectations for adult learning in their schools.

Hope in Higher Achieving Schools

“Our principal was all into STEAM because it all starts with the building!”

“In order to be a good teacher, I have to implement STEAM.”

Hard to Believe in the Lowest Achieving Schools

“Nobody knew what the initiative was all about, so most were skeptical, but most definitely didn't buy into it...we all thought it would be over after a year.”

“[I felt] a lack of motivation, like, I already teach two subjects and an RTI and now you want me to teach a STEAM class?”

Teachers in very low achieving schools held lower expectations for success in STEAM than their higher achieving counterparts. These teachers had very little opportunity to share their perceptions about STEAM with anyone. When asked about tracking progress in the lowest achieving schools, one teacher said, “Nobody kept track.” Another boasted, “I kept track of lesson plans I made for my students.” Self-maintained lesson plans did not, however, create a structural sharing of learning in the lowest achieving schools. Teachers in these schools worried about not being in their classrooms while they were at professional development during the school year. They worried that substitutes could only maintain behavior and not advance learning. They commented on the inequities in that they had no money for physical resources, and neither did their students. They also felt that their students would not

benefit from *structureless* STEAM projects: “I did [know how to implement STEAM] as far as the lesson, you just introduce it like a lab or you just have the instructions of what they're supposed to do, and then they just have to figure out how to do it. It was like giving them a lesson without a whole lot of instructions and rules. So, they just got to figure it out, which is hard for them. They want you to tell them. It has to be a right or wrong answer. They don't want to struggle.” Just like their students who struggled, teachers in the lowest achieving schools struggled with STEAM, feeling predominantly that “every part of the implementation was unorganized.”

Comparison of Specialty and Traditional Schools' Responses

Of the 26 STEAM teachers and 6 principals interviewed, about half came from schools affiliated with a community or academic partnership like International Baccalaureate, a Cambridge partnership, a STEM magnet program, or a zoo partnership. The other half came from locally zoned traditional schools. When comparing the perceptions of these two

groups, a logical result emerged. Specialty schools appreciated their stronger organizational capacity to foster their STEAM growth.

Teachers, from specialty schools, really valued the support of their external partners as well as their principals and Discovery Education consultants. One school had a full-time professional scientist who worked with teachers to support STEAM. Another had an IB program, which already encouraged “hands-on learning and project-based design.” An IB teacher shared that STEAM “was not that big of a shift” for him because of his IB partnership. With the added external partnership supports, principals and the Discovery Education consultants may have had more time to dedicate to STEAM: one affiliated school teacher, when asked about the people who best supported STEAM, said, “Oh, definitely. My principal. Definitely my principal and assistant principal! They were both fully on board. They saw the value of it, and they knew that it would help our students excel.” The pre-STEAM established partnerships seemed to foster collaboration among teachers, administration, and the external partners including Discovery Education. In one specialty school, the Discovery Education consultant gave feedback to administration with each visit and video-recorded lessons for feedback to the innovators. Innovators met with vertical subject level teams to share what they had learned from Discovery Education and then presented to teachers in a district meeting.

Traditional school teachers seemingly perceived a less robust organizational capacity and support system. They perceived benefits from the one year with Discovery Education’s support, but did not have the opportunity that specialty schools have had to create long-term relationships with structural or academic partners. Because of this lack of long-term relationship, the entrance and disappearance of Discovery Education left these teachers confused and without direction. One teacher shared her concern about the one-year implementation, saying, “I think the biggest confusion for me, it's like, it was such a push last year. This is what we're gonna do! We're going to get on board and [we were] trying to get on board with that. Then, just having it dissolve. Now I'm confused where that fits with my pedagogy. Am I supposed to be doing that and are we done with that? Where does that fit?”

Traditional School Confusion from One-Year STEAM Partnership

“I think the biggest confusion for me, it's like, it was such a push last year. This is what we're gonna do! We're going to get on board and [we were] trying to get on board with that. Then, just having it dissolve. Now I'm confused where that fits with my pedagogy. Am I supposed to be doing that and are we done with that? Where does that fit?”

Traditional schools seemed more willing to buy-in to the STEAM Initiative because Discovery Education was their only partner. They valued the additional staffing within their own schools. With less pre-STEAM structural supports than specialty schools and the rocky rollout of STEAM, some traditional school teachers took it upon themselves to find structures and resources. According to a traditional-school teacher, “the teacher who succeeded best with STEAM was willing to take a risk, is a natural leader, and although she did everything on her own last year, this year her team is doing projects with her.” The same

teacher described above by her colleague said this about herself, “I totally bought in and took it very seriously.” The teacher individually sought and found a summer program through Purdue University to learn to implement STEAM projects in her ELA classroom. Most others made some progress with STEAM in Phase One, but expected it to go by the wayside, saying: “And we all know in a school system, anytime a new initiative is introduced, it will be gone very soon, so, you just ride the wave with it and when it’s done, it’s done.”

Comparison of Responses by School Size

Principals, more than teachers, expressed differences of opinion about STEAM with regard to school size. Size mattered. It seemed easier for principals of larger schools to buy into STEAM, likely because it was less impacting to their school overall. Larger schools had more teachers from whom to choose innovators and other teacher participants and leaned toward core teachers as their STEAM participants. Even now, one year after Phase One of the initiative, one large school’s principal is still pushing the initiative and taking active steps in hopes of becoming nationally STEAM certified. Another large school principal is excited to be building the culture of STEAM, growing collaboration among teachers, and partnering with community resources to acquire a grant to create a Makerspace in one of the classrooms. One principal claimed that in her school she sees lots of innovation happening and her school is fueled by teachers who are collaborators and learners themselves. No small school principal shared a zest for STEAM. Possibly 25 teachers were too many to take out of small schools frequently for STEAM days, and STEAM was simply disruptive. One principal, addressing the concern of the mandated 25 teachers, said:

I believe the biggest barrier was the mandates of time and teachers. You have to have eight innovators; you have to have 25 teachers. Well, 25 teachers on a given day, four times in the year being pulled out to be trained, takes a lot of time and resources in the midst of all of the other things that happened in a school. You know, teachers planning for their own content, not that they didn't want to be trained, but the mandated way of training, I believe there should have been some differentiation per school.

District Personnel Perceptions

The STEAM district personnel were charged with creating the connection between the STEAM plan and the STEAM implementation. Because the primary district leader for STEAM changed three times over the course of the year, the expectations of the initiative changed, too. One district STEAM member indicated that “the first director's vision was different from the second director’s. There were so many competing ideas.” The competing ideas made it difficult to clearly define the initiative for teachers and principals. The district STEAM team-acknowledged the failure of the district-wide professional development strategy, especially early in the implementation, and the lack of accountability throughout Phase One. One district member said, “PD was a huge barrier because teachers lost planning time. Discovery Ed did not bode well with many science educators and teachers did not know what STEAM looked or felt like. [With adaptations throughout the year,] we lost the cohort model, and shifted to school-based cohorts, so there was not much accountability.”

Summary of Stakeholders’ Perceptions of STEAM

Overall, teachers, principals, and district personnel thought the idea of STEAM was valuable. When they broke down the components of STEAM, such as collaboration, critical thinking,

problem solving, cross-curricular planning, making the content relevant to their students' lives in the 21st century—stakeholders found all those individual components valuable. Most thought they already were doing them to some degree, but philosophically no one disagreed with the basic premise of becoming a STEAM school or incorporating STEAM ideas into their curriculum. Most interviewed stakeholders indicated a growth mindset and a sense of being life-long learners themselves. Most enjoyed the challenge of learning ways to improve their practice. It is likely that these characteristics were at least partially responsible for why they were chosen as STEAM participants and why they might have been chosen to participate in the interviews for this study. And yet, despite interviewing so many generally optimistic, hard-working, and caring people, there were many complaints about the implementation of the STEAM Initiative. The complaints revolved around three major themes: communication, relevance, and resources.

V. Discussion

It is easy to imagine how a hospital responds to a massive emergency like an explosion or a bus accident. Everyone is on the scene, from first responders to nurses/surgeons and all personnel in between. Medical professionals must assess in split seconds whose injuries need immediate care and whose injuries can wait temporarily for treatment. Protocols, checklists, and specialized resources are absolutely essential in emergency response situations. Much like hospitals experiencing massive emergency situations, schools similarly experience triage situations, when school leaders must make crucial decisions that affect the growth and trajectory of their students. They must assess which issues must be tackled immediately during the academic year and which issues can be put on hold until later in the year. Unlike the hospital scenario, there is no endless supply to protocols, checklists, and specialized resources that will guarantee positive results in schools. Schools are restricted to certain protocols and checklists (curricula) and often have limited resources. With these odds stacked against schools, it is even more critical that school leaders are equipped to make the right decisions to triage challenging academic and social issues.

Considering the problem that MNPS was facing with their middle schools' low academic achievement and declining population, the STEAM Initiative was intended to respond to an emergency. The MNPS middle school emergency included losing student population to private and charter schools, low achievement on state exams, a perceived lack of rigor in the curriculum, and an ever-increasing expectation to give students 21st century skills of collaboration, critical thinking, communication, and creativity to better prepare them for college and careers. It was essential that MNPS leaders no longer ignored the issues surrounding the middle school experience and put a triage plan into action to save enrollment, achievement data, rigorous curriculum, and high expectations for 21st century skills.

A. Takeaway 1: Needed Collaboration, Critical Thinking, Communication, Creativity

There is a real need to ensure students learn collaboration, critical thinking, communication, and creativity.

Many STEAM participants agreed that the middle school students needed to increase test scores and engage with more rigorous curricula. To meet this need requires curricula focused on teaching collaboration, critical thinking, communication, and creativity skills to better prepare students for college and careers (MNPS, 2017). Since teachers were intimately familiar with their schools, classrooms, and students, they should have been highly involved in determining their own triage status and plan for the STEAM emergency. King and Bouchard (2011) highlight the importance of having needs and fit assessments as the first two steps to high quality implementation. If teachers were aware of the impending STEAM initiative and available resources, they could have communicated their needs to the awaiting STEAM experts and met the appropriate staff, with the appropriate resources, at the perfect time.

STEAM Initiative teachers ranged in job position, from first year teachers to 30-year veterans, from ignored portable-classroom teachers to socially-centered librarians, from math and science teachers to art and music teachers. The middle schools varied from very low achieving to high achieving, which included specialty schools with ties to local and national support organizations and neighborhood schools with a wide variation of resources and community supports. Each teacher brought his or her strengths and his or her weaknesses, as well as the strengths and weaknesses of their students, to the STEAM emergency room doors.

Leading the way in the STEAM Initiative were principals who were the only ones asked to conduct a very brief triage assessment with the key question: Did their schools feel ready for STEAM? Based on the survey and some political balancing, 18 schools were selected to benefit from the STEAM Initiative. Considering that very few principals understood the implementation plan or what resources were available to the upcoming STEAM Initiative, asking for their points of view on readiness was akin to asking someone lying on the ground after a bus accident if they felt ready to go to the hospital. One principal declared: “Our middle schools needed something.” In emergencies, people are often led by blind faith when the expertise offered to them is done by a reliable source. Despite the lack of clarity about the initiative, 18 principals agreed to the first step of the strategic triage plan of becoming STEAMier.

Next in line as responders were the teachers, since they would be implementing the STEAM Initiative curriculum and directly interacting with the middle school students. Just before the academic year began, teachers were informed by email that they were required to participate in the first phase of the STEAM Initiative. Unsure of what to expect, they blindly went alongside 25 of their colleagues to learn how this first triage phase would address the STEAM emergency. A teacher, from a large, specialized school, suggested to the research team: “It was time, probably overdue, respectfully, to get on board. I like to say STEAM isn't just Science, Technology, Engineering, Art, and Math, its students and teachers engaging active minds.” Many teachers made speculations about what need the STEAM Initiative was intended to address. But, without being thought partners in the triage process and unable to share both their needs and their students’ needs with STEAM experts before beginning the initiative, teachers could not imagine what to expect from their STEAM experience. However, teachers needed to effectively incorporate the 21st century skills that students so desperately needed for future success.

In order for STEAM participants to have had a positive and effective experience, it was essential that district leaders took pre- and early implementation strategies into consideration. It has been found in research that widely implemented approaches to teacher development have not been effective, particularly those aimed at reform, such as short-term workshops and fragmented courses (Yeziarski & Herrington, 2011).

B. Takeaway 2: Needed Goals and Outcomes

Goals and measurable outcomes should lead the STEAM continuation.

MNPS’ STEAM “triage unit” began in the district office; district leaders recognized the emergency with the middle school experience and opened their doors through funding and

staffing, which included contracting with Discovery Education. Discovery Education offered MNPS many resources, just like a hospital has many specialty departments in which to treat its patients. They offered online videos for multiple content areas and many hours of professional development. This array of resources was available to 450 selected middle school teachers, 25 from each of the 18 middle schools.

For teachers, the first days of the initiative coincided with their professional development days at the beginning of the school year. With minimal prior notice to the teachers, the STEAM Initiative summoned them. Teachers were not expected to create a triage plan; instead they engaged in professional development to learn about the initiative and how the resources from Discovery Education would fit into their respective classrooms. Four hundred fifty teachers from 18 schools, with varying degrees of experience, varying student populations, and varied goals, should have been exposed to the same introductory professional development. Although the number of teachers who actually attended is unknown, many teachers returned to their schools thinking that the STEAM Initiative would not meet their students' needs or address the emergency of the middle school experience. One teacher from a specialized, low performing school disclosed: "I'm trying to think if I sat through good professional development...I can't say that I did." Although some teachers left the professional development sessions and acknowledged that the experience was likely valuable to someone, they could not find the value for their specific contexts.

The first misstep in implementing this initiative was the lack of clear vision and goals during the professional development sessions. If first responders were not absolutely clear in stating their directives during an emergency, crucial seconds and lives would be lost. Unexpectedly, teachers were only introduced to the initiative via email a few days before professional development began. It can be said without a doubt that all teachers wanted a positive outcome for the sessions led by Discovery Education and wanted the district leaders to clarify what the vision, goals, expectations, and support would be for the initiative, instead of leaving more confused than they were originally. A teacher from a large, low performing middle school reported that the sessions "seemed like a big waste of time...everyone was coming back to school and having venting sessions." Leaving a professional development session with feelings of confusion and frustration from "time being wasted" does not result in teachers having positive feelings about an upcoming initiative.

Professional development for teachers is essential as most teachers improve over the course of their careers. In fact, teacher improvement seems steeper in recent years (Papay & Laski, 2018). Unfortunately, many professional development experiences are also considered ineffective (Darling, Hyler, & Gardener, 2017), which is precisely what occurred during Phase One of the STEAM Initiative. Effective professional development results from changes to teaching practice (Darling, Hyler, & Gardener, 2017; Hiebert & Morris, 2012; Kyndt, Gijbels, Groseman, 2016). The changes that district leaders wanted to occur in middle school classrooms would have benefited teachers by offering them a sustained duration of professional development during which time they have the opportunity to try what they should teach their students, work in collaborative teams, reflect on their practices through mentoring and feedback, be supported by a healthy school culture, and acquire materials that can be shared and improved. Much like the research on developing school culture and organizational capacity, professional development seemingly requires a content

focus, which is like a structured vision, and a culture of learning (Darling, Hyler, & Gardener, 2017).

Adding to the confusion about the entire initiative, resources seemed to be allocated across the schools inequitably. Unlike a true emergency triage situation, schools do not always have a supply of resources available to them on demand. Unfortunately, this was the case prior to the start of the STEAM Initiative and throughout the duration of Phase One. One teacher at a very low-performing school reported seeking separate STEAM training outside of the district. This teacher mentioned that “it [was] a lot of research from my part, to try to merge in other curriculums into my curriculum.” Across the district resource allocation was still an issue, as a teacher at another very low performing, yet small school reported that, “[STEAM] is not a not a one size fits all. Not all the same socio-economic or the same resources, for example, our kids don’t have the technology.” Many similar experiences were gathered from other teachers participating in Phase One. Another teacher shared first-hand knowledge with researchers, noting that resource allocation was inequitable. When discussing the STEAM committee, she said, “I know, because I was on the committee. They didn’t give us a dime to implement STEAM. We bought those STEAM kits with our own grant money.” Each of these perspectives indicate how dire it is to have equitable resource allocation when trying to address an emergency. It is unfair and unreasonable to expect for an initiative to be implemented with fidelity if all participants are not equipped with the same level of resources. We do not expect first responders to perform miracles without adequate supplies, and we should not expect our schools to do the same.

Teachers and principals looked to the district to establish common goals, provide adequate resources, and outline measurable outcomes, but those structures never came to fruition. No one could follow a non-existent plan. MNPS wanted to address the middle school emergency, but with all of these issues compounded, the STEAM schools were in a precarious position and, ultimately, set up for varying levels of achievement and success.

C. Takeaway 3: Personalized support

Personalized support is needed for collective growth.

Just as medical professionals go through extensive training to be specialized in one area of medicine, the same priority for training and support should be at the forefront of district leaders’ decision-making process. It is equally as important for teachers to receive specialized and personalized training and support when implementing an initiative of this magnitude. Teachers of the STEAM Initiative needed professional development and instructional leadership personally geared toward them and their students. Some teachers reported having implemented STEAM strategies for years, while others could not fathom how to incorporate STEAM activities in classrooms where students are perceived to have more basic foci or where novice teachers are most concerned with improving classroom management skills. Discovery Education responded to this need by adapting some of their later PD days, but for some STEAM schools that initial botched PD day was enough to make them ward off STEAM all together.

One important element that Discovery Education included as a part of the STEAM Initiative was facilitating meetings with individual teachers about their needs. As a result, Discovery

Education expected a positive ripple effect to occur within each school because eight innovators in every school were chosen for one-on-one coaching by their consultants. Much like furthering education credits and certificates, these Discovery Education consultants were charged with extending the learning of STEAM teachers between PD days throughout the school year. Fortunately, there were some positive interactions between MNPS teachers and Discovery Education consultants. One teacher from a small high performing school felt her Discovery consultant was “the best thing...Metro has ever done.”

However, the real lesson here is to incorporate opportunities for individualized teacher training and support from the preliminary planning stages. This was a great solution to solve a problem that occurred in the midst of the initiative. It was unfortunate that the original PD days, during which time the MNPS teachers spent time learning about the initiative, left many disillusioned, so much so that teachers complained to principals, who then complained to the district office, and finally to Discovery Education. Ensuring that teachers have productive learning experiences during initial PD sessions keeps a positive culture amongst initiative participants. This positivity also allows teachers to work in a collaborative environment and be receptive to the support provided by the district or outside resources, such as the Discovery Education consultants. Schools with collaborative cultures made strides in STEAM, some in conjunction with and others in spite of the district and Discovery Education’s influence. A principal at a low performing, specialized school understood the value in a collaborative culture. The principal indicated: “To me, the cultural changes are more important than the programmatic changes, because, like in this situation, funding goes, and then the resources go, but if you haven’t made it part of your culture, you stop, it stops. So, I’m excited to see that there are a handful of teachers here that are like, No, we got to keep going with it like this.” The district and Discovery Education relied on the idea that School Culture would support collaborative practices that would lead to a dissemination of STEAM knowledge and practices.

