DEVELOPING A CULTURE OF INNOVATION: A QUALITATIVE CASE STUDY OF A MASSACHUSETTS K-8 SCHOOL

by

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WE, THE UNDERSIGNED MEMBERS OF THE COMMITTEE,

HAVE APPROVED THIS DISSERTATION

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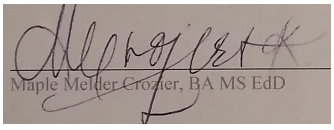

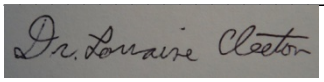

Lorraine Cleeton, EdD

Abstract

This study was designed to understand how a school can transform its instructional practices and collaborative structures to bring about rigorous, relevant, and engaging learning for all students. The purpose of this qualitative case study was to determine how a school can create a culture of innovation in teaching practices. This case study identified the decisions and strategies undertaken by a group of educators to enhance 21st-century learning for their student population. The study also examined the conditions within the school that supported innovation, creativity, collaboration, and curriculum integration.

Four research questions guided this study: How do teachers collaborate on designing curriculum and examining student work? How do teachers adapt curriculum standards and experiment with alternate methodologies? How does a school or district administration support project-based or interdisciplinary approaches to teaching and learning? What resources are available to staff for this type of professional development?

This qualitative research case study was grounded in Lewin's change theory in education. The participants of this study were 14 staff, including administrators, specialists, and teachers, from a kindergarten through Grade 8 school in a public-school district in Massachusetts. Data were collected through interviews, field notes from observations, and relevant documents pertaining to processes and outcomes at the school. These included project plans, student reflections, and the school's science, technology, engineering, arts, and mathematics team meeting notes.

Results from the study revealed a strong culture of innovation. Structures were in place that allowed for staff collaboration, providing them time to share practice, plan learning experiences, and reflect on successes and challenges. Teachers could integrate and connect

curriculum under the auspices of project-based learning. The school's leadership openly supported these efforts. In addition, the school established an inclusive team of educators that led ongoing job-embedded professional development. The results of this study could set the stage for future research on project-based learning, particularly with regard to transforming physical spaces, integrating technology, and employing instructional coaching.

Dedication

This paper is dedicated to my parents, Milton and Willa, former educators who paved the way for me to enjoy school the way they did.

Acknowledgements

I would like to thank several individuals, without whom I would not have been able to complete this project.

I had the pleasure of working with Dr. Daniella Bianchi-Laubsch throughout the dissertation process. As an advisor, Dr. Bianchi-Laubsch provided specific, helpful, and kind feedback in a prompt manner during every stage of this experience. In particular, Dr. Bianchi-Laubsch helped me to understand proper research methodology and the structure and write-up of a formal report. I also wish to thank Dr. Maple Melder Crozier and Dr. Lorraine Cleeton for serving on the dissertation committee and offering support and feedback on my research and writing.

Thank you to my editor, who was indispensable in polishing my writing and layout of the document. It is incredibly helpful to work with an expert in APA style.

Thank you to the faculty and staff at the study school. Their day-to-day work drove the content of this paper, and I am forever indebted to them for sharing with me a window into their teaching. This staff represents some of the most dedicated, forward-thinking, and collaborative educators I have ever encountered. Their collective work is exemplary, and clearly benefited hundreds of students. I especially wish to thank Mr. P. for leading these innovative efforts at this school.

Finally, thank you to my wife, Jennifer, and my children, Arni and Capri, who support me and inspire me to persevere in the face of our hectic lives.

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Chapter 1

Introduction to the Study

Rapid access to information and widespread connectivity across the globe are highly representative of the current era (Wagner, 2008). In preparing today's youth for a future of globalization and advances in technology, school leaders and staff must be able to adapt teaching and learning in ways relevant for the 21st century. The model of education represented in many U.S. public schools dates back to the late 1800s, established by the Committee of Ten (Sheppard & Robbins, 2002). This group of educated White males declared which subject areas were taught in each grade level and divided children's school days into periods of time dedicated to each content area. Students progressed from subject to subject and from grade level to grade level in an orderly fashion, absorbing the content delivered to them from master teachers (Sheppard & Robbins, 2002).

Many schools today are beginning to rethink this "factory model" of education that was devised in the Industrial Era of more than a century ago (Serafini, 2002). Modern society is more diverse, information is more readily available, and technology connects individuals across the globe. Teachers no longer need to serve as the purveyors of knowledge, and having students absorb content in a rote, passive manner is no longer effective. Rather than compartmentalizing knowledge, schools are beginning to integrate content so students can apply practices across disciplines. Schools are undertaking efforts to develop programming under the heading of science, technology, engineering, arts, and mathematics (STEAM), supporting students to be more creative, flexible thinkers (Marshall, 2005). STEAM learning represents explicit integration of these multiple content areas. Teachers and teams are experimenting with project-based approaches to learning as a way to engage all learners and prepare them for a world

drastically different from that of earlier generations. According to Pink (2009), the factor that motivates individuals the most is purpose. Today's school leaders must strive to make students and teachers alike feel that the work they do has a purpose.

Background of the Problem

Schooling throughout the 20th century was driven by the characteristics of the Industrial Era. The educational operation in U.S. schools witnessed standardized curricula and uniform structures so that given groups of students would experience identical content at identified stages in their schooling. The teacher was seen as the expert whose role was to impart knowledge on students. The expression "sage on the stage" was used to describe the interactions between this master teacher and students. The teacher often worked in isolation within a school and covered a curriculum deemed important for students to master. On the receiving end, students were to absorb facts and be able to replicate procedures deemed necessary to know (Collins & Halverson, 2009).