The teachers of Metro Nashville schools presented themselves as dedicated professionals who actively sought increased enrollment and higher exam achievement through rigorous classroom expectations. They believed in the district’s instructional framework of collaboration, critical thinking, communication, and creativity to prepare students for 21st century college and careers. STEAM provided many resources from which they have, and they might continue to, build their best teaching practices. Teachers and principals look to the district for a stable and clear vision, goals, resources, and measurable outcomes. They look to their own professionalism to find the path to meet those often elusive, district-established goals and outcomes. Teachers will always appreciate support, especially from expert sources, especially when that support is personalized to their needs as professionals and to the needs of their own students and contexts. They also value the acknowledgement of their own professionalism and value being included in the decision-making process; even more so, when an emergency is at hand. Finally, many schools model outstanding practices in adult collaboration, which lead to the dissemination of learning among teaching colleagues in an effort to improve achievement and the value of the middle school experience.

VI. Recommendations

A. Recommendation 1: Collaborative Mission and Vision

Collaborate with teachers, school counselors, and principals in preparation for STEAM success to ensure a clear, relevant mission and vision.

One of the most consistent findings of the study was the nearly unanimous perception among teachers, principals and district officials that STEAM was needed. In contrast to this finding is the equally prominent counter-factual found across interviews: teachers struggled to adapt STEAM to their own classrooms. This capacity issue was linked to a lack of pre-planning as the district's vision never became the teachers' or principals' vision. Additionally, district leaders need to include school counselors' vision, since the focus is to prepare students for college and career. School counselors have a unique perspective and can provide additional support in ensuring that students are meeting academic goals. Therefore, our first recommendation is that the district collaborate with teachers and principals in preparation for future STEAM success, ensuring a clear and relevant mission and vision.

Peter Senge and his colleagues (2000) recommend that a learning process begin with self-reflection. When a teacher imagines, without limitation, a successful implementation of STEAM in her specific classroom, what would be happening? What does it look like, feel like? How would the teacher describe it? (Senge, Cambron-McCabe, Lucas, Smith, Dutton, & Kleiner, p.61). Sharing the images of an ideal STEAM Initiative in the context of a single classroom and then in a single school will help teachers and principals conceptualize how STEAM will be valuable directly to them in teaching their subject area, the 4Cs, or helping their students achieve on state exams.

After imagining a successful STEAM implementation in individual classrooms and in the school as a whole, teachers and principals will need to constrain their vision by the current reality. Discussions about choosing strides to move toward their vision must occur, focusing on that which can be done rather than that which cannot. As steps are taken to close the gap between the current reality and the shared vision, a sense of personal mastery is created: "The practice of personal mastery keeps engaging [teachers] to set their standards higher, . . . expand and deepen their vision, and challenge themselves further" (Senge, et.al., 2000, p.65). This process of imagining a personal vision and finding commonality with colleagues will lead to a future that STEAM teachers will want to create together.

B. Recommendation 2: Stability and Clarity in Goals, Outcomes, and Teams

Strengthen stability and clarity through organized and shared goals, measurable outcomes, and team-based learning.

Just as doctors can encourage a protocol of healthy living, teachers can develop a protocol of productive learning. Therefore, this study's second recommendation is to strengthen stability and clarity through organized and shared goals, measurable outcomes, and team-based learning. Successful organizational capacity is supported by stability and clarity. Stability stems from stable funding, consistent participation, organized and

shareable information management, and supportive leadership. Clarity is defined by a shared vision, understandable goals, benchmarking, and the sharing of feedback, which provides an evaluative learning cycle (Malen, et al, 2015).

Organized and Shared Goals

Providing a clear vision will create STEAM enthusiasm and interest (Goh, Cousins, & Elliott, 2006). STEAM can only function as the center of the middle school culture if a teaching team collaborates in support of a shared STEAM vision, trusts teammates enough to expose their own thinking, seeks others' feedback, is reflective of their own practices, and works through interrelated actions with their teammates (Senge, 2006).

Measurable Outcomes

Organizational structures that would lead to measurable outcomes include the following: developing a standards-based implementation plan; creating a common rubric for evaluation; analyzing and evaluating rubric data; developing an organizational infrastructure to allow for sharing of knowledge and discussion of rubric feedback (Malen, et.al. 2015); investing in expert support like instructional coaching; and developing a system to measure district adherence to the initiative (King & Bouchard, 2011).

STEAM-team professional learning

The development of goals and outcomes can only be successful if it stems from STEAM teachers and principals themselves. Findings showed strong similarities in teacher and principal perceptions of the initiative, indicating that a district-driven agenda is not the best route to STEAM success. Schools might consider organizing teachers' schedules and room spaces to facilitate STEAM collaborations. Perhaps STEAM teachers could be in one wing of a building or all STEAM teachers could all have planning at 9:00am. Outstanding instructional leadership does not necessarily have to stem from the appointed leader of the school, the principal, or the appointed STEAM leader of the district. Reciprocal instructional leadership relationships can be developed among teaching colleagues to support STEAM. Logically, if a school or district is expecting an enhancement of student learning, the teachers must also be continually learning. For example, teachers can experience instructional leadership through a professional learning community, which "is comprised of collaborative teams whose members work interdependently to achieve common goals for which members are mutually accountable" (DuFour, DuFour, Eaker, & Many, 2006, p.11). A part of a STEAM professional learning community, teacher-led teams would meet regularly during the school year to develop common plans and common assessments, to review student work and to decide together how to respond to students who need further support as well as to those who need enhancements to meet their learning potential.

In fact, "physically placing master teachers, highly effective teachers, or coaches in central locations where they are closer to—and more likely to cross paths with—their colleagues would increase the probability that these individuals interact with and influence others. School leaders also could place lower performing or inexperienced teachers close to high performers, or place staff with complementary strengths and weaknesses in closer proximity" (Spillane & Shirrell, 2018, p.73).

When a school principal and team of teachers find themselves starting a new initiative like STEAM, they may not feel prepared to lead instruction. In this circumstance, it was and

continues to be beneficial to seek instructional leadership using external expert supports. This instructional leadership support focuses directly on improving curriculum, pedagogy, and assessment of the instructional core, as well as developing a teacher and principal support network (King & Bouchard, 2011). Discovery Education's one-on-one consultants were the most valued professional development of the STEAM Initiative and them, or a similar organization, would be an imperative addition to continued success. Continuing that expert support within the guidelines of schools' visions and the district's goals and outcomes would continue to benefit STEAM teachers and students because it offered a sustained duration of professional development during which time teachers had the opportunity to try what they should teach their students, work in collaborative teams, and reflect on their practices through mentoring and feedback (Jensen, Sonnemann, Roberts-Hull, & Hunter, 2016).

One of the difficulties of providing external experts in public schools is cost. MNPS might consider seeking outside sources of funding to create the stable financing of the initiative. A similar external financial and instructionally supporting partnership affords economically and racially diverse schools in Wisconsin support through the University of Wisconsin-Madison's Department of Educational Leadership and Policy Analysis and the State Department of Education: "Both the state department and the school district provide the funding for the leadership coaching positions and project management with the university. Annual funding is about \$60,000 per school" (King & Bouchard, 2011, p.9).

Teachers and principals in MNPS middle schools are interested in developing a true professional learning community centered on STEAM. They embrace the potential of the 4Cs, would support the development of STEAM-team-based goals, and would benefit from STEAM-team-based planning and implementation teams.

C. Recommendation 3: Target Support to Specific Needs

Target support to the specific needs of students and teachers, while focusing on academic growth and student care.

As MNPS implemented the STEAM Initiative widely in 18 of their 33 middle schools, the number of sites, and the variation of size, specialty, and student achievement level became special considerations in measuring perceptions and applying extant literature. Noted researcher and educator Richard DuFour et al. suggested, "Even the most promising strategies must be customized for the specific context of each district and school," as the most effective improvement models stem from teachers who adapt their learning to their classroom situations (2006, p.5). This specialization of strategies is particularly important for MNPS because unfortunately, widely implemented approaches to teacher development aimed at reform, such as short-term workshops and fragmented courses, have not been effective (Yeziarski & Herrington, 2011).

MNPS must foster schools' cultures of learning. Changing a school's culture is difficult because schools are characterized by deep patterns of how they do business (Murphy & Torre, 2014). Yet developing the school culture and climate is receiving considerable literary attention, especially in schools that are perpetuating achievement gaps and social inequalities like the Metro Nashville middle schools (King & Bouchard, 2011). These

schools require additional attention given that “schools with stronger initial levels of capacity are more likely to use reform efforts in ways to further enhance capacity” (King & Bouchard, 2011, p. 659). Therefore, any and every school would benefit from developing internal STEAM strategies to implement within their grade-level or content-level teams as well as systems to share their growth with other schools and with the school and district leadership.

Focus groups including teachers interested in starting or continuing STEAM as well as principals, district STEAM leaders, and Discovery Education leaders who together understand the needs of the particular students and the services and resources available should gather to discuss their vision of STEAM and their current standing in STEAM and how to bridge that gap. One-on-one or grade-level or content-area Discovery Education consultancy support would continue to be beneficial for STEAM teachers and STEAM teams to support continual differentiated adult learning, which will in turn, ensure growth and achievement for students.

VII. Conclusion

Metro Nashville Public Schools strategically introduced a STEAM Initiative for its middle schools in the 2017-2018 school year. This study investigated and analyzed the initiative's first year of implementation using primarily qualitative data. School districts across the nation, large and small, are attempting STEAM Initiatives in hopes of boosting test scores, emphasizing 21st century skills, and increasing student engagement. Further research on STEAM is needed, but that research depends upon the implementation of STEAM Initiatives. The focus of this report, and accordingly its recommendations, is on the implementation of the initiative. The district's commitment to students provides an excellent opportunity for continued growth and learning from their own initiatives.

Research Question 1: How did the implementation of the STEAM Initiative unfold across the district?

The research team found that the overall implementation of the STEAM Initiative unfolded haphazardly - lacking clearly communicated objectives and measurable outcomes. The district imagined STEAM goals before the initiative began, including using project-based learning techniques, creating interdisciplinary connections, emphasizing the 4Cs, integrating technology, developing social-emotional learning strategies, and emphasizing equity. Stakeholders interviewed for the report indicated various degrees of implementation of these goals at the different schools, but most could not identify these as the actual goals of the STEAM Initiative.

Likewise, the STEAM plan included STEAM-school-wide implementation of the Discovery Education curricula, increased interdisciplinary teacher collaboration, new honors courses, an emphasis on a growth mindset, two-to-one student-computer ratio, and accessible and well-equipped STEAM physical space. Realistically, teachers had access to the Discovery Education curricula as well as professional development to learn to use it and one-on-one consultants for individual application in the innovators' classrooms; there also seemed to be examples of increased collaboration among a few of the visited schools. None of the interviewees, however, mentioned a STEAM physical space, and the only schools that had a two-to-one student-computer ratio were schools that used their non-STEAM allocated money to obtain them. Last, MNPS announced partnering with more than just Discovery Education, including Buck Institute for Education, AdvancED, SpringBoard, and Microsoft's Imagine Academy, yet none of these were mentioned in any of the interviews, with the exception of AdvancED's STEM certification program that was mentioned in passing by two separate administrators.

In summary, the implementation unfolded far from the fidelity target and teacher and administrator perceptions, and interpretation of goals, if they could even recall them, varied from school to school, or sometimes even within a given school. The research team recommends a continued implementation of STEAM after the development and clear communication of the STEAM goals, objectives, and measurable outcomes.

Research Question 2: How did Instructional Leadership, Professional Development, School Culture and Climate and Organizational Capacity influence the implementation of the STEAM Initiative?

Using these four interconnected lenses from the extant literature, the research team found that each played a role in encouraging individual schools down a unique implementation path. Overall, the STEAM concept was largely valued, but each school folded it into the fabric of their school culture in a unique way, depending upon the existing norms and expectations, the school-level administration, the buy-in and make-up of the STEAM team, and the relationship that developed with Discovery Education consultants. All interviewed schools showed signs of becoming STEAMier throughout the implementation process, despite the haphazard way implementation unfolded.

In terms of instructional leadership, most school-level administrators were new to STEAM, therefore instructional support was largely outsourced to the Discovery Education consultant—many of whom left a positive impact on the innovators with whom they worked. The district should consider including one-on-one expert consulting as a possible next step for continuing the initiative.

In terms of professional development, teachers were overall dissatisfied. The initial STEAM PD was surprising, time-consuming, and not well received. There is great potential in professional development that gathers STEAM participants from the same content area across the district, from the same grade level, from the same school, and for PD that uses experts or local teachers as presenters. This PD should be planned well in advance, catered specifically to its audience, and not occur on school days when students are present.

In terms of school culture and climate, every school thought STEAM was a natural fit for them, regardless of achievement level, size of school, or community or academic partnership. STEAM is valued and has been incorporated into each school's ecosystem. Because of the haphazard way the initiative was implemented across the district, STEAM looked different, sometimes drastically different, at each school. The district could capitalize on the innovative and customized tactics of the STEAM schools and ask them to present their own successes and concerns within the district.

Last, in terms of organizational capacity, it was evident from the interviews that the lack of planning and resources substantially influenced the implementation of the initiative. The district should review and reconsider the allocation of resources and the alignment or misalignment to the initiative's goals.

Research Question 3: How did teachers and stakeholders perceive the STEAM Initiative?

Overall, teachers and principals found aspects, strategies, ideas, or concepts to keep and build upon throughout the year, even though most perceived the STEAM implementation poorly. When teachers talked about the components of STEAM, such as collaboration, critical thinking, problem solving, cross-curricular planning, and making their content relevant to their students' lives in the 21st century, teachers thought they were valuable; most thought they already were doing them to some degree. Negative perceptions stemmed from poor district communication and feedback loops, irrelevant PD, and a lack of real resources. Nevertheless, teachers found a way to make their classrooms and schools STEAMier than they were prior to the initiative. The district could build upon the ingenuity, creativity, and resourcefulness of its teachers, while also considering how it could make improvements in the areas of communicating objectives vertically down to teachers, relevance of professional development, and appropriate resource allocation.

VIII. Limitations and Future Research

The current study offers a snapshot of the perceptions of a sampling of stakeholders from the STEAM Initiative, yet with hope that the initiative will continue, future research would be beneficial to the MNPS district and to similar districts seeking to implement STEAM.

A. Limitations

The study was limited by selection bias. To gather all the stakeholders' perspectives, the study would have included students, families, Discovery Education consultants, the superintendent, and the board of education's members as well as the perspectives that were actually gathered from STEAM teachers, principals, and district personnel. From the perspectives gathered, every effort was made to interview schools that represented the district as a whole, yet there was no randomization in selecting the schools for the STEAM Initiative from the beginning, no randomization in selecting the nine schools to be interviewed for this study, and no randomization in selecting which teachers to interview within schools. MNPS chose schools to participate in the STEAM Initiative based on the pre-implementation readiness survey. Schools were chosen for this study based on their participation in STEAM Initiative of 2017-18, size, specialty, and achievement ranking. Interviewed STEAM teachers were selected by principals, primarily based on their schedules on the interview days. Each participant was aware that they had been selected for the interview because they were a MNPS employee who participated in the initiative.

B. Future Research

With the hope that funding is found to support a continuation of the STEAM Initiative, additional research is recommended. Data should be gathered from all Phase One STEAM participants to determine which of them wants to re-engage with STEAM and what they see as future STEAM goals for their specific students. Then, focus groups in each school comprised of interested teachers along with the district's STEAM director and a Discovery Education leader, who are knowledgeable about the available services and resources, should develop a STEAM dream together. Once focus groups have determined the school's needs and plan, the district should cluster schools with similar needs to draw benefit from the economy of scale of such a large district without forgoing the individual needs of each school.

After establishing schools' needs, available services, and available resources, Metro Nashville should determine the overarching goals, objectives, and measurable outcomes for the STEAM Initiative and share them with all stakeholders. Offering clustered support and allowing for individual school adaptation, the district will gather feedback systematically, regularly, and openly about progress toward the newly determined goals, objectives, and measurable outcomes, and actively seek to understand how teachers across the district are adapting unfolding the initiative in their own schools.

After Phase Two, a repeat of this study would help district personnel understand if the implementation is proceeding better than the first time. After the completion of the three phases of STEAM, an impact study would be useful to measure student growth and achievement, and a clustering of results should be presented by size, achievement level,

community or academic partnership, and finally, by beginning phase of each school or perhaps each teacher. It would be interesting to know if the Phase One schools will benefit most from STEAM after the completion of the initiative due to having the most time entrenched in the concepts, or whether Phase Two will likely supersede the successes of Phase One participants because of the improvements made at the district level in communication, resources, and relevance.

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X. Appendices



Appendices

A. Appendix A: Methods for Gathering and Analyzing Qualitative Data

Interviews. Through interviews, the research team explored how MNPS' teachers and administrators perceived the implementation of the STEAM Initiative.

The interviews, which lasted between 30 and 50 minutes, were conducted using the interview protocols created specifically for the teachers, principals, and district personnel. Through the main questions, probes, and follow-up questions, researchers were able to glean the themes, patterns, and insights connected to the study's conceptual framework. Patton (2002) argued, "qualitative inquiries study how people and groups construct meaning," and the interviews allowed the research team to find "substantively meaningful patterns and themes" (p. 5). All interviews were recorded digitally in order to ensure interviewee responses were captured accurately and completely. All interviews occurred on site with a few exceptions for non-school level interviewees.

Documents. Through a review of concrete artifacts, the research team sharpened the conceptual understanding of MNPS' STEAM Initiative. "Documents provide the inquirer with information about many things that cannot be observed," such as "aspirations, arrangements, tensions, relationships, and decisions that might be otherwise unknown" (Patton, 2002, p. 376). Specific analyzed documents included interview transcripts, the MNPS website, the MNPS instructional framework, the Discovery Education website, district STEAM media releases, news reports from the STEAM launch, state report card data for the district and for each school, the STEAM readiness survey, district PD data, photos of STEAM projects, and samples of STEAM projects.

Site visits. Through site visits to nine schools, the research team had the opportunity to talk with teachers and principals, watch a STEAM related-arts class, take photographs of STEAM projects, and glean a general sense of school culture by interacting with various STEAM participants. Site visits allowed the research team to better understand the symbols, rituals, and context of the STEAM Initiative.



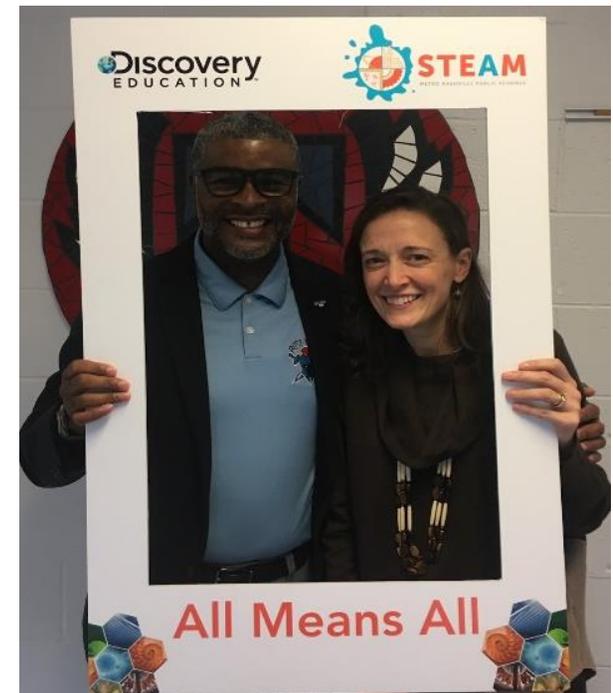
Current MNPS STEAM Projects

The research team used three main strategies to analyze and organize qualitative data: 1) individually completed analytic memos, 2) listening tours, for each interview, and 3) concept clustered matrices.

Analytic Memos. After completing our interviews at each school site as well as with district personnel, the research team wrote analytic memos to reflect on the experiences as a whole. The writing was in first person, narrative in form, and highlighted the themes that emerged from the interviews. The memos helped the researchers reflect on the visit and begin to decipher the data. After sharing with the research team, a listening tour was implemented to analyze each interview.

Listening Tour. The *listening tour* was a data analysis strategy that called for the researchers to listen to the same interview three times, each time focusing on a different component. The first time the researchers focused solely on gaining familiarity with the particular interview. The second time they connected interview response ideas to the project's conceptual framework within the four lenses: Instructional Leadership, Professional Development, School Culture, and Organizational Capacity. The third time researchers noted illustrative quotes and other forms of evidence, such as observations and documents, for each theme that emerged from the interviews. Between the listening cycles, the research team continued gathering the consistent ideas emerging within and among the interviews. After writing analytic memos and completing listening tours, the team compiled all the data collected from the listening tours into a concept-clustered matrix.

Master Matrix. The concept clustered matrix allowed for organization and analysis of the qualitative data based on the conceptual framework, combining not only the main ideas and key quotes, but also gathering documents and observations. The team then combined the individual matrices into a master matrix. This master matrix encompassed all the responses within the conceptual framework to allow for a gathering of the overall perspective of participants, but it was also coded for each category of interviewee: 1) core teacher, such as science, math, social studies, or English; 2) specialty teacher, such as librarian, STEM teacher, PE teacher, or music teacher; 3) school principals; and 4) district personnel, such as STEAM instructional or technological coaches and STEAM director; then, each category of school: small or large; high, low, very low achieving; and specialty or traditional. This final procedure was designed to help researchers conceptualize all the data as a whole as well as to see commonalities in clusters, so that the final findings could be generalized to the district or specified to certain participants or types of schools to ensure appropriate recommendations for the future.



Vanderbilt research team member visiting STEAM schools

B. Appendix B: Master Matrix

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Organizational Capacity	Needs Assessment	Job market; build excitement for learning; inquiry thinking (we don't want to teach them rote); it is actually time, actually	"it was time, probably overdue, respectfully, to get on board." "I like to say STEAM isn't just Science, Technology, Engineering, Art, and Math, its Students and Teachers engaging active minds"	core teacher	large	low	special
		There are a lot of teachers in our district who were not teaching the foundations of STEAM; probably for the older teachers; There was some older teachers that needed this You don't have to spend millions on PD...	"if you are following the TEAM rubric in your everyday lesson you should be including all of that (STEAM stuff)" "It would have been so great to hear from a teacher who is really good at implementing STEAM in their classroom and teaches in a 5th grade classroom"	core teacher	large	low	special
		Trying to Raise our math and science test scores, by going more hands-on and greater collaboration		core teacher	large	low	special
		Critical thinkers		core teacher	large	low	traditional
		They wanted to combine humanities with art/science		core teacher	large	low	traditional
		Solved the problem of creating a greater awareness in science, and making students more science ready		core teacher	small	very low	special
		Solved the problem of having more engaging instruction		core teacher	small	very low	special
		STEAM did not solve any problem, just took money and time from teachers	STEAM is just the hands on, math and science, and projects. It was a culminating activity, but that's what we already do as educators.	core teacher	small	very low	special
		District was trying to get students to understand what other careers are available to them		core teacher	small	very low	traditional
		Teach students 21st century skills and get Nashville students aligned with the rest of the country; we want National leaders		core teacher	small	very low	traditional
		problem of sending equipped students into the workforce for the growing number, in esteemed careers.		core teacher	large	very low	traditional
		purpose was to build bridges to scientific skills because students weren't prepared to collaborate or problem solve, test scores were low in science		core teacher	large	very low	traditional

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Organizational Capacity	Needs Assessment	combatting lower order thinking in classrooms, but it didn't align with instructional needs	STEAM doesn't necessarily always correlate directly to them performing. it's not the same type of task and thinking that they're always being asked to do on the tests.	core teacher	large	very low	traditional
		Level the playing field, some interdisciplinary aspects of instruction, beefing up the science instruction and just bringing us up to speed on project based learning		non-core teacher	small	very low	special
		On paper, it was 100% a great idea... but every bit of the implementation has been...	Lack of critical thinking	non-core teacher	small	very low	traditional
		STEAM initiative was in line with districts goals,		non-core teacher	small	very low	traditional
		Knowledge of other careers		non-core teacher	small	very low	traditional
		Prepare kids for the future		non-core teacher	small	very low	traditional
		student loss in middle school	We are a neighborhood school. We have zoned kids and some are bussed in from Edgehill. We get the Green Hills population. In 7th and 8th grade, we lose kids to other schools.	non-core teacher	large	high	special
		Exploring high school pathways, 21st century skills, 4Cs	I think they were trying to get middle schools a chance to explore like in high school. Let me get some ideas on some things that I could do to figure out what Academy I want to do.	non-core teacher	large	low	special
		Address retention at middle school teir Enhancing the teaching and learning experience		principal	large	low	special
		Engagement and rigor in the classroom; teach 21st century skills... the new ones, now that its 2018		principal	large	low	special
		Didn't need it, already doing it	Some schools had already been doing hands on learning and project based design. This is part of IB program. And then those initiatives have been in the district since the last administration. So this was not that big of a shift. I think it failed because they tried to cookie cutter and make it the same for every school.	principal	large	high	special
		Problem to solve was student engagement, hands-on learning in every classroom, grow test scores		principal	large	high	special

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Organizational Capacity	Needs Assessment	Student achievement, student grown, and increase enrollment		principal	small	very low	traditional
		One principal have a very clear understanding of why middle school STEAM as a District Executive Director, AP over high school health sciences, she noted...	"The biggest problem that our district was trying to solve with STEM for middle schools was to raise the rigor and engagement for our middle schools. There were we spent 10 to 12 years redesigning our high schools, we spent a lot of years impacting reading at the elementary during that time, we had no focus on what was happening in our middle schools. And then when we start looking at data, it's like, ooh, our high school in our kids are graduating more, they're engaged in more they're getting all these, you know, industry certifications are right kids are growing, but our middle schoolers, we're losing a lot of our middle schoolers to charter schools or private schools or why right? Well, it's because we're not engaging our middle schools and their developmental level for things that connect them to what's happening at the high school. And then building on what's happening in elementary. Our middle schools needed something."	principal	large	low	special
		moving from that teacher center focus to a student centered focus, student understanding of how the concepts relate to real world, and connections to future jobs and careers		principal	small	high	special
		address MS education (transformative process)	"I mean, I can tell generally, I don't know what you know, specifically...but i'm going to assume it was to address middle school education. Meaning that, we've focused on elementary, we focus on high school, but we haven't really focused on transforming our middle school. So I kind of see it as trying to be a transformative process to improve teaching and learning."	district			

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Organizational Capacity	Needs Assessment	drop in enrollment in MS (students going to charter, private, or homeschool) wanted to make middle schools attractive to parents initiative fit in with strategic plan in some pieves, but not totally vision/mission aligned too many mandates/initiatives		district			
		elem students leaving when its MS time wanted something new; inquiry approach more teaching thru doing attract and retain students that were leaving for MS increase rigor in a diff way to boost attendance		district			
		equity issue in quality of school experience (student achievement) science instruction on backseat (elem + MS level) textbooks decades old/quality senior leadership made decision then charged him w/task		district			
		low achievement (test scores) at a lot of schools increase literacy (science literacy = STEAM)		district			
		Strong support from Prinicipal and Discovery Ed; - funding for the individual classroom was lacking, we didn't have the lab equipment we needed to do the STEAM - The science kits are not made for 6-8th grade - not every kid has a class set - Very few computers in the building - Lack of resources		core teacher	large	low	special
	Org Capacity Building	Zoo Partnership, we bought more computers and cameras; We don't have enough computers; Experience working with PBLs;	"I don't think the district will ever go 1:1"	core teacher	large	low	special
		Discovery Ed had activities for history I could access		core teacher	large	low	traditional
		The district took away student opportunities to learn because the teachers were taken out of class for this so often.	They basically just gave us what we already have. They just taught us to navigate through the Discovery, the online platform, and the district already had that.	core teacher	small	very low	special
			"Every part of the implementation was unorganized"	core teacher	small	very low	traditional

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Organizational Capacity	Org Capacity Building	Consultants worked with us, they gave us resources		core teacher	small	very low	traditional
		No clear structure in place, which is why it probably failed.		core teacher	small	very low	traditional
		Lots of PD and a coach for innovators	There were a lot of structures, but not very well executed.	core teacher	large	very low	traditional
		Last year one teacher worked with outside resources to create STEAM connections, which is impacting grade level collaboration and STEAM practices this year.	In our collaborative planning every Thursday (this year), we talk about STEAM and try to build a project, one every nine weeks.	core teacher	large	very low	traditional
		No money for materials	"I am always collecting stuff."	core teacher	large	very low	traditional
		Barriers were time and resources	Some of the more hands on learning things we wanted to do, we just didn't have money to do it. We don't have a supply closet.	core teacher	large	very low	traditional
		After a whole year and coaching, ending the program left her confused in knowing the goals of her teaching and the expected pedagogy	I think the biggest confusion for me, it's like it was such a push last year and like, this is what we're gonna do this we're going to get on board with and trying to get on board with that. And then just having it dissolve, now I'm confused where that fits with my pedagogy. Am I supposed to be doing that and are we done with that I we like where does that fit?	core teacher	large	very low	traditional
		As a new teacher, she kept receiving emails about STEAM team and STEAM, but she assumed it didn't apply to her, so she just deleted them and didn't go to the initial training.		core teacher	large	very low	traditional
		Discovery Ed is an online platform, that is very expensive, that the district pays for.	it's a place that they have a lot of videos, a lot of images, a lot of things that will go along with the social studies standards,	core teacher	small	high	special
Discovery Ed online to replace out textbooks, PD and coaches came twice a month to plan and implement lessons with us	If it's a video, they got a video with the questions. If it's a sound clip, you can listen to and have questions. They got enough on there that you could do one everyday and it isn't the same thing. And then they have the primary source documents, pictures, everything, I don't have to go hunting 20 million places. Most of it is right there. It's perfect.	core teacher	small	high	special		

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Organizational Capacity	Org Capacity Building	to increase student knowledge through increased rigor		core teacher	small	high	special
		Brought in a Science Resident - full time professional scientist to work with teachers; - Funding is not there to get the results we want		non-core teacher	large	low	special
		JB spent \$13k on STEAM kits... they work great, but with out them we wouldn't be doing any STEAM... STEAM initiative did not pay for this		non-core teacher	small	very low	traditional
		None... We have science and math teachers in the building... but that's about it...		non-core teacher	small	very low	traditional
		All schools received \$7000 to buy whatever they wanted in technology	All 18 schools got \$7000 in tech, Makerspace, Raspberry Pi, Green screen, tripod, cameras: Technology requested last spring through STEAM initiative arrived this fall. There are so many positives that came out of it, like the new technology, that we didn't see at the beginning.	non-core teacher	large	low	special
		Barriers included time to plan together, didn't meet as a school until October	Time to plan; not everyone went to Discovery Ed and there was not enough time to share what they learned. Everyone missed one training for another.	non-core teacher	large	low	special
		Feeling of increased capacity at Oliver	This year, it was reiterated that (last year) was just a year to get our feet wet. We are more comfortable implementing STEAM.	non-core teacher	large	low	special
	Org Capacity Building	Zoo partnership, design center, strong foundation; environmental/conservatio/science focus Already had strong partnerships; on the front end, the district was very organized and made it easy to get started - Big difference between filling out the STEAM application for the district and going through an actual process that transforms you into a STEAM school - more than just a label		principal	large	low	special
		1:1 technology; we had the confidence... And then the district forced unnecessary PD days		principal	large	low	traditional
		lack of focus, changing leadership killed the initiative		principal	large	high	special
		They promised us 2:1, but they gave us carts that didn't match our classrooms; I had to do a lot of research myself to understand what STEAM was all about; we only had a single day of PD, but it was abstract; lack of leadership (no director for most of the year)		principal	small	very low	traditional

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
		Who was ultimately responsible for the program? Principal, leadership team	the principal initiated but the development of a teacher leadership team to continue it wasn't fully established.	principal	large	low	special
		prepared for changing society, hand-on, collaborative, engaged	That's what STEAM does, really driving home those future jobs and careers.	principal	small	high	special
		professional development, made specific to content areas (after the first one), support from coaches (twice a month), principal was "all into STEAM"	Social studies teachers weren't really sure how to utilize STEAM as much so I think the professional development structure was really important.	principal	small	high	special
		School felt so successful because there was an outside company Advance, who did a preassessment, shared reflective data, and a rubric to measure STEAM		principal	small	high	special
		Teacher buy-in - change is scary, most embrace it, but some don't and for some, it took a while	It took up all of our professional development dates for the year. So for some teachers, that was hard, because that wasn't the only thing that they felt they needed help with.	principal	small	high	special
		Once school created their own structures, focusing on common lesson planning formatting focusing on real world application in all subject areas, leading to increased student engagement		principal	small	high	special
		program measured by conversations with Central Office personnel, but nothing tangible		principal	small	high	special
Organizational Capacity	Org Capacity Building	Discovery Ed led process and worked w/innovators at schools pull out model and coaching on site; off site PD 5 learning tech specialists who worked with 18 schools all schools were either in phase 1, 2, or 3 3 STEAM coaches		district			
		assigned a site based coach and attended one PD day	They made it a top priority as far as finding an outside source for coaching, they were visibly committed to the work, but now they're not here, the coaches from discovery, so we will need to take it on, so I don't really know what's going on right now	district	small	very low	special
		had the idea, but not truly developed expectations not clearly defined not prepared/no plan		district			

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Organizational Capacity	Org Capacity Building	<p>structures were created on a coach to coach level they were hired under one director then received a new director and he went on leave, they didnt have a director most of the time</p> <p>the goal was coaching, not the structure</p> <p>each coach created own model; she went school by school and sent out emails</p> <p>lots of Discovery Ed collab. every school had a diff coaching model (Discovery Ed)</p> <p>easier for her to fit in structure around 4Cs --> more engagement in science</p> <p>used 4Cs rubric created by Discovery Ed as convo starter</p> <p>SKILLS: relationship building = huge w/coach; being able to work well w/others; be very resilient led PLCs based on science standards (one school in particular)</p> <p>collaborative shift in practice communication was huge --> sometimes had to pop in; email was main method of communication (didnt get the best response rate) needed relationship with principals as well organization was key --> files for each teacher on google drive balance between schools; didnt want to fall in trap of only visiting schools where she felt welcome; equitable but not equal (used data to plan and be very strategic) strengthen presentation skills --> very intentional about speaking in front of adults</p> <p>instructional background/previous coach experience (research based)</p>	"Unfortunately, structures were kind of created from coach to coach level."	district			
		<p>perspective --> announcement that Discovery Ed was partner</p> <p>no knowledge about goals/vision</p> <p>supportive in terms of resources (multi million \$ package - Discovery Ed)</p> <p>requested coaches</p>		district			
		<p>contracted w/Discovery Ed</p> <p>PD sessions and had own Discovery Ed consultant to help w/innovators</p> <p>skills: open mind, pedagogy, willingness to put in effort and time, determination, persistence</p> <p>nothing that motivated her</p>		district			

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Organizational Capacity	People Capacity Building	Lewis had high expectations for the science teachers, we are already a solid group;	"In order to be a good teacher, I have to implement STEAM"	core teacher	large	low	special
		We were all doing the STEAM anyway... its just a good way to teach	"All the science teachers here are pretty much the same thinkers" "We learn more from each other than any of the PD"	core teacher	large	low	special
		Discovery Ed person was monumental and super helpful in helping us as a school guide us into becoming a STEAM school		core teacher	large	low	traditional
		There were no clear objectives; they never took it to the next level, they gave us the resources, but where are we going with this...	Felt like a dog chasing his tale	core teacher	large	low	traditional
		Motivating - yes	That was what it was designed to do; anything hands on and engaging I'm always motivated to try to do doesn't always work out once you get into class trying to do those things, but it's always exciting and things you want to try. - KR	core teacher	small	very low	special
		created positions: A Discovery coach came to the school and there was a STEAM related arts teaching position, which is not gone		core teacher	small	very low	special
		some confusion on which teachers held which roles: were you STEAM trained or were you an innovator?	I don't even know. I went to training in summer, and then I was an innovator. And then I wasn't, but I did have someone come into my room, but the person changed to Dr. Flood and then I wasn't anymore-TP	core teacher	small	very low	special
		Lack of motivation (note: all JB teachers teach a STEAM class;	Lack of motivation, like, I already teach two subjects and an RTI and now you want me to teach a STEAM class	core teacher	small	very low	traditional
Capacity	Building	I had no idea what STEAM was, then I realized it was nothing more than what we were already doing... We weren't sure what it looked like in a classroom; attitude was okay here's something I have to do... it was often not sure of what I was supposed to be doing; last year there were a lot of things that I implemented that I have never done before... a lot of it was fun and students were enjoying themselves	"You call me a STEAM innovator; I have gone to the trainings. But what am I supposed to be doing?"	core teacher	small	very low	traditional
		Discovery Ed people had ways to close gaps in our knowledge - which was helpful		core teacher	small	very low	traditional
		only additional skill was time to sort it out		core teacher	large	very low	traditional
		Foci was scattered - implementing all the things she lists here (interesting, she didn't mention STEAM as one of the things)	"Cloze reading strategies, 4 Cs, Holstein implementation, IFL lessons, project-based learning"	core teacher	large	very low	traditional