This model of education existed throughout the 20th century. In the later part of the century and into the 21st century, U.S. education reforms led to high-stakes standardized testing and strict accountability measures. The goal was for all students to reach levels of proficiency on major indicators of knowledge, particularly in mathematics and literacy. A predominant theme in schools was to help students succeed on standardized tests, and educators continued to witness a skill-based approach to learning. As advances in technology proliferated and access to information became ubiquitous, schools were using models of education that were becoming obsolete. Students were disengaging from instruction, citing a lack of relevance and disengagement from packaged curricula and associated worksheets (Luke, 2004). Essentially students were still consumers of vast quantities of content. Whereas the goal of the educational

model was to support the needs of all students, school districts continued to demonstrate disparities in student achievement data among groups of students, particularly among students with varied socioeconomic status and racial backgrounds.

In recent years, schools have begun to modernize practices in realizing the need to engage children in meaningful learning for the 21st century. Understanding that access to content is readily available, schools are seeking to enhance "the 'Four Cs'" of collaboration, communication, critical thinking, and creativity (National Education Association [NEA], 2012, p. 5) in order to prepare students with the skills they need for success in the real world. Wagner (2008) identified that schools have begun to transform teaching and learning in efforts to motivate students and help empower them to achieve in an ever-changing society. Many school leaders and educators across the country have begun to redefine learning through problem-based or project-based methodologies, seeking to develop classroom cultures that are simultaneously rigorous and relevant for all students. Schools across the nation must improve current models of education for children to succeed in the future (Wagner, 2008).

Statement of the Problem

To date, little research has focused on supporting students through innovative approaches in curricula. In this study the focus was on creating a new type of curriculum. One public school district in Massachusetts is representative of the schools that Wagner (2008) claimed are in need of reform. By standardized state measures, the school district achieves at high levels, and the community as a whole is characterized as affluent. Within the district, citizens place a significant value on education as a whole, and in general great resources are available to support student learning. At the same time, the district has demonstrated a consistent gap in achievement between White students and students of color for a decade. Throughout the course of 15 years,

the student population has grown from approximately 6,000 to 8,000 students, and students are increasingly diverse in terms of socioeconomic status, English learner status, and race. The school district has a history of academic freedom and autonomy for teachers, but the culture has trended toward greater standardization and coherence across the district. Teachers have voiced their concerns about feeling overwhelmed with curriculum demands and are struggling to maintain a reputation of success while adapting to current conditions.

In particular, teachers in kindergarten through Grade 5, who are responsible for supporting all major content areas of English language arts, mathematics, science, and social studies, have shouldered the burden of extreme curricular demands in a district with a culture of exceeding expectations in all academic areas. The literacy program has scripted methodologies and strict time commitments. The mathematics program, under review at the time of the study, consistently has been debated over levels of rigor. Both the science and social studies curricula are contained in binders of resources that many elementary teachers claim they do not have time for, given their other requirements. In addition to a lack of enough time daily to engage in all subject areas sufficiently, not enough time is built into the master calendar for teachers to collaborate on curriculum.

The school district provides some formal professional development structures, which are also being examined for improvement over the next 3 years. The district also has what is known as Teacher Collaboration Time the last period of each Friday afternoon, and staff make the most of this opportunity. Teachers of middle school students tend to support just one content area and also have noted challenges in covering curriculum standards in their allotted time frame. Further, the district has experienced turnover in building principals in all eight kindergarten through Grade 8 (K-8) schools during the past 3 years, in addition to changes in central office

administration. Consequently, building momentum around the district's vision, mission, and goals has been challenging.

Amid changes to the landscape of the school district, pockets of innovation have begun to emerge within the eight K-8 schools. The instances of innovative teaching and learning are not systematized and vary among the eight schools. For example, one school is new construction containing a 2,000 square ft (185.8 square m) makerspace with the potential for high-quality engineering and design. Another school converted the desktop computer lab to a science, technology, engineering, and mathematics (STEM) lab with 3D printing and other high-tech machinery. In each of these schools, a small number of teachers utilize the space and equipment with their students. These instances offer reason for optimism. Individual students with a passion for hands-on learning and who otherwise might struggle in a traditional classroom setting have thrived when given opportunities to create. Certain interested teachers have begun to integrate design thinking into their curricula and have developed projects that allow students to learn by doing. On other occasions, particular staff members have learned how to use the various technologies and have opened up space in their schedule to allow students to tinker and engineer.

Citing the seemingly siloed curriculum demands in each of the content areas, many teachers have shied away from this type of project-based learning environment. Reluctance also could be based on insufficient professional development or an undefined vision of teaching and learning at the district level. However, educators in the district have noticed that in the initial instances when students and teachers have engaged in unique project-based learning experiences, both have experienced optimism and hunger for developing, expanding, and refining these opportunities.

According to Wagner (2012), an educational environment built around innovation is essential for the future of the economy. Educators must teach students to collaborate, persevere through challenges, and experiment with new ideas. Using the principles of design thinking, schools must support imagination, curiosity, creativity, and problem solving to motivate children and set them up for success in society. Wagner (2012) supported an interdisciplinary approach to teaching and learning for students to derive meaning and purpose in their daily work.

Some teachers at one school in the study district have begun to discuss these ideas and have developed a keen interest in supporting all students through innovative approaches. From a distance (the school is geographically isolated from every other school in the town), school staff have seen physical and virtual construction of labs and makerspaces emerge elsewhere in the school system to enhance design thinking within the district's curriculum. Lacking space within its physical plant for the appropriate number of classrooms and even a staff room, the school staff is seeking equitable opportunities for students; as a result, some teachers have come forward to advocate for a better future of teaching and learning for their students. These teachers represent a wide spectrum of academic programming and, in the district's tradition of autonomy, are ready to rethink how best to prepare students for the future. This study examined one school's decision-making processes and actions to bring about innovative teaching and learning for all students.