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Organizational	People Capacity	STEAM teachers had to be good at technology, know how the website worked	"I'll be honest. I didn't use Discovery Ed. much."	core teacher	large	very low	traditional
		Once the teacher was "promoted" to innovator in February or March, she had a great partnering experience with the Disc Ed coach	She was really helpful and she was really good about getting me strategies I could apply with kids who have low levels of academic language, and being able to kind of help them express their knowledge in ways other than reading and writing,	core teacher	large	very low	traditional
		Barrier for me was planning time, other teachers partnering with other outside sources (Vanderbilt) had 4 weeks in the summer to plan with their support person	we could have had some just time to plan out some actual lessons to get the school year started. That would have been awesome.	core teacher	small	high	special
		Discovery didn't work right away		non-core teacher	small	very low	traditional
		We had lack of supplies and resources and money... Most people in th building didn't want to do the PD or the initiative... We had enough training (1 PD and a lot of meetings)		non-core teacher	small	very low	traditional
Organizational	People Capacity	Disc Ed coach - no impact	I met with the Discovery Ed. Coach, but he didn't have anything to offer that was different than the way I already teach. I have always used STEAM ideas. I think we had two consultants, one in the beginning and one in the end. For me, it was just another person who wanted to watch in my classroom. She did share some things from Discovery Ed. Mostly I already knew it.	non-core teacher	large	high	special
		trainings left everyone a bit lost, no concrete lesson plans for STEAM		non-core teacher	large	high	special
Organizational Capacity	People Capacity Building	Leary at first, but found internal support system which helped	Yes, some were leery at first, but there was a good support system in place through the tech team.	non-core teacher	large	low	special
		No additional skills were required for STEAM	We already have teachers with great practices, so it was just tweaking, not piling on one more thing.	non-core teacher	large	low	special
		We had a great science team, Science lead who had exp with STEAM, Robotics team		principal	large	low	traditional
		The district tried to get everyone excited about STEAM; we thought this thing would have lasted 3 years, but my teachers thought it would only last a year; we are actually more STEAM this year than last year; STEAM is a way to engage kids and get them to want to come to school; took 2 days for PD and it was a lot for the teachers and a lot for the school in terms of subs; only half my teachers were getting the PD or a part of the initiative	"We are more STEAM-focused this year than last year"	principal	small	very low	traditional

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
		Selecting Innovators - chose teachers who were open for collaboration, interested in connecting their curriculum to other content areas, who built good rapport with students, who were willing to learn and be coached to do something different in the classroom	That was a key. It was never inspiring. So it was also so haphazardly done in discovery, it seemed very disorganized for group, they're supposed to have it all together.	principal	large	low	special
Organizational Capacity	People Capacity Building	The way the initiative was presented was disrespectful.	I feel like many of our initiatives are pushed onto teachers, instead of inviting teachers to share what they need, and then giving them what they need. There is kind of an assumption, we're gonna do STEAM, we assume you don't know how to do this. So we're going to send you somebody to tell you how. And then you have a natural resentment. It's like, but I've been doing this for 10 years	principal	large	low	special
		teachers needed the skills of backward planning to tie curriculum to the real world		principal	small	high	special
		Her position was to observe other teachers; many chose not to implement any of STEAM	I was observing teachers putting into practice what they had learned, some did and some didn't, but it was more of the didn'ts than the dids. The outside coach tried and tried and tried to work with them but the life of a teacher, you know, (implication: they didn't choose to work with her)	district	small	very low	special
		Selecting Innovators -	They put me down as an innovator. I was put in as an innovator because we were short some.	district	small	very low	special
		STEAM teacher positions	Last year we had a STEAM teacher, but that position is now defunct. She was pulled out to be a pseudo administrator.	district	small	very low	special
		communication was a barrier requires teacher buy in -lost some of it -became a burden for teachers need to do a better job with onboarding should start smaller (2-3 schools) and focus on a grade level there were some divided schools that lacked cohesiveness and didn't have the same PD		district			

Lens	Category	Interview Findings	Quotes	Interviewee
Organizational Capacity	People Capacity Building	<p>first director's vision was diff from 2nd director sat down with 2nd director to develop 90 day plan for coaching checklist (how Discovery Ed fit into the plan) diff perspectives and visions for each iteration of leadership streamlining of info - so many competing ideas took the Discovery Ed model -- as it unfolded it didn't seem like it would fit MNPS (initially started with cohort model) PD days = huge barrier -- teacherse lost planning time to attend PD launch of Discovery Ed PD = didn't bode well w/many science educators teacher perspective = didn't know what it looks or feels like cohort model = heterogeneous; shifterd to school based cohorts consistency w/PD not very effective -- 1 STEAM and Discovery Ed Coach some people had several coaches and some had one person each principal selected who wanted to participate barriers for coaching -- who was sending what to principals? convos w/Discovery Ed -- some were unproductive; it felt like Discovery Ed was inflexible to fit needs of MNPS turmoil for a little while; needed to tread lightly to keep relationships shifted coaches at the end of Dec/beg of Jan wasn't very much accountabiilty about progress that was being made 3 coaches collaborated a lot but not as streamlined as it could've been -- no data</p>	<p>"It was almost as if I had three different jobs" "Almost like we needed a flowchart because there were so many moving parts"</p>	district
		<p>was called into a meeting rather than here are the resources no criticism of senior leadership was encouraged</p>		district

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty	
		was called into a meeting rather than here are the resources no criticism of senior leadership was encouraged		district				
	People Capacity Building	financial support (funding) and supplies lack of consistent access to tech schools were allowed to implement as they saw fit time -- wasn't enough to plan and carry out no consistent message when rolled out Discovery Ed coach put in her own money/resources Never inspired teachers	"And I also think there was not a consistent message when the thing rolled out and I think that was confusing for a lot of teachers as to what the expectation was, or how this actually works."	district				
Organizational Capacity	Adaptation Decisions	Teachers indicated needed to adapt the STEAM plans due to lack of resources	I mean, I guess if you try and steam activities, this is nice to have just whatever it is, whether it was clothes pins, ping pong balls, popsicle sticks. A Discovery Coach came in and set up an escape room but I didn't get to keep the locks, so it couldn't be repeated. And that's something that that really could have grabbed them put the steam in the puzzle.	core teacher	small	very low	special	
		Felt it applied to social studies only for her	This year, we all teach social studies, it really helped me through social studies. There's not a lot of math through Discovery online. It is mostly social studies and science.	core teacher	small	very low	special	
		Last year, during the initiative, one teacher figure out how to incorporate cross-curricular activities, and this year, she is sharing them with her whole 7th grade team, but she makes no reference ever to the district's STEAM initiative, seems to be all outside sources	Kids are collaborating more this year, because everybody was on board with it, we need to create more strategies in which kids actually work together to do anything	core teacher				
		kept a coaching log (daily and weekly) daily log was personal and tracked schools visited and what transpired weekly log was district level google doc that tracked schools visited and what she did		district				
		among innovators, not really	"we didn't"	district				
		Discovery Ed Consultant did walkthroughs and talk to us; she would give us feedback	"I'm doing my job and I'm doing it well and I'm teaching the way I'm supposed to teach and I still have this woman coming in here breathing down my throat"	core teacher	large	low	special	
		15-20 minute observations from consultant with trivial feedback; not benefit to my time; no process evaluation, nope, none	"I could have sat through all those trainings and came back to my classroom and done absolutely nothing"	core teacher	large	low	special	

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Organizational Capacity	Process Evaluation	Discovery Ed people helped keep us accountable, they were really good and supported her, and helped me understand how to implement STEAM;		core teacher	large	low	traditional
		submitted lesson plans, pictures for social media (all self-driven), held conversations with students		core teacher	small	very low	special
		Nobody kept track.	We didn't. There were so many things in place, so we were just grasping.	core teacher	small	very low	special
		We don't stick with anything long enough to know if it really works or not; they just roll out stuff after stuff		core teacher	small	very low	traditional
		Discovery Ed coach was helpful and gave quality feedback, gave me some cool tips		core teacher	small	very low	traditional
		Part of the lesson plans we had to include the 4 Cs and the Principal kept us accountable; we also had walk-throughs from the STEAM consultants - who gave us feedback		core teacher	small	very low	traditional
		We set goals for ourselves and included them in lesson plans;		core teacher	small	very low	traditional
		Teacher kept track with regular lesson planning, no knowledge of any other tracking of implementation		core teacher	large	very low	traditional
		Kept track with Power Point Lesson Plans (made for students)		core teacher	large	very low	traditional
		No formal tracking, but I agreed with my 1st semester coach. We kept a log of what i tried.	I remember keeping a log for first half of the year, maybe, and then not doing it. When we switched over to the new coach.	core teacher	large	very low	traditional
by	on	I tracked my progress by emailing with my coach, sending her pictures and reflections. I asked for feedback, and she would send one idea at a time which wasn't overwhelming,		core teacher	large	very low	traditional
		Discovery coach gave feedback to admin with each visit, videoed lessons for feedback to innovators. Innovator met with vertical subject level team to share what she had learned from Discovery and presented to teachers in a district meeting.		core teacher	small	high	special
		Discovery coaches came once a month, shared info through Padlet, gathered survey data	At the training, they taught us to do a project to make a plasticware tower and they asked us to bring back the results and we did, but nothing formal where it was checked off that we did it or we didn't.	non-core teacher	large	low	special
		Little evidence, unless the Principal requested it	"Its like, okay, you are a STEAM school, but what's the evidence where's the proof?"	principal	large	low	special
		Because there were no measurable end goals, knowing what to do was not possible	This year we accomplished, it was an undefined blob of goo. Because it just could have gone anywhere. And it just so borders were so undefined. No one really knew.	principal	large	high	special

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Organizational Capacity	Process Evaluation	There was nothing		principal	large	high	special
		Nope, nothing.		principal	small	very low	traditional
		Teachers went to school admin for process evaluation support, admin went to Central office, but there was so much turnover at Central Office.	There was a lot of turnover last year with the STEAM central office director, one chair started out and he left, there was another one, he left, David carried it out the rest of the year.	principal	large	low	special
		Feedback - none		district	small	very low	special
		really didn't have feedback besides discussions (these occurred more towards the end of the year) this was b/c of shift in leadership (3 different directors) measuring effectiveness/growth wasn't there had to do STEAM nights not at all w/fidelity of implementation connected w/no leader appeared as an initiative that was thrown out there		district			
Organizational Capacity	Process Evaluation	Not a lot of measures mainly qualitative main feedback from Discovery Ed training over the summer the feedback was not overwhelmingly positive and expectations for implementation were high through test scores		district			
		no measure directly for innovators; did what she normally did no formal tracking no idea how it was going across the district		district			
Organizational Leadership	Staffing	Discovery Ed coach was the very helpful, number one supporter		core teacher	large	low	traditional
		Discovery Ed coach was supportive		core teacher	large	low	traditional
		The greatest supporter is Jennifer Berry, and the teachers' didn't realize she had taken over this year.		core teacher	small	very low	special
		Supporters- internal 6th grade team and the Discovery coach		core teacher	small	very low	special
		There was a Discovery coach; teachers hid from her, she was nice. She tried.	I think somebody came in. I think we had a person. That person tried to meet with me, but I tried to hide from her. She was here. She was a nice lady. She did her part.	core teacher	small	very low	special

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Instruct		ELA teacher wanted it to succeed, but none of the PD addressed ELA. Her best supporter was a new Disc Ed coach 2nd semester.	Our mid-year coach from Discovery Ed. was very helpful, like brainstorming what that could look like in an ELA classroom. We had to get very creative because the (other)coaches did not know and the PDs did not know either.	core teacher			
		Discovery Ed coach was a sounding board, modeled, made STEAM fit seamlessly into lessons (coach was changed at semester and teacher did not have 2nd sem support)		core teacher			
		For ESL new teacher, the coach (starting in Feb)mada a big difference	She was really helpful and she was really good about getting me strategies I could apply with kids who have low levels of academic language, and being able to kind of help them express their knowledge in ways other than reading and writing. So I really liked it, they quite enjoy the activities that we did. And also she helps specifically with implementing reflection in my classroom at school.	core teacher			
		There was an administrative role in the school called Dean of Instruction, she was responsible for STEAM	she did a good job of getting people excited about steam, and really making ways for our coach to connect with us.	core teacher			
Instructional Leadership	Staffing	Steam coach came 2 times a month, planned with teacher, implemented the next time, met with admin to give feedback, videoed teacher lesson to offer feedback - she learned as a teacher to slow down and not to answer her own questions. The classroom teacher then met with a social studies team each week to share what she learned from her steam coach. She also presented to district teachers at the end of the year.	The lady that we had actually had taught social studies in high school and middle school. And so she was the first person that could explain to me why we needed STEAM in social studies. Because every, every other time we go to the workshops, they also did two days of PD at the beginning of school for all the schools that were doing the STEAM initiative to show them how to use do different activities in your classroom, they actually did actually different activities that you can do in your classroom to incorporate thing, but none of the activities that they did those first two days really had anything to with social studies, he was doing the math focus or science focus, So when the coach came, she really was able to explain to me how social studies and steam work together and it was really just incorporating the four C's. And once she said that, and we went through several lessons. I was like, Oh, now this is makes sense, because it was not something that we weren't already doing.	core teacher	small	high	special
		Discovery Ed coach was the best support I got this year; admin was not very supportive		non-core teacher	small	very low	traditional

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
		positive discovery ed coaching experiences	McMurray had a great Discovery Ed coach second semester. We planned together and felt very connected.	non-core teacher	large	low	special
Instructional Leadership		The real support came from the LTS tech coaches.	The tech team had lunch and learns and chose to take on STEAM responsibilities himself. He shared the STEAM information with teachers who did not participate with Discovery. Our technology team put out an end of year survey. Our support came from our LTS tech coaches. He planned and cotaught with me a 6th grade unit.	non-core teacher	large	low	special
		opposite from above, same school	The McMurray coach was not very engaged.	non-core teacher	large	low	special
		Discovery Consultants worked with principal and teacher		principal	large	low	special
		Discovery was amateurs	It's a world wide company or whatever, but you would have never thought anybody had ever done anything like this.	principal	large	high	special
		Best supporter was the STEAm coach	she had a really big knowledge base, but I think the biggest thing was that she was really good at coaching. So, she would observe, co-teach , plan, and she would follow up . She was an effective coach. That's what really made the difference: she knew how to work with teachers.	principal	small	high	special
	Staffing	Principal buy-in	Our principal was all into STEAM because it all starts with the building!	principal	small	high	special
		We did have a steam coach but we were a little bit ahead of the initiative (School had other outside organizations providing themwith STEAM structure and expectations).		principal	small	high	special
		Discovery Ed coach was very consistent with expectations, coached teachers, gave meaningful feedback,		principal	small	high	special
		doc to share that tracked what was done more documentation; less protocol		district			
		4Cs focus feedback form					
	9	personally created feedback tool (classroom walkthrough tool) some teachers were receptive to feedback varied based on school – some principals were supportive of initiative and some weren't		district			

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty	
Instructional Leadership	Staffin	there were drafts of feedback protocols, no final products Curriculum + Instruction team developed protocol for observations for STEAM (outside of Discovery Ed)		district				
		Discovery Ed consultant and STEAM coach saw district coach in building but coach never came to her		district				
	Explicit Buy-in	Admin that is really into STEAM			core teacher	large	low	special
		We were volun-told... after the first meeting no one knew what was going on... if they were excited, that first meeting poured water on that campfire	It just sounded like another thing...	core teacher	large	low	traditional	
		I totally bought in, I was fired up and took the time to make it fit my class; many were not buying in and there was no pressure from DH for them to buy in or even go to the PD		core teacher	large	low	traditional	
		Jennifer Berry	I did a steam camp this summer and she was awesome!	core teacher	small	very low	special	
		No	the district just let us know what we were doing	core teacher	small	very low	special	
		Science teachers seemed to be excited, us math teachers were more curious, and the other subjects were sceptical; They made it such a big deal that I made it intentional, which made me a better teacher	"We just looked at each other, like, What is this?"	core teacher	small	very low	traditional	
		Teachers are never excited		core teacher	small	very low	traditional	
		Excited at the beginning, but no one (PD or coaches) knew how to connect it to ELA		core teacher				
		Teacher who succeeded best with STEAM was willing to take a risk, is a natural leader, and although she did everything on her own last year, this year her team is doing projects with her		core teacher				
		Nobody knew what the initiative was all about, so most were skeptical, but most definitely didn't buy into it... we all thought it would be over after a year		non-core teacher	small	very low	traditional	
		Some teachers were very excited and went all in	non-core teacher	small	very low	traditional		
	Most people weren't excited		non-core teacher	small	very low	traditional		

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Instructional Leadership	Explicit Buy-in	No buy-in for the initiative - plate too full	For schools like Jere Baxter, the focus should be on academics instead of throwing in an extra, extra thing. STEAM is a great idea, but some schools on the priority list, Teachers already have a lot on their plate and STEAM just overloads and overloaded circuit. STEAM couldn't get the work it needed.	non-core teacher	large	high	special
		Negative experience across the board	I missed the training for my new circulation system because I "had to attend STEAM".	non-core teacher	large	low	special
		For STEM related arts teachers, buy-in was easy.	For me, STEM is engaging, a passion, but other teachers don't like change. As a biology teacher, I know the lesson plans and the standards.	non-core teacher	large	low	special
		Negative experience across the board	Last year was a negative experience – the teachers were yelling and there was lots of resistance, they just didn't have time.	non-core teacher	large	low	special
		Negative experience across the board	People don't really like change. STEAM was just "One more thing", and it was really just a tweak on what we were already doing. There was a change 2nd semester and it became much less of a chore.	non-core teacher	large	low	special
Leadership	Buy-in	Principal has bought into STEAM; requested walk-through from district to evaluate; Continues to push initiative in school; Taking active steps to become STEAM certified - Created STEAM leadership team this year, should have had it in year one		principal	large	low	special
		Barrier was mandate of number of teachers and time	I believe the biggest barrier was the mandates of time and teachers. You have to have eight innovators, you have to have 25 teachers. Well, 25 teachers on a given day, four times in the year being pulled out to be trained, takes a lot of time and resources in the midst of all of the other things that happened in a school, you know, teachers planning for their own content, not that they didn't want to be trained, but the mandated way of training, I believe there should have been some differentiation per school.	principal	large	low	special

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
		very excited b/c of something new; wanted to do initiative potential educational shift (long term view) 3 phase experience	"its called STEAM here, but its STEM"	district			
Instructional Leadership	Explicit Buy-in	super excited b/c she's a science educator at heart opportunities for science educators to grow excited to see district support model that she knew works some parents didn't know school was a STEAM school or what STEAM meant district shared a video eventually during PD launch wasn't planned out as much as it should've been. then there wouldn't have been as many barriers great collaboration with the arts dept currently at magnet STEAM school created vision and mission w/advisory council once they were on the same page then they could coach more effectively MS had to create application to be participants	"nice to see money follows what people are saying"	district			
		1st impression was a bit of a shock lack of awareness about consultation wondered: what were other options? why Discovery Ed? what about in house? lack of clarity		district			
		not excited at all; felt it was ridiculous		district			
Support/Supervision		Dr. Lewis was a Fantastic supporter; Discover Ed consultant was very supportive	"she always went above and beyond"	core teacher	large	low	special
		Admin supports us	"I have never been told no"	core teacher	large	low	special
		Almost none of it was for SS, they gave us Science training	I felt like they never had someone come in and teach us how to apply this to Social Studies	core teacher	large	low	traditional
		Support came from the 6th grade team and the Discovery coaches were very supportive.		core teacher	small	very low	special
		Discovery coach was very willing to lend support, but teachers complained so much that principal did not require their participation, so they avoided contact with the coach	The coach would sit in on lessons and chime in on lessons. That was the positive part.	core teacher	small	very low	special
		Admin supported us; Discovery consultants were helpful; I could email if I needed help		core teacher	small	very low	traditional