Purpose of the Study

If schools are to prepare students as future workers and citizens, students' daily learning experiences must coincide with the skills necessary to succeed outside of school. Schools must redefine what students need to know and be able to do before they graduate as access to knowledge becomes more widespread and technology renders many skills obsolete. This

research used a qualitative case study to seek answers to the framing research questions. Specifically, this study was designed to understand how a school can transform its instructional practices and collaborative structures to bring about rigorous, relevant, and engaging learning for all students. The purpose of this qualitative case study was to determine how a school can create a culture of innovation in teaching practices. This case study identified the strategies and decisions undertaken by a group of educators to enhance 21st-century learning for their student population. The study also examined the conditions within the school that support innovation, creativity, collaboration, and curriculum integration.

Staff at the study school specifically, and in general other educators throughout the Massachusetts district, may benefit from this study, being at the forefront of educational research on the topic of innovation. Educators in the district can be informed of educational practices that support all students in the modern era of education and learn how positive change can scale through a school and a district. In addition, any educational leader who seeks to bring about greater innovative experiences in a school or district may benefit from this study. Educational leaders seeking to transform their environments from traditional characteristics of teaching and learning to more project-based cultures may be able to adopt some of the features identified in this study.

Theoretical Framework

This qualitative research case study was grounded in change theory in education, as described by Lewin (as cited in Schein, 1996). Although the change process in schools can be both challenging and time consuming, continuous improvement is achievable when proper conditions are in place. The notion of voluntary professional development for teachers is built upon support from administrators, combined with the attitudes and beliefs of staff that they are

able to take risks to put into practice new ideas (Guskey, 2002). This condition is based on what Lewin described as psychological safety (as cited in Schein, 1996).

Lewin (as cited in Kaminski, 2011) described organizational change in three stages: unfreezing, change, and refreezing. Essentially, individuals first generate support around dismantling the status quo, then move to a more productive state, and finally ingrain new practices into their normal operation (Kaminski, 2011). These phases of the change process should be evident in this research study.

Research Questions

To determine the conditions needed for schools to develop a culture of innovation, this study was guided by the following research questions:

1. How do teachers collaborate on designing curriculum and examining student work?
2. How do teachers adapt curriculum standards and experiment with alternate methodologies?
3. How does a school or district administration support project-based or interdisciplinary approaches to teaching and learning?
4. What resources are available to staff for this type of professional development?

Importance of the Study

The intent of this study was to contribute to the overall knowledge base about processes that schools can undertake to bring about reform in teaching and learning. Specifically, this study examined how a school builds a culture of innovation organically, that is, out of a collective desire to improve outcomes for students rather than having decisions imposed from the administration. Based on the need to prepare students adequately for success in the 21st century, staff involved as participants in this study took actions that could lead to whole-school change.

Operating in an environment that is innovative, collaborative, and forward thinking, participants had an opportunity to share their journey of shaping a school culture for the future. This study contributes to the field of education by highlighting conditions that schools need to have in place in order to build a culture of innovation. The study school in one Massachusetts district represented an opportune starting point to conduct this research, as staff at the school was ready to embark on this path to improving outcomes for students.

Definition of Terms

The following terms are used throughout this qualitative case study.

Design thinking: Refers to a method for the practical, creative resolution of problems. Designers use this process strategically and repeatedly. There are many visual models of this process. No matter the visual, the basic components are *empathize* (seek to understand), *define* (identify the problem), *ideate* (come up with ideas), *prototype* (make an example of your idea), and *test* (try it out and evaluate).

Engineering and design: Refers to a process very similar to design thinking. Although attributable to engineers, the process can be applied to almost any situation. The process is essentially the same as in design thinking, though the model could look slightly different.

Makerspace: Refers to a physical place where individuals or groups can utilize the design-thinking process and access various equipment. A makerspace is a laboratory for innovation and exploration. Items in a makerspace could include 3D printers, sewing machines, carpentry tools, art and craft supplies, and electronics.

Project-based learning: Refers to student experiences that contain many of the following elements operating together: a challenging problem or question, sustained inquiry, authenticity, student voice and choice, reflection, critique and revision, and a public product. Students are also

connecting curriculum standards with success skills such as collaboration, problem solving, perseverance, and creativity.

STEM: Refers to the integration of these content areas. Adding arts to the areas results in the acronym STEAM.

Delimitations, Limitations, and Assumptions of the Study

This case study was specific to one school in Massachusetts and, as a result, may be difficult to replicate or generalize to a larger population. Even within the study school district, there is variability among the eight K-8 schools. Therefore, the circumstances that evolve at the study school might not apply across the school system. In addition, this case study took place during the course of the entire school year and was, therefore, constrained by that temporal boundary. The participants in this study served as pioneers for leading change in their school and are held in high esteem by this researcher. It was important not to let personal biases influence the research process. A limited number of interviews were conducted during this study, and as a result, the assumption was that the attitudes and feelings of this group of participants represented those of the entire school.

Summary

The origins of education in America were based on preparing students for an age of industrialization, and throughout several decades, schools became accustomed to this model. The needs of students are much different from those of the last century, and, therefore, the U.S. education system must adapt to the present circumstances. Change in schools can be difficult, yet many educators have begun to realize that in order to motivate, engage, and prepare students adequately, schools must move from a one-size-fits-all approach rooted in factual knowledge to a complex paradigm of problem solving, critical thinking, and flexibility. This study was designed

to describe the efforts of one K-8 school in Massachusetts in the pursuit of innovative teaching and learning in service of the needs of a diverse student population. This chapter has introduced the research problem, theoretical underpinnings, and importance of this study. The next chapter describes in greater detail the existing literature on this topic of innovation in schools.

Chapter 2

Literature Review

The system of education established in the United States more than a century ago is based on an antiquated model, and significant research exists on the need for schools to improve teaching and learning practices to support the needs of students in the 21st century. In conjunction with major advances in technology, many school systems are rethinking what is essential for students to know and be able to do. A large body of research exists on innovation in schools, with much evidence from firsthand observations across the country. Simultaneously, researchers have examined the conditions within school environments conducive to supporting change initiatives in service of innovative learning for all students. This section provides an overview of the literature on the theme of reforming education to serve the needs of students in the 21st century.

Conceptual Framework

Lewin's (1951) theory of organizational change provided context for this research. Lewin's work on organizational change dates back to the mid-20th century and is characterized by a three-stage process: unfreezing, moving, and refreezing. In the unfreezing phase, individuals within the organization utilize both quantitative and qualitative data to identify areas in need of improvement. Based on that information, the organization then moves to a new state of operation, developing different behaviors and values. Such changes may involve the structure of the organization and the specific roles of employees. Finally, based on these modifications, the organization repositions itself, thereby creating new norms and ways of operating (Lewin, 1951).

Lunenburg (2010) elaborated on Lewin's theory of change as it pertains specifically to education, noting that the educational model must adapt to current societal conditions to remain

effective. The world is changing rapidly based on several factors, including technology, the environment, the labor market, societal diversity, and globalization. Schools must recognize the need for continuous improvement or they will lose relevance. Knowing that individuals typically prefer stability over change, Lunenburg put the onus on educational leaders to bring about needed changes, while simultaneously lessening resistance to change. This notion corresponds to Lewin's force-field theory of change. Lewin posited that individuals who resist change do so out of fear, lack of knowledge, lack of autonomy, or lack of trust (Lunenburg, 2010). As a result, the school leader needs to communicate regularly, involve staff as participants in the decision-making process, and provide the necessary support for personal development and improvement.

Bidwell (2001) incorporated these ideas as well in describing how schools can improve. Using neoinstitutional theory, Bidwell indicated that large-scale top-down initiatives will not have a lasting impact on school improvement. Staff members demonstrate allegiance to their school culture, and their specific roles have confirmed their identities as professionals in the field. However, change processes that are built from the ground up have a better chance of diffusing widely through the organization. Collaborative staff networks have the ability to maintain stability or engender change. When teacher leaders are empowered to collaborate with building leaders, innovation is more likely to take place.

These ideas further connect to the theory of transformational leadership, as first described by Bass in 1985 (as cited in Eyal & Roth, 2011). School administrators can support necessary change efforts by empowering staff to participate in creating a school's vision and goals. Individuals who play a role in shaping the future of an organization are intrinsically motivated, as participants can construct their own meaning and purpose for the work. In so doing, the school

leader can create the conditions for success by collaboratively building a vision and providing the necessary professional development that needs to accompany any change.

These changes that improve schools and bring about greater levels of motivation and innovation are also rooted in collaboration theory. Morton et al. (2009) found a direct connection between multidisciplinary collaboration and innovation. As the environment outside of schools requires increasingly complex problem solving, so too do schools face these challenges. The theory in this case supports groups of adults working in tandem to achieve goals that could not be accomplished individually. These collaborators have a common interest and have a stake in the success of the work. Similarly, this group of adults needs support from administrators in order for the work to be sustainable, and it must engage in reflective practice throughout the experience.

If collaboration in schools is not the norm, strategies exist to improve cohesion. Reich (2017) described a four-stage cyclical process by which educators can bring about whole-scale change in their schools. For progressive improvements to spread from small incidents of effectiveness to systemic progress, staff first must have the opportunity to come together around a common interest. Second, Reich promoted a "bias to action" (p. 3), whereby small groups of educators begin working on a novel idea even before a long-range plan is in place. Third, this group of collaborators continues to implement their ideas amid successes and challenges, understanding that these high and low points are a natural part of the innovative process. Finally, the teams refine and adjust their practice based on the progress they have made. The process is iterative because modifications to these initial steps naturally lead to further actions and deeper collaboration. Furthermore, Reich claimed that successful change occurs through such iteration rather than formal planning. In other words, teachers try out an idea, see if it works, and then

strive to make it better. They do not set landing points for future progress at a later date. The logistics are not important, but rather educators' participation in a design-thinking process of their own will more likely result in systemic change.

Topic Rationale

Reich (2017) described four real-world shifts that have significance for schools in the modern era: (a) how learning has changed, (b) how work has changed, (c) how universities have changed, and (d) how the science of learning has changed. First, given the proliferation of internet access, individuals have increased capacity to design and absorb content through informal unstructured means across the globe. Reich posited that this phenomenon challenges the traditional role of the teacher as purveyor of information to students. Second, most manual tasks once occupied by humans in the workforce can be accomplished by computers. The labor market has witnessed major declines in both routine and nonroutine manual tasks. Robots provide hospital service delivery, water heater regulators are computerized, and freight trucks are self-driving, all jobs that were traditional performed by individuals. The trend has grown toward working with new information and solving unstructured problems (Levy & Murnane, 2013). Again, there are distinct implications for what is being asked of students in classrooms based on what is needed in the future workforce.

Third, once seen as the pinnacle of a student's educational experience, colleges and universities are rethinking their teaching and learning operation. Based on students' widespread access to information, many institutions are replacing the traditional lecture with more actively engaging experiences for students. Postsecondary schools are providing more practical experiences, portfolio assessment, and blended online components to support students in their pursuit of career readiness (Reich, 2017). For example, Olin College of Engineering in

Needham, Massachusetts, designs its curriculum based on the integration of engineering, the arts, and entrepreneurship. The institution views creativity, communication, and collaboration as key components of the academic experience. Students engage in hands-on project-based design throughout their enrollment (Kerns et al., 2005). The notion is that if colleges and universities change their practices to prepare students better for careers, then elementary and secondary schools will follow suit.

Finally, scientists know more about learning and the brain than in earlier generations. With the advent of machine learning, researchers have begun to understand what makes human learning unique, and are understanding that learning has a major social component. Meltzoff et al. (2009) described social interaction as a prerequisite for student learning and suggested that schools capitalize on children's natural curiosity and emotional development amid a growing body of artificial intelligence. Clearly, based on changes outside the confines of schools, educators must adapt instruction and models of teaching to support the needs of this modern generation.