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Instructional Leadership	Support/Supervision	Admin was excited, told us it was a good thing for our students; he did his best to support everyone; Great admin... we have made enormous improvements over the last three years... but those are due to school leadership, not STEAM		core teacher	small	very low	traditional
		Coaching first semester was good - he did a good amount of the work to make it fit seamlessly into my lesson. He knew what it was like to try something new and he gave empathy.		core teacher			
		Discovery coach and administration supported teacher difficulties	our administration was very good about listening to our concerns, and I believe our principal actually met with the organizers to voice our concerns. He asked us for letters. And we brought it all to them, which was, which is how you ended up with a different Discovery Ed. person, which was great.	core teacher			
		Awful to lose the coaching partnership with Discovery	I actually went to the discovery ed conference that they have every year. And while we were there, we got the news that we will not be able to participate with them anymore. And that was just awful. It was awful. When you had a person come in, and you know that they're gonna be pushing you.	core teacher	small	high	special
		Best supporter - principal!	Oh, definitely. My principal. Definitely my principles and assistant principal. they were both fully on board. They saw the value of it, and they knew that it would help our students excel.	core teacher	small	high	special
		Relationship with the STEAM coach was outstanding, connected the 4 Cs to the social studies curriculum	.And we Oh, my God, we developed some great, great lessons together. I really hate hate, hate, hate, I cried when the district did not renew their contract. In 21 years it was the best thing that I feel like Metro has ever done.	core teacher	small	high	special
		Support made this the best initiative in 21 years in Metro	It made sense. we're going to do something and then they helped to actually do it. Not just showed you how to do it, but gave you support. And it was a lot of work. I'm not going to tell you a story. her coming two days a week, I mean, that that was 2 planning days per month that I missed, For whatever reason with her. And it was intense. Like, sometimes she would come and we'd eat lunch. And then we meet after lunch. So it was not just an hour but an hour and a half. But that was my choice to give up my lunch time to meet with her because I feel like it was so important to me and the children.	core teacher	small	high	special

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty	
Instructional Leadership	Support/Supervision	We did not get help from a Discovery Ed consultant; Carry is a disctrict person who has been a great help	Carry is the bomb.com	non-core teacher	small	very low	traditional	
		Much of the leadership seems to come from within the teacher circles	The STEAM coaches come and get ideas from me. We have discussion groups. The coaches take what they see here and share them with other teachers. A coach comes every two weeks. I don't need the help. She can come and share and she passes it along. The more I share, the more I come up with.	non-core teacher	large	high	special	
		Discovery Consultant was knowledgeable and supportive - Year 1, I was mostly an organizer - This year, I am taking on the role of instructional leader behind implementing the STEAM initiative - because of necessity		principal	large	low	special	
		District learning technology coaches offered more support than Discovery Coaches.		principal	large	low	special	
		kept offering suggestions supported other coaches no person in authority to ask for support		district				
		Discovery Ed consultant = thought person and resources no resources unless provided by Discovery Ed consultant		district				
Professional Development		They told us what we were going to do... but then it was immediately turned over to Discovery Ed, who then gave us a 6-hour PD on software	I'm trying to think if I sat through a good professional development... and I can't say that I did"	core teacher	large	low	special	
		We knew nothing, and then they brought in Discovery and it was difficult to know the connection between Discovery and STEAM, etc... It was confusing, because we weren't sure if it was new or different or just something we have always been doing	"Seemed like a big waste of time... Everyone was coming back to school and having venting sessions"	core teacher	large	low	traditional	
		2 Teachers felt they got basic skills from 1st PD	I feel like they were presented to me. But implementation was going to take more work. I would have to learn more on my own	core teacher	small	very low	special	
	Initial Prep		None		core teacher	small	very low	traditional
			I had one PD as initial prep; also there were several that we just didn't go to; they taught us the 4 Cs, how to use the Discovery website	"Why am I not in the Math PD?"	core teacher	small	very low	traditional
			I don't remember going to any PD over the summer; very little prep before		core teacher	small	very low	traditional

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty	
		ELA teacher was really excited, but the trainings had nothing to do with ELA		core teacher	large	very low	traditional	
		One school had outside training through Purdue University		core teacher	large	very low	traditional	
		a couple of days of PD and coaching	No. I really leaned on what I had learned in previous years in Chicago, we had a big push for it too, so those experiences maybe prepared me more for it than these trainings.	core teacher	large	very low	traditional	
		Were told they were on the STEAM team and nothing more, it was an unknown	So just felt like, Oh, this is going to be extra work on us this year.	core teacher	large	very low	traditional	
		1st year teacher - deleted all the emails, assuming it didn't apply to her, and skipped the first trainings		core teacher	large	very low	traditional	
		Not good intro	Our introduction to STEAM was an email, not the best way to present a new initiative.	non-core teacher	large	low	special	
Professional Development	Initial Prep	A couple day PD for teachers; not very impactful		principal	large	low	special	
		Roll-out day - great for principals, terrible for teachers, principal quotes teachers as saying...	Oh my god, that was so awful, so boring. So not put together so disorganized and so uninspiring, we dread having to do this.	principal	large	high	special	
		STEAM knowledge before initiative began	I don't think any particularly related to stem unless they had gone to, you know, state or other trainings. There's, there's a few teachers, I'd probably say three or four teachers that are science teachers there were always looking for STEM activities. When Discovery Ed came in, I feel like it was a two day training to understand the implementation year.	principal	large	low	special	
		They were motivated to start, but...	We're going to bring you tools; they're going to be coaching with you; we already have professional development set up; in the very beginning, the idea of it all, I think they were genuinely motivated to start. As the year went along, and getting in the weeds of it, it started to turn because of the demands of time, last year, STEAM kind of took over everything that was happening in a school building.	principal	large	low	special	
		In first PD, I didn't see the vision yet.	it wasn't a big undertaking, but at the beginning of the year, I was lost as to where they were going until a month or so into it, when we got a plan.	principal	small	high	special	
		no PD prior to starting		district				
		one in-service day w/teachers across the district (very beginning) series of all district days or PD for smaller session (half of year)		district				

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
	Impact	Multiple PDs that were beneficial - - Actually, I already do all this stuff... I do STEAM in my classroom - Impacted my lessons... more open-ended, more engaging - PBLs		core teacher	large	low	special
		Waste of time... I wasn't in my classroom; I want to listen to STEAM teachers who are doing this well, not the Discovery Ed Consultant	If teachers are doing it in their classroom, they should be going to STEAM trainings"	core teacher	large	low	special
Professional Development	Impact	Waste of money on initiative and then waste of money in resources, because we don't have access anymore	"Nothing fundamentally changed anything I did"	core teacher	large	low	special
		It challenged me and pushed me outside my comfort zone... Best was the in-house stuff we did		core teacher	large	low	traditional
		Strategies and resources	My most used resource was the boards on Discovery Education, where you can pull up videos and put them on the board and have whatever you need to present all of the materials to the students. - T2	core teacher	small	very low	special
		Didn't care for PD or external coaches, appreciated internal networking	I didn't need the (coaching) people come in, but the part I liked was collaborating with other teachers from other schools. (1) . It was people coming in and telling us to do what we've been doing. (2)	core teacher	small	very low	special
		And then I just give up because none of its for me	And the people doing it can't help us because they specialize in ELA	core teacher	small	very low	traditional
		Having the Kit is the best thing, because the kids love the kits, but we bought them		core teacher	small	very low	traditional
		It was generic PD throughout the year...	They mix all the related arts people up, so typicallys the stuff they are talking about has nothing to do with anything you would ever do, even the STEAM portion	core teacher	small	very low	traditional
		I always take something away from the PD		core teacher	small	very low	traditional
		STEM teacher tweeks only	I did have access to the Discovery Ed materials – I used the videos. I used some of the tech nook resources. I even used some of the SMS strategies – 2 sentence summaries, but I changed them to Instagram summaries.	core teacher	large	high	special
		I have added a lot of hands-on activities and mathematical discourse; increased collaboration among my students; the PD wasn't really that helpful for me... I learned so much more with the Discovery consultant; I don't see the STEAM coach this year		core teacher	small	very low	traditional

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Professional Development	Impact	I made sure I included the 4 Cs into my curriculum; we had to teach the students and the community what STEAM was; I have changed my approach, my students are now "problem-solvers" and this filters through all my lessons and units;		core teacher	small	very low	traditional
		found success 2nd semester in implementing a STEAM project in ELA	It allowed me to think outside the box a little more than I normally would have. It allowed me to be more flexible like having a giant mess in my room for the kids really with some really cool stuff. We're going to do it again this year.	core teacher	large	very low	traditional
		Not implemented with fidelity ; not organized or thought through well enough to do that		core teacher	large	very low	traditional
		PD did not apply to ELA	Discovery Ed kept saying things about like, all the resources they had, for instance, they have like a science and social studies tech book on their website. Anytime we did PD, they would give us planning time to use only those resources. And there wasn't anything in those resources for ELA that fit in with the scope and sequence. There was a lot of trying to adapt with that, and I just, I felt like they were really prepared for math and science.	core teacher	large	very low	traditional
		Maybe they implemented it like they wanted to, but halfway through the year, they found it wasn't working.	I didn't find it useful for the most part. So it's hard because then you end up doing some of the work on your own or just totally forgetting it all together.	core teacher	large	very low	traditional
		Motivation impact - negative	It totally threw my motivation under the tank!	core teacher	large	very low	traditional
		Our steam teacher and our sheltered math teacher loved it.		core teacher	large	very low	traditional
		resources in PD, but no skills	I learned about a lot of resources, but not how to implement those in my classroom with the constraints that I have.	core teacher	large	very low	traditional
		resources in PD, but no skills	I think I got hooked up with a lot more resources than I wouldn't have ever been exposed to previously. I wasn't really using discovery online. After, most of my texts that I pulled and modified for social studies were from Discovery. Their videos were awesome. And he figured out how to more effectively use those and my kids get concepts from those videos and apply them in their talking and writing.	core teacher	large	very low	traditional
		Why? She didn't know, but since she deleted the first emails and missed the first PD, she thinks not knowing why was probably her own fault.		core teacher	large	very low	traditional

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Professional Development	Impact	After PD, this is not going to happen.	I could not, before we went to the training even after the training, I was like, This is not gonna happen in social studies. It wasn't. All they were doing was folding paper and building structures and doing bridges. What does that have to do with social studies? I have 100 plus standards; I don't have time to do none of that!	core teacher	small	high	special
		Example of a lesson that a S.S. teacher learned from Discovery Ed Coach	we were working on the Renaissance. And my Discovery Ed coach said, Why don't you all use Klande Wiley because he is the African American artist, the young man that paints these portraits, these Renaissance portraits, but he puts everyday people into his Renaissance portraits. And sometimes he also uses celebrities like Michael Jackson. he was the one that actually painted the, the presidential portrait of Barack Obama. So we started our class off with that. And then we went into who the artist was, and what is the key to think about the portrait. It was mind blowing. It was mind blowing, Those kids is remember that, the seventh graders, I have them as eighth graders now and we still talk about that.	core teacher	small	high	special
		SOS strategies, 4 Cs - used three each day!		core teacher	small	high	special
		I got storyboards... some techniques... I still use Discovery Ed online curriculum		core teacher			
Development	Impact	Minds have been shifted in the school; students experiences have been enhanced - grade level PBLs - Only half the teachers were able to go to the PD	"disconnect between the quality of the PD... compared to the quality of the visits from our coach"	principal	large	low	special
		Like othr district initiatives, it weas not focused or targeted		principal	large	high	special
		some individual teachers learned from the PD and applied to their classrooms; we are now applying the 4 Cs and monthly STEAM Fridays		principal	small	very low	traditional
Development	Impact	Negative impact on smaller schools	25 was the magic number: Innovators and 25 team members. I happen to have a school with 30 teachers. So when it came time for district professional development day, that particular principal could not engage her faculty in anything else involved with their school because it had to be stem training, but then those 25 teachers also sometimes felt like they were missing the school wide information that was happening back in the building, because they were they had to go to STEAM.	principal	large	low	special

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Professional Development	Impact	No knowledge of implementation impact from PD in terms of teaching or motivation	Feedback from many teachers was that it felt activity based as opposed to instructional design, previous professional development that some teachers have had been like project based learning. The more ideal situation would be to take an engineering design process and run it through project based learning that the culminating experience is steamy, you actually know which standards you're learning in the process. You can give a kid a bag that has pipe cleaners and popsicle sticks and, you know, spaghetti noodles and say, build a tower and then talk about the design process. But at the end of that activity, as a student, really, did they learn weights and measurements?	principal	large	low	special
		Teacher thought more about 21st century skills, utilized more technology, more collaboration, lots already had student-centered classrooms		principal	small	high	special
	Impact	This AP attended principal's training, but she was the only AP there. Principals' training was good, but there was no AP training for anyone but this one.		principal	small	high	special
		Veteran teachers with STEAM coaches were motivated to try something new		principal	small	high	special
		No impact, no feedback, no additional resources, but she met with the coach 6 times	None, it was more culturally based. Just another thing that teachers felt like they needed to put on their plate, a mandate, another push down from the district. It wasn't presented as something that could help your teaching.	district	small	very low	special
		absolutely impacted coached it was DIY coaching model -reading/research on coaching theories eventually affected motivation		district			
	Impact	no impact at all stuff presented wasn't relevant -- a bunch of strategies no impact on motivation idea/concept = solid; execution = not the best	"I think the idea behind it was good, but I think the execution of it was not very good. But a lot of that, I think, had to do with the fact that there was no leader at the time for it."	district			
		None					

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Professional Development	Understanding of Implementation	PDs were the same thing over and over - they showed us how to navigate the Discovery resources - Implementing the 4Cs		core teacher	large	low	special
		They told us the innovators would be trained and then train the rest of the building; then they stopped talking about it; This looks great on paper, but why are you pulling in non-teachers to teach the teachers I don't understand the big picture		core teacher	large	low	special
				core teacher	large	low	traditional
	Understanding of Implementation	How? It was a lesson that they had to figure out how to do it, rather than being told.	I did as far as the lesson, you're just introduce it like a lab or you just have the instructions of what they're supposed to do, and then they're just have to figure out how to do it. It was like giving them a lesson without a whole lot of instructions and rules. So they just got to figure it out, which is hard for them. They want you to tell them. It has to be a right or wrong answer. They don't want to struggle.	core teacher	small	very low	special
		What? Yes	Yes.. Because most of mine was based on the standards that I was teaching you just fine activities to do the tie in with that and got the flow was helpful with that when she was here.	core teacher	small	very low	special
		What? Trickier.	As a math teacher? I think a little bit trickier. I think I was supposed to do cross curricular lesson more so than isolated. - TP	core teacher	small	very low	special
		How? I didn't understand what they were doing in the PDs.	Not the way they wanted it. The reason I didn't like going to the training was because I didn't understand what they were doing. They were so advanced, so we just fluffed what we already had.	core teacher	small	very low	special
		What? No	I guess that was what all of those PDs were about that I didn't go to.	core teacher	small	very low	special
		Why?	Yeah, to make sure we are doing that math and science, and make it more engaging, for college readiness	core teacher	small	very low	special
		Thought it was to help students understand jobs available to them in the future		core teacher	small	very low	traditional
I think we are understanding it; On-site PD was better and more relevant		core teacher	small	very low	traditional		
It all flows together for me, the 4 Cs made sense to me; but really incorporating "STEAM" is something that most of us were already doing		core teacher	small	very low	traditional		

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
		All PD was geared to math and science, not useful to ELA teacher	they spent like five to six PDs on explaining what the steam meant. And then every activity or anything they modeled was for math or science.	core teacher	large	very low	traditional
Professional Development	Understanding of Implementation	How? Hard to figure out, but eventually she did, not because of PD but because of coaching	Yes. I was very driven to make it work for ELA. I really wanted to see it done. And I really wanted to pioneer something since everybody kept telling me no or I don't know/ where I don't. I knew it could be done. But we just had to figure out how.	core teacher	large	very low	traditional
		What? No		core teacher	large	very low	traditional
		Why? For career preparation		core teacher	large	very low	traditional
		Of all the w questions, all I knew was it was supposed to happen in my classroom.		core teacher	large	very low	traditional
		The PD days were not super useful to me, a lot geared to science, not much for math		core teacher	large	very low	traditional
		After PD, teacher thought there was no way she was going to pause her class for STEAM	I was like, I gotta stop? And we got to take three days a week, two weeks to make a model? Like, did that help the learning? No!	core teacher	small	high	special
		nothing was beneficial in being subject specific before the one on one coaching	We needed to know how to use the strategies for social studies, I had no idea how steam even was supposed to look in the social studies classroom. Even after we had the two days of the district workshop, and then we had other days that we had to come out of the classroom during the school year, nobody ever addressed it until the coach came.	core teacher	small	high	special
		The implementation only lasted a year and then they pulled Discovery Ed - PBL, engineering design process, cross curricular planning, connecting students to careers, four Cs - STEAM is in every class, not a checklist		principal	large	low	special
		What? No defined outcomes.	There were no defined outcomes. What does this look like? We talk to our teachers about if they are going to teach something, what are you going to measure? Define the measurement.	principal	large	high	special

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Professional Development	Understanding of Implementation	What? Nobody knew	Well, that's the problem. I'm not sure anybody knows how it was supposed to happen. You know, theoretically, it was going to be a nice integration of science, technology, engineering and math into every classroom in the building. But teachers were never taught how, or what that looks like for one, to how to make that happen. And three, given the resources to make that happen. So the only resource we were given was two robotic balls. They were toys and expensive toys, but that was it. And, and then the discovery online book, which some teachers still use.	principal	large	high	special
		Most saw this as just something else to do; had to do research to know what STEAM was		principal	small	very low	traditional
		How? Yes, they knew how because of the coaching.		principal	large	low	special
		What were they supposed to do?	I myself didn't get the bottom line. What are we trying to do at the end of this year? That's the goal, right? What was the goal? I personally didn't ever really know the goal.	principal	large	low	special
		Beginning PD presented the 4 Cs, what is STEAM, 8 days total PD		principal	small	high	special
		They knew what they were supposed to do. (Keep in mind this school had the outside organization that provided them with STEAm pre-assessment, rubric, and post-assessment tools)		principal	small	high	special
		Why? I don't think teachers had enough of the why.		principal	small	high	special
		When and where? Not really/No		district	small	very low	special
		a lot of teachers didn't get it she understood concept and value	"I understood"	district			
		Support	Support	Discovery Ed consultant was excellent and gave good feedback and always had a takeaway		core teacher	large
- Disc Ed Consultant showed me how to do Escape Rooms - and that was awesome - Most of PD was showing you Discover Ed resources, like how to use their textbook - They taught us the Board Builder, videos are out of date	"She was a good resource"			core teacher	large	low	special
		Discovery coach changed mid-year. One teacher had a positive impact all year, the other lost innovator status mid-year.	Discovery coach would leave the teacher little notes with positive things that you did well or ideas, she would come once a month	core teacher	small	very low	special
		She would hide from the coach, but also said she was her best support and tried and tried.	The coach would sit in on lessons and chime in on lessons. That was the positive part.	core teacher	small	very low	special