Moolenaar and Sleegers (2010) indicated that innovation in education is essential to improve the academic experience for today's youth. They extended the notion of the importance of the aforementioned social interactions to the adults working in schools. Collaborative environments that promote safe academic risk taking are essential for innovation to occur because teachers feel empowered to experiment with ideas and implement them with colleagues. When school leaders trust teacher teams to make pedagogical decisions, educators are more likely to adapt their practice, tinker with modes of delivery of instruction, and implement creative solutions to support the diverse needs of students. Strong adult relationships are critical to developing cultures of innovation.

One such innovation in schools has been the establishment of makerspaces or STEM and STEAM rooms. These laboratories are centers of engineering and design where students engage in hands-on learning by doing. Students are creators of their own learning and have opportunities to integrate content, use a variety of tools, and develop solutions to unstructured problems. School systems across the country have sought to provide students with hands-on, personalized, and social experiences that employ design thinking. According to Galaleldin et al. (2016), universities as well as secondary schools continue to install makerspaces among their facilities to provide more hands-on learning opportunities. At the university level, makerspaces have been connected to engineering programs. At the elementary and secondary levels, these labs have resided in refurbished computer labs or libraries or represented new forms of construction in schools. As this is an emerging trend, many schools have encountered initial challenges in integrating the makerspace into regular academic programming. Schools are seeking opportunities to merge the content demands outlined in state or national standards typically seen in the classroom with the 21st-century skills needed by students; this integration is aided by the existence of a makerspace. Because school staff are still learning how to support a multidisciplinary approach in an open environment that makerspaces provide, more research needs to take place on this topic.

Shively (2017) concurred that makerspaces have the potential to prepare students for their future after formal schooling. These laboratories allow students to pursue their passions; enhance skills using a variety of tools and materials; and engage in the engineering and design cycle of prototyping, iterating, and refining their work. As this is an emerging field of study, more research is needed to determine the effectiveness of makerspaces, particularly in the elementary years.

Related Studies on Innovation

A small number of studies have been conducted related to the confluence of project-based learning, innovative instruction, and makerspaces. In each study, researchers sought to analyze the impact of 21st-century school reforms on overall student learning. This body of research is informative for the purposes of bringing about meaningful, engaging learning for today's students. Common themes have emerged in this research, including innovation with project-based learning, real-world curricula, technology, and makerspaces.

Innovation With Project-Based Learning

Project-based learning emerged as an offshoot of problem-based learning in the 1970s in Western Europe (de Graaff & Kolmos, 2007). Its origin is in engineering as a way to connect students' thinking to relevant topics in the field. Throughout the last several decades, project-based learning became its own entity, as a curricular approach centered around open-ended or unstructured problems. Some of the early features of project-based learning in schools were contextualized content, interdisciplinary themes, and student collaboration and communication (de Graaff & Kolmos, 2007). In today's education system, project-based learning is a pedagogical approach to support students' active engagement in topics that are relevant. The major components of high-quality project-based learning include a challenging problem or question, sustained inquiry, authenticity, student voice and choice, reflection, critique and revision, and public products (PBLWorks, 2019). The elements of project-based learning are representative of innovative models of teaching and learning.

Toolin (2004) conducted a study of six middle and high school science teachers across six schools in New York City during a school year to determine to what extent teachers would incorporate elements of project-based learning into their practice. The mixed-methods study

examined several factors among participating teachers, including their number of years of teaching experience, the number of workshops they attended related to project-based learning, the existence of any coteachers in the classrooms, and student standardized test data. Toolin conducted regular visits to the different schools, observing classrooms and meetings throughout the year. Some of the visits included one-on-one interviews or conversations, which generated extensive notes. Toolin also collected and examined curricular materials, teachers' lesson plans, student work samples, and test data.

In Toolin's (2004) study, four teachers embraced elements of project-based learning, while two teachers rejected the approach. In triangulating the data, Toolin discovered that the four willing participants had a combined total of 20 years of teaching experience, attended 12 professional development workshops collectively, had two coteachers to assist in their classes, and had varied student results on the New York exam. The two unwilling teachers had a combined 2 years of teaching experience, attended just one workshop, had no coteaching partners, and also had varied student test results. Reluctant teachers were caught in a dilemma involving adhering strictly to the state standards and helping prepare students for standardized testing, or providing rich, inquiry-based, hands-on learning experiences in the style of scientists. Teachers thought these methodologies were mutually exclusive.

Toolin's (2004) research indicated a range of teacher perspectives and student experiences in science. Whereas some teachers focused solely on teaching practices that would help students succeed on the state test, others put forth a much more innovative approach. The most noticeable factor in the differences among teachers was the extent of professional development afforded these teachers in the few years leading up to the research. The tenure of individual teachers did not correlate with their attitudes toward innovation, but rather the focal

points of their professional learning. The research underscored the importance of job-embedded support and collaboration for teachers. Those teachers who adopted a more innovative, project-based approach described how they were provided additional resources in the form of time and physical equipment in order to carry out these changes in instruction. Madden's (2013) research corroborated these results. In schools that afforded teachers opportunities to experiment with technologies or different teaching strategies, students were more engaged with their learning. By allowing teachers to partake in action research and developing personalized learning pathways for students, these schools improved overall outcomes for students and adults alike (Madden, 2013).

Gultekin (2005) conducted a study of fifth-grade social studies classes in which teachers undertook the planning of curriculum around project-based learning principles. The intent was to produce greater student ownership of the learning, with the goal of improving student outcomes in content and practice skills. Using a mixed-methods approach, Gultekin collected data from both students and teachers throughout several months. The quantitative portion consisted of pre- and posttests to measure student progress on the content standards addressed in the various units. These efforts were followed by qualitative components, in which Gultekin interviewed students and teachers individually to learn about their attitudes, opinions, and experiences throughout the process. Some scripted questions involved students' abilities to collaborate with peers and teachers having sufficient time to plan lessons in a project-based environment.