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
Professional Development	Support	Some people had to go, ELA teachers decided not to go, Science teachers did their own thing... People just didn't go to the PD		core teacher	small	very low	traditional
		Discovery Ed consultants came in and gave us feedback		core teacher	small	very low	traditional
		Discovery Ed consultant was very helpful		core teacher	small	very low	traditional
		An excited ELA teacher did not find support until 2nd semester when the Discovery Ed coaches changed and she finally found someone who could help her connect STEAM to ELA	I was excited that it was gonna be pushed out school wide and excited to kind of like, figure out what that looks like an ELA classroom, because it's generally for math and science. But, what did it look like in an ELA classroom? We had to get very creative because the coaches did not know and the PDs did not know either until our new mid-year coach from Discovery Ed. She was very helpful, like brainstorming what that STEAM could look like in an ELA classroom.	core teacher	large	very low	traditional
		No support for implementation except feedback from students, teacher even sought her STEAM training from outside sources, separate from the district initiative -	It's a lot of research from my part, to try to merge in other curriculums into my curriculum.	core teacher	large	very low	traditional
		She never had contact with a Disc. Ed. coach and said those coaches would have never had time for ELA, they only worked with math and science teachers	the person always focused more on the science and the math people and ELA was always left out.	core teacher	large	very low	traditional
		I got feedback from my coach - super helpful, was an extra teacher for new lessons when kids have lots of questions, gave immediate feedback, modeled for me		core teacher	large	very low	traditional
		PD throughout the year; only half had access Teachers did not look forward to going to PD, but did enjoy connecting to the Discovery Consultant		principal	large	low	special
rofessional Development	Support	Because of the difficulties many schools were having sending 25 teachers to off-site PD, schools were allowed mid-year to shift their training to on-site.	So at the at the mid year, schools were allowed to do training on site where they didn't have to come and go, they were allowed to send four people instead of eight, they were able to tailor make that training for the size of the school and the demands of the school. And had that been an option at the very beginning, I think the buy in would have been a lot better.	principal	large	low	special
		no feedback provided as a coach possibly received some feedback/had debriefs towards the end of the year reflection was done between the 3 coaches		district			

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
P	Suppo	met w/Discovery Ed consultant gave herself opportunities -- no more than anything else		district			
School Culture and Climate	Fit Assessment	Natural fit for us; we've done this forever	"Natural fit for us, we have the zoo school"	core teacher	large	low	special
		We are already a STEAM School; second school in the nation with a zoology class; incredible teachers	"We are a family"	core teacher	large	low	special
		Our principal signs up for everything and wants whatever he thinks will help the students; In theory STEAM is a good fit for Croft; everything about us is diverse, students are diverse	"Our focus was in the wrong area and we implemented it incorrectly" "When you sell it to a bunch of teachers as something else to do, you don't get the backing"	core teacher	large	low	special
		Our school will do whatever... we will comply... We will check the boxes; admin always wants to try new stuff to see how it works; we have great parent support	If its something new, we want to try it	core teacher	large	low	traditional
		Principal is charismatic and the district trusts him to implement things... also we are a 1:1 computer school, which is probably why we were chosen		core teacher	large	low	traditional
School Culture and Climate	Fit Assessment	Perceived good school fit: Picked because of being a medical health and design center school	We try to focus on the health and medical sciences and bring in just more awareness to illnesses and how to prevent them like we have medical Monday's when you focus on something like how does you know the lungs work, just being aware we have partnerships. We have partners who offer us free physicals and just things like that.-T2 Yeah, our students just need exposure and it can't be too much.- T1	core teacher	small	very low	special
		We were supposed to be already moving toward becoming a STEAM school		core teacher	small	very low	traditional
		I have no idea why we were chosen, but I like that we were... Everything goes back to exposure - its good that we are exposing our kids to this stuff		core teacher	small	very low	traditional
		Other than being an amazing school... they knew our principal would push it; and we are a priority school... let's see if STEAM can get students to enjoy the learning process;		core teacher	small	very low	traditional
		It was a good fit for us... I think it was to improve test scores, we do everthing with this in mind...		core teacher	small	very low	traditional
		Chosen because of having a good STEAM related arts program and for population of low-achieving students		core teacher	large	very low	traditional

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School Culture and Climate		We were struggling. Not a good fit with language barriers.	having language barriers, it was too much unclarity for them to deal with, something that was almost too open ended, they needed some guidelines	core teacher	large	very low	traditional	
		We were told we would be part of STEAM and then got no further information	I don't think super excited. It was not like the it was great news. I think it was very unknown	core teacher	large	very low	traditional	
		chosen because of super diverse population - if they could do it at this school, they could do it anywhere - plus the school was Title 1 and needed any available resources	super diverse population, were like a really good guinea pig in that way. Look it worked there with all of that!	core teacher	large	very low	traditional	
		chosen because test scores are low and teachers are willing to "step out of the box"	STEAM is very cool and a really nice idea. I think that more consideration should be given to how to make sure that the basic skills are being equipped, like a lot of STEAM is if you have these basic skills, you apply them. So if you don't have the basic skills, how do you do STEAM?	core teacher	large	very low	traditional	
	Fit Assessment		Priority schools could not manage STEAM.	For schools like Jere Baxter, the focus should be on academics instead of throwing in an extra, extra thing. STEAM is a great idea, but some schools on the priority list, Teachers already have a lot on their plate and STEAM just overloads and overloaded circuit. STEAM couldn't get the work it needed.	non-core teacher	large	high	special
			Principal was on board, partnership with zoo made this an easy choice; good fit if they would continue funding it		principal	large	low	special
			Relationships first approach. Great culture, great teachers who buy into the system		principal			
		It was presented as a cookie cutter - same for everyone - but this school is unique.	(This school) it's a different demographic, it's a different culture it's a different community so and there are other schools in the same position so it could not work because they designed one way fits all just didn't fit	principal	large	high	special	
	Because we are the bottom performing schools		principal	small	very low	traditional		
	It was the perfect fit because of high academic achievers, high interest in the arts and music	STEAM "connects all of the parts and pieces, stem and engineering design. That's music, visual and performing arts, you know, it takes an artistic angle to create a bridge or design a building or look at, you know, civil engineering, the creativity, the four C's of collaboration, communication, creativity, and I always missed the other one, it's in there, all the parts and pieces were here. So it made sense for all of her to become a school, that stem initiative, it just lands there well."	principal	large	low	special		

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
		Some were picked because it would be easy implementation, some because STEAM would help with deficits		principal	small	high	special
		school was going through a STEAM certification process, so Discovery Ed supported them in advancing through the steps to become STEAM certified		principal	small	high	special
		We were already a science and math magnet	we were really ideal to go through this process	principal	small	high	special
		randomization in a spreadsheet		district			
School Culture and Climate	Fit Assessment	questionnaire had to be submitted by principal, AP, or dean of students/dean of instruction asked whether they wanted to be in phase 1, 2, or 3 recommendation --> surveyed schools to determine readiness		district			
		methods to choosing schools -invested in STEAM already -not invested yet, but profound interest and readiness (desire); right teachers, but not right facilities; approval by admin (school level) -considered motivation theory -handful of schools w/new administrators -- wasn't a good idea to choose -equal representation amongst school board members (politics of implementation) his job to look at data, not policy selected previously priority or innovation schools		district			
		no idea schools who were interested applied and then were selected principals were into concept (asked question after moving into coach role) good fit but execution wasn't done well school had high EL population (McMurray MS) needed adequate resources and training to carryout why were others picked?		district			
		Great Collaboration, great team work, I learn from my colleagues		core teacher	large	low	special
		6th grade team - very strong - 3 teacher team		core teacher	small	very low	special
		The STEAM related arts teacher was most responsible for STEAM in the building, but that position is gone this year.		core teacher	small	very low	special

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
School Culture and Climate	Implementation Teams	Very little team work... No cross-curricular work		core teacher	small	very low	traditional
		sharing occurred among grade level team in the school, good partnership with 2nd semester Disc coach		core teacher	large	very low	traditional
		1st year teacher in portables - no team	I was in the portables last year cycle. And to be honest, I didn't see a lot of other people's classrooms	core teacher	large	very low	traditional
		new teacher and Discovery coach - good team	I think when my Discovery Ed coach would follow up with one suggestion or say "Have you tried this?", like an accountability piece. It kind of made me excited to show it. I could email her little pictures and anecdotes to be celebrated and appreciated.	core teacher	large	very low	traditional
		Disc coach and Soc Studies teacher, who then met with subject level team, then presented at district level while coach met with admin and gave feedback to everyone with every visit		core teacher	small	high	special
		no collaboration in learning	I was not a big part of the teacher community. The school was horrible. I tried to share with other teachers, but the environment wasn't conducive to sharing.	non-core teacher	large	high	special
		STEM collaborative relationships take time to build.	It takes time to evolve; it took years for me to build up community partnerships and great resources – Urban green labs among others. (In my new school) for me, the first quarter was rough, but now teachers want to work with me. Teachers are worried about content and collaboration. Once they see success in STEM, they feel more freedom in their classrooms, in my last school, our scores went up in math and science, and we feel support from our current principal.	non-core teacher	large	low	special
School Culture and Climate	Implementation Teams	The district tech coaches took on STEAM and formed collaborative lunch groups.	Once teachers got past the idea of it being "one more thing", we made lunch groups that met each week and it created great ties among colleagues.	non-core teacher	large	low	special
		Discovery tech coaches did not make good teammates for teacher learning, they lived out of state, did not come frequently, monopolized time when they were there, wanted core teachers, but the teachers pushed back and were resistant	They were strangers. They weren't local folks, and again, they tried to apply the same pathway to everyone.	principal	large	high	special
		Last year, the teachers did not feel part of a STEAM team, they felt mandated to participate. Teachers weren't even sure if they held innovator roles or not, nor did they know who did.		principal	large	low	special

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
School Culture and Climate		Motivation was based on interest in collaboration and self-motivated growth		principal	large	low	special
		Value that came from steam was in creating collaborative partnerships, regardless of the program or the funding	To me, the cultural changes are more important than the programmatic changes, because, like in this situation, funding goes, and then the resources go, but if you haven't made it part of your culture, you stop, it stops. So I'm excited to see that there are a handful of teachers here that are like, No, we got to keep going with it like this.	principal	large	low	special
		implemented collaborative grade level planning time, weekly vertical teaming		principal	small	high	special
	Implementation Teams	Admin got feedback from coaches on what was happening in the classrooms, plus collaborative planning meetings with admin, Admin feedback to teachers through collaborative planning. Some choice in end of year PD for which admin gave survey to teachers to gather feedback		principal	small	high	special
		teams varied by campus and who submitted questionnaire		district			
		not really, plan wasn't very clear		district			
		Collaboration is evident			large	low	special
		Dumb it down, lack of resources to implement	It is not a not a one size fits all. Not all the same socio-economic or the same resources, for example, our kids don't have the technology. We would have to dumb it down because they don't have the resources or support at home.	core teacher	small	very low	special
	Adaptation Decisions	JB bought STEAM kits with their own money and that has been the most beneficial and most relevant STEAM thing JB has done... Probably the only STEAM thing they actually do... The rest was considered a waste by 3/4 teachers		core teacher	small	very low	traditional
		Admin would always want us to do her meetings over the STEAM meetings or PD... Discovery Ed people would get frustrated because Admin scheduled things during the times they were supposed to come in		core teacher	small	very low	traditional

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
School Culture and Climate	Adaptation Decisions	Finally figured out how to incorporate into ELA with a new 2nd semester coach	Nothing was off limits or impossible to do. And any idea she had or any idea I had, she was very encouraging of and tried to, like, find a way to make it work. She really listened to my frustrations about it, kind of put my mind at ease. We were able to do like a really cool STEAM project in ELA by the end of the year.	core teacher	large	very low	traditional
		found a way to incorporate STEAM into ELA, example	STEAM ELA project didn't really have like very blatant math connection, what we did like a project in response to a novel, we read the novel Refugee and we also read A long walk to water. And the students got to pick a character from one of those books and identify a major problem they face and then engineer some sort of solution for it, and build prototypes and research and thought, Oh, yeah, they didn't have like very blatant like math and science connections, but they needed both math and science.	core teacher	large	very low	traditional
		had to adapt for ESL needs and time	I get my kids for 180 days a year. I have to teach them language. I have to teach them social skills. I have to teach them all these things that maybe aren't always considered. Oh, you can work that into steam, but it's the time constraint.	core teacher	large	very low	traditional
		had to negotiate what was feasible for a first year teacher	I started to negotiate out which parts of steam I felt like as a first year teacher who was teaching low level else what I could do feasible. And so we think, are you figured out like I could, she gave us the spotlight strategies. And I could implement that	core teacher	large	very low	traditional
		Zoology class		principal	large	low	special
		District should determine outcomes; schools determine the path.	We have different parents, we have a different community, we have different teachers. And it can't be something that's just crammed down the throats of teachers. It's got to be something we live instead of something that we do. And we can't get to that point. As long as they're forced feeding. I think that's the key. So I think we're gonna have to let schools design how they're going to implement steam, whatever, that's going to mean the district needs to define the outcome. How we get there needs to be allowed to be determined by the school.	principal	large	high	special
	I adapt everything the district hands down to us... 4 Cs in the lesson plans; STEAM Fridays		principal	small	very low	traditional	

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
School Culture and Climate	Adaptation Decisions	This year, one school added a STEM related arts teacher.	this particular teacher teaches his engineering design process stem projects, and he's fabulous because he makes connections to the standards that are being taught on the grade levels and incorporates his projects to reinforce what they're talking about.	principal	large	low	special
		District STEAM initiative supported the school's own STEAM certification process, which they were seeking independently of the district initiative. That external certification provided structures for the school to measure their STEAM implementation, pre-assessments and post-assessments with specific goals.		principal	small	high	special
		The biggest thing we pushed was the 4 Cs - how to relate to the real world, being problem solvers	incorporating the four C's communicating, collaborating, critical thinking and creativity, because that made it not so broad, it was helped provide a structure.	principal	small	high	special
		We did what was best for our school, what would fit the Advanced (company) plan, looking more at the student than the teacher.		principal	small	high	special
School Culture and Climate	Adaptation Decisions	<p>phases connected to district's strategic plan</p> <p>2 sets of coaches (district and Discovery Ed)</p> <p>-2 schools shared 1 Discovery coach at the beginning of the year</p> <p>-in January, every school had 1 Discovery coach</p> <p>-Discovery coaches had to provide specific amounts of PD</p> <p>only she tried to balance w/Discovery coaches</p> <p>-scheduled to be at schools together (observations, discussions)</p> <p>Discovery coaches were only supposed to go to 8 innovators in a school</p> <p>innovators were considered the lighthouse b/c they would eventually be coaches</p> <p>some innovators elected to participate and some were voluntold</p>		district			
	Adaptation Decisions	<p>a lot of resistance</p> <p>didn't understand/lack of resources</p> <p>involves a lot of planning</p> <p>lost whole summer</p> <p>launched at beginning of year</p> <p>coach provided one step at a time and accountability</p>	"felt like it was just one more thing we had to do"	district			

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
School Culture and Climate	Explicit Buy-in	- for the non-Science teachers, there wasn't much buy-in; but its better this year, because we have a STEAM leadership team		core teacher	large	low	special
		- could be overwhelming for new teachers		core teacher	large	low	special
		Several people refused to be a STEAM innovator; more pushback from non-science teachers		core teacher	large	low	special
		We were told we had to do it, but we could have chosen not to... And I was fine with that; I was all for it at first... but it was sold as another initiative and just another thing to do	"And we all know in a school system anytime a new initiative is introduced it will be gone very soon so you just ride the wave with it and when its done its done"	core teacher	large	low	special
		Teachers will buy into things just because DH is all in it together		core teacher	large	low	traditional
		I totally bought in and took it very seriously		core teacher	large	low	traditional
School Culture and Climate	Explicit Buy-in	Resistance? There was no resistance. They both attended training all year long in their own building except for the initial summer training.		core teacher	small	very low	special
		By the end of year 1, Haynes T2 was excited about a STEAm camp they held in Summer 2018. Just after that, she learned Discovery would not be coming back and STEAm was over.	STEAM Camp, it helped me know that I could do STEAM. Our theme was water. So every, every day there was an activity that was centered around water, whether it was hydro energy, they built a contraption to use hydro energy to turn a wheel, water in our bodies, and what, how much is in there, what the job of it is, and, you know, water, we just did some kind of aspect of water every day. And we got to do those hands on lessons. I was like, Oh, this can work. This is how you do it. But I wasn't worried about how I wrote it in my lesson plan. How was I going to evaluate the students? And if you were going to come evaluate me what that looked like, I could just do what he's trying. * We had a Discovery Ed person who was the lead on it. There were 4 schools that did it for a week. So we just had one group of 20 and we would just kind of divvy them up. * It was really fun and then, I found out we weren't doing it anymore.	core teacher	small	very low	special
		Resistance?	A school wide decision was not to go. As a district, we worry about scores, but they were taking away my time teaching.	core teacher	small	very low	special
		There was just a fear of the unknow... not much resistance		core teacher	small	very low	traditional
		really excited at the beginning, but no one knew how to connect STEAM to ELA		core teacher	large	very low	traditional

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
		This teacher went to STEAM training at Purdue University and implemented all kinds of STEAM projects into her ELA classroom, including sheep brain dissection, but she indicated no learning or collaboration that stemmed from the district's initiative.	They picked me (to participate in STEAM) because I was heading to Purdue for the summer thing. I've always incorporated curriculum from different areas.	core teacher	large	very low	traditional
		I had the most resistance myself because my kids weren't learning when we were doing STEAM and we were being pushed to do things outside the 8th grade standards.		core teacher	large	very low	traditional
		Community buyin happened with the STEAM family night including a helicopter and cool experiences for kids		core teacher	large	very low	traditional
School Culture and Climate	Explicit Buy-in	Frustration from low achieving school because of the specific challenges they face	It was being framed, almost like we had a deficit perspective with our kids, which I think is the opposite of what everyone here has of our students we really think of them as having so many different strengths, they're just not strengths that always mesh well with STEAM.	core teacher	large	very low	traditional
		STEAM ended last April or May. It wasn't enough time to see if there was an effect.	If I had my Discovery Ed coach again this year, would I have been able to take a second step? Now, I guess I will keep using my Spotlight Strategies.	core teacher	large	very low	traditional
		wasn't excited about the training ("Just another meeting"), but loved coaching	As soon as I got involved with my Discovery Ed Coach, and just got a couple of strategies that I saw I could implement right away, my enthusiasm for it really grew.	core teacher	large	very low	traditional
		It really took off in science, but everything was geared toward science.		core teacher	small	high	special
		motivation changed with positive feedback from the students	when I saw my kids light up! And, you know, they were really getting into it, At first I was like, they're going to think this is stupid. They're not going to want to do this. But, when they I saw their little faces, and they were really into it. My coach told me this was gonna happen.	core teacher	small	high	special
		some school cultures have other priorities, like discipline	A colleague told him "How do I add STEAM to what is already in front of me?" AT Jere Baxter, they just couldn't do it because of the behaviors there.	non-core teacher	large	high	special
		Some teachers were worried...There is a misunderstanding of the overall goal of the implementation	"Everyone thinkin, what is this, is this just another thing?"	principal	large	low	special
		Teachers did it because we told them to do it...		principal	small	very low	traditional

Lens	Category	Interview Findings	Quotes	Interviewee	Size	Achievement	Specialty
		Motivation was fueled by teachers who were collaborators and learners themselves	Participating in the initiative grew academic connections in the building for teachers who already have those skills, they want to collaborate, they want to find new activities, they're already kind of self motivated, and are open to finding new ways to engage their students. So for teachers that are already have that belief system or desire, they're encouraged by an opportunity to grow and develop. So I think that in itself created the buy in for teachers to even be willing to participate.	principal	large	low	special
School Culture and Climate	Explicit Buy-in	This year, the new principal is trying to connect the STEAM ideas to the bigger picture. Her staff did not know who had the title of innovator, but she sees much innovation in the classroom, and prefers to attribute the word innovator to those who are actually demonstrating innovation, rather than stamp the title on some arbitrary group that went to training.	"It was too fast, too fast. I don't think we spent enough time really making sure that people understood what we were trying to do as opposed to put the stamp on top of the middle school so that we can say that we have something."	principal	large	low	special
		Just a little resistance at the beginning because they were already a science and math magnet		principal	small	high	special
		Resistance?	Oh, substantial, caused by the mandate, we're ust trying to get classroom management down pat. I did not feel supported by a team, going through STEAM together.	non-core teacher	small	very low	special
		tried to answer as many questions as possible if something was unknown, protocol was to ask whomever was in charge resistance was b/c of lack of communication and no specific game plan no backwards planning no buy in, so teachers were less supportive b/c of not knowing vision wasn't clearly articulated ELA and Math classroom teachers were concerned about accountability (test scores + evaluation) how will initiativee help test scores? -- this was a barrier	"it felt best to stick to what they knew instead of risking test scores and evaluation"	district			
School Culture and Climate	Explicit Buy-in	not really any pushback some wanted more info and some had concerns overall, excitement or enthusiasm more feedback was received from schools that weren't chosen		district			
		dean on instruction was responsible for implementation wasn't really a team admin was supportive but no formal follow up		district			

C. Appendix C: Teacher Interview Protocol

Good morning! I am going to ask you some questions about your STEAM Initiative. Anything you tell me is confidential, and there is no right answer. I just want to take note of your perceptions. Would you mind if I record just so I can make better notes? At any time, you can tell me to stop recording.

Professional Background/Icebreaker

1. What courses do you teach? How long have you worked here? How long have you worked for MNPS?

Organizational Capacity

2. NEEDS ASSESSMENT: Usually when a school district is doing something new, they are trying to solve a problem. What problem do you think the STEAM Initiative was meant to address? So, how did the STEAM plan fit into the district's mission or priorities?
3. ORG CAPACITY BUILDING: What structures were in place to help you implement the STEAM plan? What skills were required to help implement the STEAM plan? Was there any part of the pre-implementation process that made you feel really motivated or prepared to move forward with STEAM?
4. PEOPLE CAPACITY BUILDING: What were the barriers to getting started? Were there structures or personnel that helped remove those barriers? Did you have anyone who was an "innovation champion," who led the way through the barriers to success? What was it about that person that makes you call him/her the innovation champion of superseding barriers?
5. ADAPTATION DECISIONS: How did you keep track of the things you implemented or the changes you made to make things work in your classroom? Did anybody else keep track? Was there any system to share your implementation experiences?
6. PROCESS EVALUATION: Over the course of the year, how did you measure the strengths and weaknesses of the STEAM Initiative? Did somebody gather information on different aspects of the innovation or on the performance of the different individuals doing the implementing? Did you get feedback about how it was going across the district or across your school? How? In your opinion, do you feel that, overall, the STEAM Initiative was implemented the way it was intended to be (with fidelity)?

Instructional Leadership

1. STAFFING: Who was your best supporter while you were implementing last year? Did you feel like that person knew how to implement STEAM practices more than you did? Did that person have any expertise in implementation science – like how the process of trying new ideas would work? Did your person have ideas on how to evaluate how you were doing along the way?
2. EXPLICIT BUY-IN: How genuinely excited were you and your teaching colleagues about delivering the initiative at the beginning? What made you feel that way? Of all the folks in the district, who showed the most genuine buy-in for the success of the program?
3. SUPPORT/SUPERVISION: Who (not the name, just the position within the district) did you talk to when you ran into challenges with implementing the STEAM Initiative? What help did you need? Did you feel like there were resources available to solve the issues?

Professional Development

1. INITIAL PREP: What kind of professional development were you provided in preparation for the STEAM Initiative? Did you feel like you learned the skills needed to begin?
2. IMPACT: How did the preparation impact your teaching in the classroom? How did the preparation process impact your motivation last year?
3. UNDERSTANDING OF IMPLEMENTATION: Overall before you began, did you feel like you had sufficient training to know WHY you were implementing a STEAM Initiative? Did you feel like you had sufficient training to know WHAT you were supposed to implement? Did you understand WHEN and WHERE your innovation was to take place? Did you have sufficient training to know HOW to implement?
4. SUPPORT: To what extent did you receive feedback during the preparation process? Were you given adequate opportunities for reflection? To what extent did you receive coaching and expert support throughout the year?

School Climate/Culture

1. FIT ASSESSMENT: Your middle school was one of 17 selected to implement the STEAM Initiative. How do you think the different schools were selected to participate? Why do you think your school was chosen? Did you feel like the STEAM Initiative was a good fit for your school?
2. ADAPTATION DECISIONS: Did you have to make changes in the district's plan to make the initiative fit your students' needs? In what ways did you make changes?
3. EXPLICIT BUY-IN: How much resistance did you perceive from other team members as you were starting implementation? What were their specific concerns or questions?
4. IMPLEMENTATION TEAMS: Did you feel supported by your team as you were implementing the STEAM Initiative? In what ways were you supported? Who was responsible for the organizational implementation of STEAM in your school? What structures, procedures, and/or policies helped or hindered implementation of the initiative?

Closing Questions:

1. What lessons have been learned about implementing this innovation that we can share with others who have an interest in doing it too?
2. Is there anything else that you wish I had asked you about this STEAM Initiative that I haven't?

D. Appendix D: Principals' Interview Protocol

Good morning! I am going to ask you some questions about your STEAM Initiative. Anything you tell me is confidential, and there is no right answer. I just want to take note of your perceptions. Would you mind if I record just so I can make better notes? At any time, you can tell me to stop recording.

Professional Background/Ice Breaker

- How long have you been the principal at_____? What do you enjoy most about your job?
- What kind of experiences did you have with STEAM prior to the launch of the initiative?

Organizational Capacity

1. I am going to ask you some questions about your STEAM Initiative. Anything you tell me is confidential, and there is no right answer. I just want to take note of your perceptions. Does that sound ok? Would you mind if I record just so I get better notes?
2. OC: NEEDS ASSESSMENT: Usually when a school district is doing something new, they are trying to solve a problem. What problem do you think the STEAM Initiative was meant to address? How did the STEAM plan fit into the district's mission or priorities?
3. OC: ORG CAPACITY BUILDING: What structures were in place to help you implement the STEAM plan? What skills were required to help implement the STEAM plan? Was there any part of the pre-implementation process that made you feel really motivated or prepared to move forward with STEAM?
4. OC: PEOPLE CAPACITY BUILDING: What were the barriers to getting started? Were there structures or personnel that helped remove those barriers? Did you have anyone who was like an "innovation champion", who led the way through the barriers to success? What was it about that person that makes you call him/her the innovation champion of superseding barriers?
5. OC: IMPLEMENTATION TEAMS: Did you feel like you were implementing STEAM as part of a team? With whom (roles, not names)? In what ways were you supported? Who on this team was most responsible for the organizational implementation of STEAM in your school? What structures or procedures helped or hindered implementation of the initiative?
6. OC: PROCESS EVALUATION: Over the course of the year, how did your district measure the strengths and weaknesses of the STEAM Initiative? Was there information gathered on different aspects of the innovation or on the performance of the different individuals doing the implementing? Did you get feedback about how it was going? How? How did your school keep track of the things your teachers implemented or the changes they made to make things work in their classrooms? In your opinion, do you feel like overall the STEAM Initiative was implemented the way it was intended to be (with fidelity)?

Instructional Leadership

1. IL: STAFFING: Who was the best supporter of your teachers while you were implementing last year? Did you feel like that person knew how to implement STEAM practices more than you and your teachers did? Did that person have any expertise in implementation science

- like how the process of trying new ideas would work? Did your person have ideas on how to evaluate how you were doing along the way?
- 2. IL: EXPLICIT BUY-IN: How genuinely excited were you and your teachers about delivering the initiative at the beginning? What made you feel that way? Of all the folks in the district, who showed the most genuine buy-in for the success of the program?
- 3. IL: SUPPORT/SUPERVISION: Who (the position of the person, not the name) did you talk to when you ran into challenges with implementing the STEAM Initiative? What help did you need? Did you feel like there were resources available to solve the issues?

Professional Development

1. PD: INITIAL PREP: What kind of professional development were you and your teachers provided in preparation for the STEAM Initiative? Did you feel like you learned the skills needed to begin?
2. PD: IMPACT: How did the preparation impact your teachers' teaching in the classroom? How did the preparation process impact your motivation last year?
3. PD: UNDERSTANDING OF IMPLEMENTATION: Overall before you began, did you feel like you had sufficient training to know WHY you were implementing a STEAM Initiative? Sufficient training to know WHAT your teachers were supposed to implement? Did you understand WHEN and WHERE your innovation was to take place? Did you have sufficient training to know HOW to implement?
4. PD: SUPPORT: To what extent did you as the instructional leader receive feedback during the preparation process? To what extent did you receive coaching and expert support throughout the year? What was that coaching like for school leaders?

School Culture and Climate

1. SC: FIT ASSESSMENT: Your middle school was one of 17 selected to implement the STEAM Initiative. How do you think the different schools were selected to participate? Why do you think your school was chosen? Did you feel like the STEAM Initiative was a good fit for your school?
2. SC: ADAPTATION DECISIONS: Did your school team have to make changes in the district's plan to make the initiative fit your students' needs? In what ways did you make changes?
3. SC: EXPLICIT BUY-IN: How much resistance did you perceive from other team members as you were starting implementation? What were their specific concerns or questions?

CLOSING

1. What lessons have been learned about implementing this innovation that we can share with others who have an interest in doing it too?
2. Is there anything else that you wish I had asked you about this STEAM Initiative that I haven't?

E. Appendix E: District Personnel's Interview Protocol

Good morning! I am going to ask you some questions about your STEAM Initiative. Anything you tell me is confidential, and there is no right answer. Would you mind if I record just so I can take better notes? At any time, you can tell me to stop recording.

Professional Background/Icebreaker

1. How long have you worked in education? How long have you worked with MNPS?
2. What is your favorite educator moment? How long have you been a coach? Did you have any experience with STEAM in education prior to the launch of this initiative?

Organizational Capacity

1. NEEDS ASSESSMENT: Usually when a school district is doing something new, they are trying to solve a problem. What problem do you think the STEAM Initiative was meant to address? So, how did the STEAM plan fit into the district's mission or priorities?
2. ORG CAPACITY BUILDING: What structures were in place to help you implement the STEAM plan? What skills were required to help you implement the STEAM plan? Was there any part of the pre-implementation process that made you feel really motivated or prepared to move forward with STEAM?
3. PEOPLE CAPACITY BUILDING: What were the barriers to getting started? Were there structures or personnel that helped remove those barriers? Did you have anyone who was an "innovation champion," who led the way through the barriers to success? What was it about that person that makes you call him/her the innovation champion of superseding barriers?
4. ADAPTATION DECISIONS: How did you keep track of the things you implemented or the changes you made to make things work in your classroom? Did anybody else keep track? Was there any system to share your implementation experiences?
5. PROCESS EVALUATION: Over the course of the year, how did you measure the strengths and weaknesses of the STEAM Initiative? Was there someone responsible for gathering information on different aspects of the innovation or on the performance of the different individuals doing the implementing? Did you get feedback about how it was going across the district or across your school? How? In your opinion, do you feel like overall the STEAM Initiative was implemented the way it was intended to be (with fidelity)?

Instructional Leadership

1. STAFFING: What was your feedback protocol during implementation? Who were the most receptive teachers to feedback during implementation last year? Did anyone have any expertise in implementation science – like how the process of trying new ideas would work?
2. EXPLICIT BUY-IN: What feelings did you and your colleagues have about delivering the initiative at the beginning? What made you feel that way? Of all the folks in the district, who showed the most genuine buy-in for the success of the program?

3. SUPPORT/SUPERVISION: Who (not the name, just the position in the district) did you talk to when you ran into challenges with coaching teachers during the STEAM Initiative? What help did you need? Did you feel like there were resources available to solve the issues?

Professional Development

1. INITIAL PREP: What kind of professional development were you provided in preparation for the STEAM Initiative? Did you feel like you learned the skills needed to begin?
2. IMPACT: How did the preparation impact your coaching of teachers? How did the preparation process impact your motivation last year?
3. UNDERSTANDING OF IMPLEMENTATION: Overall before you began, did you feel like you had sufficient training to know WHY you were implementing a STEAM Initiative? Did you feel like you had sufficient training to know WHAT you were supposed to implement? Did you understand WHEN and WHERE your innovation was to take place? Did you have sufficient training to know HOW to implement?
4. SUPPORT: To what extent did you receive feedback during the preparation process? Were you given adequate opportunities for reflection? To what extent did you receive coaching and expert support throughout the year?

School Climate/Culture

1. FIT ASSESSMENT: Your middle school was one of 17 selected to implement the STEAM Initiative. How do you think the different schools were selected to participate? Why do you think your school was chosen? Did you feel like the STEAM Initiative was a good fit for your school?
2. IMPLEMENTATION TEAMS: Did you feel supported by your team as you were coaching during the STEAM Initiative? In what ways were you supported? Who was responsible for the organizational implementation of STEAM in your school? What structures, procedures, and/or policies helped or hindered implementation of the initiative?
3. ADAPTATION DECISIONS: Did you have to make changes in the district's plan to make the initiative fit your teachers' and their students' needs? In what ways did you make changes?
4. EXPLICIT BUY-IN: How did you deal with concerns or questions about your new STEAM Initiative? How much resistance did you perceive from other team members as you were starting implementation? What were their specific concerns or questions?

Closing Questions

1. What lessons have been learned about implementing this innovation that we can share with others who have an interest in doing it too?
2. Is there anything else that you would like to share about the STEAM Initiative?

F. Appendix F: Development of Interview Items based on Meyers, Durlak, and Wandersman (2012)

This Study's Lenses

OC = Organizational Capacity

IL = Instructional Leadership

PD = Professional Development

SC = School Climate/Culture

Critical Steps in Implementation – Meyers et.al. Phases and Critical Questions (p.469-470) This Study's Possible Interview Questions

Lenses	Phase one: Initial considerations	
	1. Needs and resources assessment:	
OC/SC	a. Why are we doing this?	Why do you think your district created the whole plan to have a STEAM initiative last year?
OC/SC	b. What problems or conditions will the innovation address (i.e., the need for the innovation)?	Usually when a school district is doing something new, they are trying to solve a problem. What problem do you think the STEAM initiative was meant to address?
OC/IL	c. What part(s) of the organization and who in the organization will benefit from improvement efforts? 14 (56 %)	What parts of your organization were supposed to benefit from STEAM?
	2. Conducting a fit assessment:	
OC/SC	a. Does the innovation fit the setting?	Your middle school was one of 17 selected to implement the STEAM initiative? How do you think they picked the different schools to participate? Why do you think they picked your school? Did you feel like STEAM initiative was a good fit for your school? What makes you say so? Why do you think

		they picked you in particular? Did you feel like the initiative was a good fit for you? What makes you say so?
OC/SC	b. How well does the innovation match the: Identified needs of the organization/community?	Do you feel like the STEAM plan matched the needs of your students? District? Community?
OC/IL	c. Organization's mission, priorities, values, and strategy for growth?	How did the STEAM plan fit into the district's mission or priorities?
OC/SC	d. Cultural preferences of groups/consumers who participate in activities/services provided by the organization/community? 14 (56 %)	(Covered in 2b.)
	3. Conducting a capacity/readiness assessment:	
PD	a. Are we ready for this?	When you started, did you feel ready or prepared to implement your STEAM plan?
PD/IL	b. To what degree does the organization/community have the will and the means (i.e., adequate resources, skills and motivation) to implement the innovation?	What kind of resources were your provided before you began? Did you feel like you learned the skills you needed to begin? How did the preparation process impact your motivation last year?
SC (community climate)	c. Is the organization/community ready for change? 11 (44 %)	Did you think your community was ready for the change you brought through steam? Why or why not?
	4. Decisions about adaptation	
PD/SC	a. Should the planned innovation be modified in any way to fit the host setting and target group?	Once they prepared you to begin the initiative, were you locked into their plan or were you allowed to modify a bit for your classroom? In what ways?