Gultekin (2005) discovered that students benefited more from project-based learning experiences than from the traditional model of education. In the research, students reported that learning social studies content in a constructivist, project-based manner was more interesting and

relevant to their lives. The research supported the notion that students need not be mere consumers of content, but rather creators of their own learning.

Innovation With Real-World Curriculum Applications

Braund and Reiss (2006) conducted a study in secondary schools to learn to what extent the science curriculum brought students into the real world to provide experiential learning opportunities that would engage and motivate all learners. Using a qualitative approach, these researchers conducted numerous classroom observations and interviews of teachers during a school year. They compared the responses to questions based on teachers' use of a traditional science laboratory versus out-of-school learning experiences, such as field trips. They also examined students' levels of engagement with the material in the different environments, using a rubric they had developed to record their observational data. In examining these qualitative data, they found that the benefits of a more innovative approach included greater interest in the subject matter that potentially could extend into higher education and beyond. The advantages of such experiential learning include the ability to integrate science with other content areas, the opportunity to participate in authentic learning experiences, the exploration of scientific phenomena in the natural environment, and a social dimension to learning content. Pedagogical approaches differed among teachers, and those who had extended the learning outside the classroom walls witnessed more positive attitudes toward learning science than those who adhered to a more traditional structure (Braund & Reiss, 2006). Innovative teaching and learning exist when students can relate learning to the real world.

In a similar manner, Ehiyazarian and Barraclough (2009) studied science learning at the university level with the hopes of gaining insight into students' future employment in STEM fields. These researchers undertook a qualitative case-study approach, utilizing student surveys

as the primary data collection tool. These questionnaires asked students about their understanding of the applicability of the content they were studying as these university students began to project into their lives in the workforce following graduation. After the series of surveys, the researchers then established several focus groups for the same groups of students, probing further into the school-to-work connections within their science education. They tabulated the results of this qualitative research based on common themes and attitudes expressed by the participants. These researchers found that when students had opportunities to engage in relevant hands-on learning experiences, they were more likely to pursue additional learning in science. The two most impactful factors in students' experiences were self-reflections and real-world applications of the content. The former is a key component of project-based learning and corresponds to 21st-century competencies. The latter helps to provide meaning for students as they decide upon future employment.

Innovation With Technology

Mioduser et al. (2003) conducted studies in schools in the broader realm of innovation. Their investigations centered around leveraging technology to enhance instruction. These researchers sought to discover how digital tools could transform teaching and learning processes to impact students both in and out of the classroom. The supposition was that technology could be a viable tool to create meaningful change in schools. Under the premise that the purpose of education is to promote student success in the real world, Mioduser et al. examined the impact of technology on students' levels of inquiry, ability to reflect on their learning, and processing of information, all seen as important skills at the turn of the 21st century.

In essence, innovation as a concept was deemed synonymous with advances in technology (Mioduser et al., 2003). The research charted progress along a continuum ranging

from schools' current situation to a state of significant change in pedagogical approaches and learning outcomes. The descriptors used to determine levels of innovation included the logistics of time and space of learning and connections to curriculum standards. Mioduser et al. (2003) found that schools that were the most innovative incorporated projects, exhibited student-to-student and teacher-to-student collaboration, and utilized a variety of learning spaces beyond the traditional classroom. However, it should be noted that this study linked innovation primarily with advances in technology. Improving the use of educational technology can be seen as innovative and represents one particular avenue of modernization for schools.

Innovation With Makerspaces

Sheridan et al. (2014) studied makerspaces as an innovation in education. These researchers described makerspaces as an emerging phenomenon as school systems seek to incorporate the engineering and design components of the Next Generation Science Standards. They also cited changes to art education that include a greater focus on habits of mind. In addition, they observed instances of makerspaces in public libraries and museums as centers of creativity, exhibition, and tool usage. Citing former President Obama's 2009 address that called for increased student involvement in science and engineering, Sheridan et al. indicated that making and learning by creating, not consuming, support student learning, and as a result, community makerspaces provide a pathway toward that goal.

Sheridan et al. (2014) indicated that prior research on this topic corresponded to implementing specific technologies, as described earlier. They noted empirical data on coding software, electronics components, and multimedia creations. Their study sought to delve deeper into the cognitive processes students exhibit in makerspaces, based on the principles of constructivism. Their work focused on the design-thinking process, beginning with empathy and

continuing through ideation, prototyping, and iteration. Sheridan et al. undertook a comparative case-study approach, examining the characteristics of makerspaces in three different settings: a community work space, a village workshop located in a church, and a children's museum. The researchers sought to identify features that were similar across all makerspaces. The research team partook in more than 150 hours of observations and interviews of the staff and participants in each setting. They also examined work products and online postings related to each space's operation and offerings.

The researchers discovered a pattern of curriculum integration in the STEAM fields, a high level of participant engagement, a disposition toward critique and revision, and a commitment to public exhibition (Sheridan et al., 2014). The makerspaces studied transformed traditional practices of teaching and learning. Sheridan et al. (2014) concluded that makerspaces were inherently interdisciplinary, highly engaging, and provided for the diverse needs of the learners who participated. As such, makerspaces are incubators of innovation. However, it is important to note that whereas Sheridan et al. studied education through the lens of different makerspaces, each with its own arrangement and operation, none of these experiences occurred in K-8 public schools. Makerspaces are promising centers of innovation for students because they allow for problem solving, creativity, and perseverance using tools and other materials. Makerspaces support hands-on learning by doing and have potential to enhance innovation in schools.

Library Makerspaces

Moorefield-Lang (2015) contributed to the scarce body of research on the benefits of establishing makerspaces in educational settings. Using a case-study approach, Moorefield-Lang examined six makerspaces based on the transformation of traditional school libraries into centers

of innovation. Earlier models of the operations in libraries correlated to the state of education at the time, that is, as centers to consume information. As education has moved into an era of increased student ownership of learning, so too have some school libraries evolved into places for creation. As was the case in other research, Moorefield-Lang discovered that all makerspaces are unique yet embody the philosophy of student-centered engagement, collaboration, and design learning. Similarly, the librarians developed skill sets beyond those of the traditional librarian and more in line with professionals in STEAM fields. Furthermore, some librarians have created the conditions for mobile makerspace resources that can be temporarily brought to classrooms in the absence of a designated makerspace when libraries could not be renovated.