OC/PD/SC	b. What feedback can the host staff offer regarding how the proposed innovation needs to be changed to make it successful in a new setting and for its intended audience?	What tight were the implementation expectations? Who did you talk to if you wanted to alter a part of the STEAM plan? Did you have to make changes in the district's plan to make the initiative meet your students' needs?
OC	c. How will changes to the innovation be documented and monitored during implementation? 19 (76 %)	How did you keep track of the things you implemented or the changes you made to make things work in your classroom? Did anybody else keep track? Was there any system to share your implementation experiences?
	5. Capacity Building Strategies	
OC/PD/IL/SC	a. Obtaining explicit buy-in from critical stakeholders and fostering a supportive community/organizational climate:	Who were the best supporters of your implementation of the STEAM initiative? Were you surprised at all by who your greatest supporters were or was that support system organized from the get-go?
OC/IL/SC	b. Do we have genuine and explicit buy-in for this innovation from:	
	i. with decision-making power in the organization/community?	When you think about all the decision makers that it took to implement the STEAM initiative, like you in your classroom, maybe your colleagues supporting you, maybe your principal, maybe the district office folks, who showed the most genuine buy-in for the success of the program? Why do you think that person was so into it?
IL/SC	ii. From front-line staff who will deliver the innovation? The	How genuinely excited were you and your teaching colleagues about delivering the

	local community (if applicable)?	initiative at the beginning? What made you feel that way?
IL/PD	c. Have we effectively dealt with important concerns, questions, or resistance to this innovation?	How did you deal with concerns or questions about your new STEAM initiative? How much resistance did you perceive as you were starting? From whom?
OC/IL/SC/PD	d. What possible barriers to implementation need to be lessened or removed? Can we identify and recruit an innovation champion(s)?	What were the barriers to getting started? Was there anything that helped remove those barriers? Did you have anyone who was like an “innovation champion”, who led the way through the barriers to success? Who was that for you? What was it about that person that makes you call him/her the innovation champion of superseding barriers?
OC/IL	e. Are there one or more individuals who can inspire and lead others to implement the innovation and its associated practices?	Who inspired you the most in the STEAM process? What is an example of what you learned from that person?
OC/IL	f. How can the organization/community assist the champion in the effort to foster and maintain buy-in for change? 23 (92 %)	When the district goes back to implementing the STEAM initiative in the other middle schools, how can they foster buy-in from the next group of teachers? What supports can they give to the new group that would have helped you if you had it?
	6. Building general/organizational capacity:	
OC	a. What infrastructure, skills, and motivation of the organization/community need enhancement in order to ensure the innovation will be implemented with quality?	Do you feel like overall the STEAM initiative was implemented with quality? What structures were in place to help you implement the STEAM plan? What skills did you acquire that helped you implement the

		STEAM plan? Was there any part of the pre-implementation hype that made you feel really motivated to move forward with STEAM?
	i. improved communication within the organization and/or with other agencies;	Over the last year, was there improved communication in the organization because of STEAM? What did that look like?
OC/IL/SC (community climate)	ii. enhanced partnerships and linkages with other agencies and/or community stakeholders). 15 (60 %)	Did you feel like STEAM enhanced your partnerships outside your school with the district or the community or somebody? In what way?
	7. Staff recruitment/maintenance:	
IL	a. Who will implement the innovation? Initially, those recruited do not necessarily need to have knowledge or expertise related to use of the innovation; however, they will ultimately need to build their capacity to use the innovation through training and on-going support	Who in your school implemented the STEAM initiative? Who picked you or did you volunteer? Why do you think they picked you and the others in your building?
SC/IL/OC	b. Who will support the practitioners who implement the innovation? These individuals need expertise related to (a) the innovation, (b) its use, (c) implementation science, and (d) process evaluation so they can support the implementation effort effectively	Who was your best supporter while you were implementing last year? Did you feel like that person knew how to implement STEAM practices more than you did? Did that person have any expertise in implementation science – like how the process of trying new ideas would work? Did your person have ideas on how to evaluate how you were doing along the way?
OC/IL/PD	c. Might roles of some existing staff need realignment to ensure that	Did you feel like the implementation has people-power? Like there were folks who

	adequate person-power is put towards implementation? 13 (52 %)	knew what they were doing and could help make it happen? What make you think so?
	8. Effective pre-innovation staff training	
PD	a. Can we provide sufficient training to teach the why, what, when, where, and how regarding the intended innovation?	Overall before you began, did you feel like you had sufficient training to know WHY you were implementing a STEAM initiative? Sufficient training to know WHAT you were supposed to implement? Did you understand WHEN and WHERE your innovation was to take place? Did you have sufficient training to know HOW to implement? (Likert scale)
PD	b. How can we ensure that the training covers the theory, philosophy, values of the innovation, and the skill-based competencies needed for practitioners to achieve self-efficacy, proficiency, and correct application of the innovation? 22 (88 %)	Blend into previous...how could they do it better for the next group for each of the above questions?
	Phase two: Creating a structure for implementation	
	9. Creating implementation teams:	
OC/PD/SC/IL	a. Who will have organizational responsibility for implementation?	Did you feel like you were implementing the STEAM initiative on your own or did you feel part of a team? Who did you think of as being members of the STEAM team? Of all those folks, who was responsible for the organizational implementation of STEAM?

IL/PD	b. Can we develop a support team of qualified staff to work with front-line workers who are delivering the innovation?	Did you feel like the other people on your STEAM team were well qualified to support you? Why or why not?
OC/IL	c. Can we specify the roles, processes, and responsibilities of these team members? 17 (68 %)	What were the different roles from the classroom all the way out to the community that people had to help make this STEAM initiative work?
	10. Developing an implementation plan:	
OC/PD	a. Can we create a clear plan that includes specific tasks and timelines to enhance accountability during implementation?	Did you have a plan that included specific tasks and timelines for STEAM last year?
OC/IL/PD/SC	b. What challenges to effective implementation can we foresee that we can address proactively? 13 (52 %)	What were challenges you found in effectively implementing the STEAM initiative?
	Phase three: Ongoing structure once implementation begins	
	11. Technical assistance/coaching/supervision:	
OC/IL/PD/SC	a. Can we provide the necessary technical assistance to help the organization/community and practitioners deal with the inevitable practical problems that will develop once the innovation begins? These problems might involve a need for further training and practice in administering more challenging parts of the innovation, resolving administrative or scheduling conflicts that arise, acquiring more support or resources, or making some required	What did you need when you met those challenges? Were the resources available to solve the issues?

	changes in the application of the innovation 20 (80 %)	
	12.Process evaluation	
OC	a. Do we have a plan to evaluate the relative strengths and limitations in the innovation’s implementation as it unfolds over time? Data are needed on how well different aspects of the innovation are being conducted as well as the performance of different individuals implementing the innovation 24 (96 %)	Did you guys ever evaluate the process, the strengths and weaknesses of the STEAM initiative at different points over the last year? Did somebody gather information on different aspects of the innovation or on the performance of the different individuals doing the implementing? How did they measure?
	13.Supportive feedback mechanism	
IL	a. Is there an effective process through which key findings from process data related to implementation are communicated, discussed, and acted upon? How will process data on implementation be shared with all those involved in the innovation (e.g., stakeholders, administrators, implementation support staff, and front-line practitioners)? This feedback should be offered in the spirit of providing opportunities for further personal learning and skill development and organizational growth that leads to quality improvement in implementation 18 (72 %)	(If they measured...) did you ever get feedback from the process evaluations? Were you involved in any discussions on how it was going? Did you ever see data anyone collected about the process? Did you ever see feedback about how other people were seeing the initiative like principals or tech folks, or community members? (If they did not gather feedback or share it), do you think it would have been helpful to provide that feedback and then get to see what others were saying? If you did have that information, how could it have helped you to improve along the way?
	14.Phase four: Improving future applications	
OC/IL/PD/SC	a. What lessons have been learned about implementing this innovation	What lessons have been learned about implementing this innovation that we can

	that we can share with others who have an interest in its use?	share with others who have an interest in doing it too?
		Is there anything else that you wish I had asked you about this STEAM initiative that I haven't?

G. Appendix G: Data Comparison of all Metro Middle Schools

School	Total Students	Racial Composition TDOE 2016-17 School Profile Data				Econ. Disadvan.	Limited English	Disabilities	Years Principal at School/Work Total	Special Programs	Math Scores (On Track or Mastered in 6-8) TDOE School-Level Accountability Data 2017	Science Scores (On Track or Mastered in 6-8) TDOE School-Level Accountability Data 2017	Average	STEAM School Interviewed	STEAM School	
		White	African American	Hispanic	Asian											
Meigs Magnet Middle	696	57.8%	26.7%	5.9%	9.3%	10.1%	1.3%	4.5%	6/6	Academic Magnet	77.5%	91.3%	84.4%			
Rose Park Middle	446	33.9%	53.8%	9.2%	2.9%	27.1%	4.5%	3.8%	5/25	Math and Science Magnet School	48.1%	76.4%	62.3%	1	1	High Achieving
John Trotwood Moore Middle	670	57.9%	31.2%	5.7%	5.1%	28.4%	4.0%	18.1%	6/6	IB School	48.3%	75.1%	61.7%	1	1	
Head Middle	561	27.5%	58.6%	5.2%	8.7%	26.4%	2.5%	5.2%	4/4	Math and Science Magnet School	51.9%	68.6%	60.3%		1	
Bellevue Middle	692	56.2%	31.1%	6.6%	5.5%	34.1%	5.9%	18.1%	2/4	IB School	31.2%	61.8%	46.5%		1	
Dupont Hadley Middle	610	60.5%	25.1%	12.0%	1.9%	37.8%	5.5%	14.3%	6/6		28.9%	62.6%	45.8%	1	1	Average Achieving
Neely's Bend Middle	236	13.1%	41.5%	44.1%	0.4%	60.2%	17.8%	12.7%	2/8		27.7%	56.0%	41.9%			
William Henry Oliver Middle	834	48.7%	28.7%	13.7%	8.0%	30.5%	15.7%	10.2%	1/1	Cambridge School	27.7%	56.0%	41.9%	1	1	
HG Hill Middle	631	44.4%	28.5%	19.7%	7.1%	46.3%	15.5%	17.6%	9/11		25.3%	51.0%	38.2%			
Croft Middle	652	36.8%	20.1%	35.7%	6.9%	43.3%	25.9%	11.8%	1/3	Partnership with Nashville Zoo	18.1%	52.8%	35.5%	1	1	
Isaac Litton Middle	471	43.1%	46.1%	8.5%	2.1%	48.0%	5.1%	18.3%	2/6	STEM Magnet School	16.3%	47.3%	31.8%		1	Low Achieving
Apollo Middle	800	20.6%	30.9%	44.9%	3.6%	57.0%	32.8%	13.5%	2/6		14.4%	39.3%	26.9%			
Two Rivers Middle	466	29.4%	44.8%	22.5%	3.0%	58.4%	13.3%	15.0%	5/5	Leader in Me	15.0%	37.8%	26.4%			
John Early Museum Magnet	391	10.2%	83.1%	4.3%	2.3%	76.2%	2.3%	18.7%	5/17	Museum Magnet	18.0%	30.8%	24.4%			
Donelson Middle	761	38.1%	43.8%	15.5%	2.2%	49.8%	10.6%	16.7%	5/5	Cambridge School	13.8%	28.5%	21.2%			
Goodlettsville Middle	515	28.3%	45.2%	21.9%	3.1%	54.4%	12.4%	16.3%	1/1	STEM & IB	8.6%	33.7%	21.2%			
East Nashville Magnet Middle	466	7.9%	89.3%	2.1%	0.4%	49.6%	1.1%	10.5%	1/20	Paideia	13.3%	28.4%	20.9%			
Margaret Allen Middle	488	24.8%	43.2%	28.3%	3.5%	61.3%	26.4%	14.8%	3/5		11.1%	28.3%	19.7%			
John F. Kennedy Middle	770	20.8%	46.1%	29.5%	3.2%	46.8%	24.9%	11.2%	9/21		10.8%	27.1%	19.0%		1	

School	Total Students	Racial Composition				Econ. Disadvan.	Limited English	Disabilities	Years Principal at School/Work Total	Special Programs	Math Scores (On Track or Mastered in 6-8)	Science Scores (On Track or Mastered in 6-8)	Average	STEAM School Interviewed	STEAM School
		White	African American	Hispanic	Asian										
Source	TDOE 2016-17 School Profile Data					TDOE 2016-17 School Profile Data			STEAM Readiness Survey	TDOE School-Level Accountability Data 2017	TDOE School-Level Accountability Data 2017				
Dupont Tyler Middle	569	32.3%	42.7%	20.7%	3.3%	52.0%	11.8%	13.4%	1/1	STEM School	10.9%	26.4%	18.7%		
Thurgood Marshall Middle	870	20.1%	40.9%	32.5%	6.2%	44.7%	23.8%	15.3%	5/9		13.2%	22.9%	18.1%		
McMurray Middle	851	12.0%	18.3%	52.8%	16.7%	69.3%	59.0%	11.3%	5/5		15.4%	19.7%	17.6%	1	1
Antioch Middle	723	21.6%	32.5%	38.3%	7.5%	57.4%	36.7%	11.3%	2/2		11.2%	23.4%	17.3%		1
Creswell Middle Prep School of Arts	428	9.6%	88.8%	1.4%	0.2%	47.4%	0.7%	12.6%	1/3	Arts School	10.6%	23.1%	16.9%		1
West End Middle	467	45.2%	43.3%	5.8%	5.1%	30.4%	4.3%	21.6%	3/3	IB	10.6%	23.1%	16.9%		
Moses McKissack Middle	344	7.0%	84.9%	8.1%	0.0%	85.8%	5.8%	18.3%	1/1		12.5%	21.0%	16.8%		1
Jere Baxter Middle	297	17.2%	55.6%	25.3%	1.7%	81.8%	14.5%	17.8%			11.0%	22.0%	16.5%	1	1
Madison Middle	543	17.7%	57.3%	23.4%	1.7%	71.1%	13.3%	19.0%	1/1		8.6%	19.7%	14.2%	1	1
Gra-Mar Middle	358	14.8%	71.2%	12.3%	1.4%	78.5%	11.7%	20.4%	3/3		11.0%	14.4%	12.7%		1
Stratford STEM Magnet Lower School	388	17.7%	72.6%	7.1%	2.1%	72.2%	6.5%	16.0%	1/12	STEM Magnet School	8.1%	16.4%	12.3%		1
Joelton Middle	337	27.0%	65.9%	6.5%	0.3%	73.9%	2.7%	19.3%	1/20		N/A	12.0%	12.0%		
Wright Middle	716	19.6%	20.9%	53.9%	5.6%	67.2%	39.2%	13.7%			5.3%	18.4%	11.9%		
Haynes Middle	282	1.4%	97.9%	0.0%	0.7%	66.0%	0.0%	20.2%	1.5/11	Health and Medical Science Magnet School	8.0%	14.7%	11.4%	1	1

Low Achieving

TDOE Sources: <https://www.tn.gov/content/tn/education/data/data-downloads.html>

H. Appendix H. Study Initiation Details

Interviews and emails were exchanged in the early fall of 2018 with the MNPS Director of Curriculum and Instruction who was the primary liaison/contact for the research team with the district's central office personnel, department of research, and school principals. The Director of Curriculum provided the team with pre-implementation survey data summaries, professional development data, and helped secure access to the nine STEAM schools for interviews. Teachers, principals, and district personnel, including STEAM instructional coaches and STEAM directors, were contacted for interview by phone or email in November 2018.

This study on STEAM was valued because the district had invested substantial funding, time, and professional development and support in the initiative during the 2017-18 school year. Sustained monetary and local support was planned for at least three years to allow for continuing growth of the initiative to encompass all MNPS middle schools. Although the strong investments and long-term plan should have created a smooth initiative implementation, the district was concerned that with shifts in the initiative's leadership over the course of the first implementation year and the inability to continue funding at the same level for a second year, the initiative may or may not have been perceived as successful. Having paused the funding for the STEAM Initiative, the district was highly interested in taking the opportunity to evaluate the first year's implementation to appropriately make decisions about how best to proceed.

A qualitative design was used to respond to the project questions. The design included 38 interviews at nine schools. Interview items intended to elicit interviewees' perceptions of the initiative's host setting, its structures for initial implementation, structures to support ongoing implementation, and the improvement of future applications. The interview protocol focused on the STEAM implementation through the lenses of MNPS' Instructional Leadership, Professional Development, School Culture and Climate, and Organizational Capacity.

I. Appendix I: Data Comparison of all STEAM Middle Schools

School	Total Students	Racial Composition TDOE 2016-17 School Profile Data				Economically Disadvantaged TDOE 2016-17 School Profile Data	Principal Yrs worked at STEAM Readiness Survey	Special Programs STEAM Readiness Survey	Math Scores (On Track or Accountability Data 2017)	Science Scores (On Accountability Data 2017)	Interviewed STEAM
		White	African-Amer.	Hispanic	Asian						
Antioch Middle	723	21.6%	32.5%	28.3%	7.5%	57.40%	2/2		11.2%	23.4%	
Bellevue Middle	692	52.6%	31.1%	6.6%	5.5%	34.10%	2/4	IB School	31.2%	61.8%	
Creswell Middle Prep School of	428	9.6%	88.8%	1.4%	0.2%	47.40%	1/3	Arts School	10.6%	23.1%	
Croft Middle	652	36.8%	20.1%	35.7%	6.9%	43.30%	1/3	Partnership with Nashville Zoo	18.1%	52.8%	x
Dupont Hadley Middle	610	60.5%	25.1%	12.0%	1.9%	37.80%	6/6		28.9%	62.6%	x
Gra-Mar Middle	358	14.8%	71.2%	12.3%	1.4%	78.50%	3/3		11.0%	14.4%	
Haynes Middle	282	1.4%	97.9%	N/A	0.7%	66%	1.5/11	Health and Medical Science Magnet School	8.0%	14.7%	x
Head Middle	561	27.5%	58.6%	5.2%	8.7%	26.40%	4/4	Math and Science Magnet School	51.9%	68.6%	
Isaac Litton Middle	471	43.1%	46.1%	8.5%	2.1%	48%	2/6	STEM Magnet School	16.3%	47.3%	x
Jere Baxter Middle	297	17.2%	55.6%	25.3%	1.7%	81.80%	N/A		11.0%	22.0%	
John F. Kennedy Middle	770	20.8%	46.1%	29.5%	3.2%	46.80%	11/21		10.8%	27.1%	
John Trotwood Moore Middle	670	57.9%	31.2%	5.7%	5.1%	28.40%	6/6	IB School	48.3%	75.1%	x
Madison Middle	543	17.7%	57.3%	23.4%	1.7%	71.10%	1/1		8.6%	19.7%	x
McMurray Middle	851	12.0%	18.3%	52.8%	16.7%	69.30%	5/5		15.4%	19.7%	x
Moses McKissack	344	7.0%	84.9%	8.1%	N/A	85.80%	1/1		12.5%	21.0%	
Rose Park Middle	446	33.9%	53.8%	9.2%	2.9%	27.10%	5/25	Math and Science Magnet School	48.1%	76.4%	x
Stratford STEM Magnet Lower School	388	17.7%	72.6%	7.1%	2.1%	72.20%	1/12	STEM Magnet School	8.1%	16.4%	
William Henry Oliver Middle	834	48.7%	28.7%	13.7%	8.0%	30.50%	1/1	Cambridge School	27.7%	56.0%	x

J. Appendix J: Participants

The research team interviewed a total of 38 STEAM participants from across nine middle schools and at the district-level: 26 teachers, seven school-level principals, three STEAM district coaches, and both the past and current STEAM directors. The table below presents school codes to show the number of interviews per school, but also to maintain confidentiality.

The principals were the initial emailed contacts for their schools. Once they had agreed to participate, principals selected the teachers in their schools for the study. All interviewed teachers and principals participated in STEAM in 2017-18 and were a sample of convenience based on principal selection and the availability to meet on the date and time of the arranged school visits.

School Code	Position	Subject Taught
D	Teacher	English
D	Teacher	English
I	Teacher	English/Social Studies
D	Teacher	English as a Second Language
I	Teacher	English as a Second Language
D	Teacher	Math
A	Teacher	Math/Social Studies
A	Teacher	Math/Social Studies
G	Teacher	Science
G	Teacher	Science
G	Teacher	Science
A	Teacher	Science/Social Studies
E	Teacher	Social Studies
H	Teacher	Social Studies
H	Teacher	Social Studies
B	Teacher	STEM
C	Teacher	STEM
I	Teacher	Music
I	Teacher	PE/Wellness
F	Teacher	Unknown
F	Teacher	Unknown

School Code	Position	Subject Taught
B	Librarian	
A	Literacy Coach	
G	Resident Scientist	
B	Tech Coach	
E	Asst. Principal	
H	Asst. Principal	
B	Principal	
C	Principal	
E	Principal	
F	Principal	
G	Principal	
District	STEAM Coach	Science/Social Studies
District	STEAM Coach	Science/STEM
District	STEAM Coach	
District	STEAM Director	Biology/Chemistry/Physics
District	STEAM Director	Science