The research identified challenges associated with librarian-initiated makerspaces (Moorefield-Lang, 2015). The biggest obstacles were resource allocation and professional development. With the former, the schools involved had limited budgets and, therefore, struggled with the annual challenges associated with purchasing fixed and consumable equipment. Second, makerspaces were more effective if more educators could collaborate to make the experiences enriching for students. Beyond the original librarian, schools needed to maintain a sustainable model for continuous education and improvement, so more teachers could instruct students on using tools and plan a meaningful curriculum. The research indicated that the most common collaborators were colleagues in technology education, the creative arts, or the science department (i.e., the STEAM fields). Moorefield-Lang (2015) also noted that further research on this topic is needed because the study was limited to the school library as the locus of ideas, instead of the entire operation of a K-8 public school, for example. Again, there is the potential for establishing stronger cultures of innovation in schools if librarians collaborate with professionals in the STEAM fields.

Despite relatively little empirical evidence on the evolution of school innovation, educational leaders across the country have offered significant literature and analysis, based on observations in schools. Wagner and Dintersmith (2015) described a culture pervasive in American schools of competition and anxiety around traditional notions of success. Based on the preponderance of standardized testing that starts in elementary school and continues through high school, many students have been trained to place extreme importance on test scores as a means to get into college, which in turn will position students for future success. From a history of U.S. education with teachers disseminating information to students, only to see students absorb this content and repeat it back to teachers, schools had compounded this model of teaching and learning with additional pressures of accountability. Students have expressed the importance in their minds of memorizing factual information and earning high scores, while simultaneously admitting episodes of boredom and an overall lack of relevance to their day-to-day work in school (Wagner & Dintersmith, 2015). Many students became trapped in an era of teacher lecture and were left disengaged from learning in an atmosphere of fear of falling behind their peers in the race to postsecondary education. The reliance on these traditional measures will need to change with a shift to innovation in the classroom, as rote information will no longer be a reliable measure of learning.

Based on the need to reform practices that appeared to be out of date, educational leaders, in 2000, founded High Tech High in San Diego, California (Wagner & Dintersmith, 2015). The premise of this charter school was that students would be better prepared for the future in an environment encapsulating project-based learning. Education reformers behind the creation of High Tech High sought an experience where students could become more flexible thinkers, adept at solving unstructured problems, and collaborative in their approach to learning. These initial

developments occurred in high school and have expanded to include elementary and middle schools as part of the High Tech High network (Wagner & Dintersmith, 2015).

Although it is too early to determine the long-term effect of the impact of a High Tech High education on students' preparedness for employment in the real world, some research has been done to identify short-term outcomes. Employing a quantitative analysis of High Tech High data, Beauregard (2015) examined to what extent students who attended this particular charter school were likely to enroll in 4-year versus 2-year colleges. Using statistical regression techniques with data obtained from students enrolled at High Tech High throughout 4 years, Beauregard discovered that High Tech High graduates were significantly more likely to attend 4-year colleges than 2-year schools. These results provided optimism for the school model designed around 21st-century skills and project-based learning.

Lichtman (2014) indicated that access to information has increased exponentially this millennium, altering the fabric of U.S. school systems. Schools need to change their ways of operating because it is no longer necessary or practical for teachers to serve as purveyors of information. Lichtman (2014) noted that school and district leaders must serve as champions of change for changes in classroom practice to be successful. He described innovation as recalibrating processes and reassigning resources based on new ideas. Innovation is not synonymous with advances in technology, but rather a shift in one's mindset around new learning. Couros (2015) developed this notion further by stating that schools embrace a philosophy of continuous improvement, which is only made possible by a willingness to change.

Lichtman (2014) identified several characteristics of the classroom that need to be in place for students to be prepared for the 21st century. These include opportunities for creativity, engineering and design, content integration, and global communication. Curriculum and

instruction should be built around students' interests so they develop ownership of the learning. For teachers to feel comfortable reforming their practices, they must feel supported by their administration to take such academic risks (Lichtman, 2014). School leaders must allow for teacher discretion in curriculum design and provide the necessary resources to support this work. At the same time, teachers must see themselves as lifelong learners not content with the status quo in their work with students (Boss & Larmer, 2018).

Certainly, obstacles within the educational operation easily could serve to halt such progress. Teachers often have cited a lack of time as the primary reason for not changing their practice. Teachers have increasing demands placed upon them given the unique needs of a wide range of learners. Professional development structures may be inadequate to support continuous refining of their practice. Moreover, the school system may not have identified goals and priorities based on their values (Lichtman, 2014). These potential obstacles place a large responsibility on educational leaders to create the conditions in which teachers can innovate. Lichtman (2014) likened a school district to an ecosystem that, with its diverse makeup and ability to connect individuals across venues, evolves operationally based on the needs of its members. Systems must change in order to survive in the 21st century. Using an approach called zero-based strategic thinking (Lichtman, 2014), successful, adaptive school districts build their vision from scratch, based on their values, and subsequently align their resources to match these ideas. The alternative is to continue to operate in an antiquated model that does not support students.

Couros (2015) expanded on these ideas in describing the nature of schools as learning communities. He wondered why there are instances in the classroom where students are sitting and listening passively to the teacher, when numerous examples of innovation exist outside the

school. Students are attuned to the latest developments in technology, communication, marketing, and the like, seeing the world around them change rapidly. Schools need to support students' passions by making learning relevant and engaging. For innovation to flourish in schools, students must exhibit the following eight characteristics: empathetic, problem finding, risk taking, networked, observant, creative, resilient, and reflective (Couros, 2015). Moreover, these attributes of learners serve to bring about equity of access and opportunity within schools, key components in meeting the needs of all learners and often missing in many organizations (Boss & Larmer, 2018). Teachers no longer need to serve as transmitters of information. Instead, they must serve to support dispositions of modern learners, helping to connect students as global citizens, navigating a world where information is ubiquitous.

School Reform

The industrial model from more than a century ago featured a standardized curriculum replete with low-level skills and memorization of rote content (Wagner, 2008; Wagner & Dintersmith, 2015). Those schools that replicate these efforts into the 21st-century may incorporate a data-driven approach and seek to prepare students for college (Wagner, 2008, 2012). However, A reformist model is significantly more innovative and creative. The goal of this new era of education is life readiness, based on essential skill sets and mindsets (Dintersmith, 2018). Students in this model are driven by a purpose to learn and naturally seek out collaborators across a global network. In essence, the learning is organic. Lichtman (2017) described education as being at the crossroad between a structure that no longer exists and a new vision of teaching and learning. Currently, there is a need to shift the emphasis from what one teaches to how one learns (Couros, 2015; Dintersmith, 2018; Lichtman, 2017). Developing a culture of innovation is an important transformation for schools in the modern era.

Collaboration

Collaboration is extremely important for students because it relates directly to how adults work outside of school. In contrast to earlier generations, when individuals primarily completed work independently, members of today's workforce often form teams. Sometimes these teams span continents (NEA, 2012). The following examples provide insight into the potential for collaboration across content areas:

- In foreign language, groups of students connect with peers in another country whose native language they are learning. They work together to create a presentation about the weather (NEA, 2012).
- Student teams research crime rates in various cities and gather data on possible causal factors. They then examine any mathematical or statistical relationships between the two variables and present their findings (NEA, 2012).
- Student groups interview senior citizens in their community and then create a digital storytelling movie to be shown publicly (NEA, 2012).

Lichtman (2017) indicated that change is already happening in schools. The necessity is to bring these changes to scale in districts and states. The changes needed to transform schools to adapt to a modern era of learning require connectivity and collaboration across constituencies, teams, and locales; otherwise, innovation will not take shape (Lichtman, 2017). In many cases, school change comes without explicit permission from administrators, but rather a collective will among educators to experiment with new ideas. Many instances of collaboration already are taking place. Further collaboration will advance innovative efforts even more rapidly.

Goddard et al. (2007) conducted a study to determine the effectiveness of teacher collaboration in schools. Using a quantitative approach, these researchers examined whether

levels of teacher collaboration correlated with student achievement. Their research spanned nearly 50 schools, 500 teachers, and 2,500 students in fourth grade in a large Midwestern school district throughout several months of a school year. The researchers analyzed student assessment data and obtained teacher data related to collaboration via survey instruments. Goddard et al. found a positive relationship between teacher collaboration and student achievement, specifically in mathematics and reading. The data were expressed as a linear model with a strong correlation between the variables. In essence, the more the fourth-grade teachers were able to collaborate on planning curriculum, examining student work, and sharing instructional decisions, the better the students performed on math and reading assessments. Clearly, teacher collaboration supports the development of students and helps to strengthen the culture of a school.

Curriculum Design

Lichtman's (2017) point of view was that traditional textbooks represent a model of teaching and learning that is outdated. Dintersmith (2018) concurred with this idea in the context of curriculum reform and provided a pathway for children as they develop as students. As early as elementary school, young children are able to manage their learning, assuming responsibility for assignments that require communication and reasoning (though this level of self-regulation is often determined by the privilege or socioeconomic status of the child). Students in the early years are adept at creating and building and utilize a hands-on approach to understand fundamentals of literacy and numeracy. In elementary school, students can become accustomed to learning with and through one another. In the 21st century, these students are becoming increasingly capable with technology and seek support from adults when necessary (Dintersmith, 2018).

As students matriculate into secondary school, the content of their school work can be increasingly connected to the real world, whereby they communicate with experts in academic fields all around the world (Dintersmith, 2018). Using project-based learning, students in middle school should be able to tackle issues prevalent in their communities and solve problems that ultimately will improve the conditions for current and future generations (Boss & Larmer, 2018). Students in high school should be given opportunities to research and report on topics of their own interest. They should engage in seminars, and content should be interdisciplinary in nature. All high school students would benefit from a culminating project that represents the breadth of their experience as they graduate and move to the next phase of their lives (Dintersmith, 2018).

Traditional high school curricula represent the antithesis of preparation for life after school. Dintersmith (2018) argued that technologies have completely eliminated the need for students to perform low-level calculations such as those on syllabi of calculus courses. In the real world, individuals must analyze data and solve unstructured problems. The particular mathematics high school graduates need be exposed to involve "probability, estimation, financial literacy, algorithm structuring, and digital fabrication" (Dintersmith, 2018, p. 151). From high school, tracing back to middle and elementary school, there are better approaches to curriculum design than what traditionally has been in place. Schools should reexamine their processes and materials for curriculum and instruction at all levels of child development.

Leadership Support

Lichtman (2017) contended that school leaders are the primary levers of change within the system. In a study of elementary principal leadership across the country, Orphanos and Orr (2014) sought to determine the impact of innovative leadership practices on teacher performance and morale. Undertaking a quantitative research method, Orphanos and Orr examined survey

data from nearly 800 teachers in several states, some of whose principals had been trained using innovative approaches to leadership, and some of whom had experienced a more traditional paradigm of administration and management. In particular, the more progressive leadership approaches examined involved incorporating job-embedded professional development, such as formal collaboration time, and distributed leadership mechanisms, such as seeking participation and feedback on key decisions. Orphanos and Orr found that in schools where principals exhibited the above characteristics, teachers were more motivated, satisfied with their work, and willing to collaborate with colleagues.

Lichtman's (2014) observations in schools corroborated these results. He found that those leaders who had been the most innovative collaborated deeply together with staff, distributing responsibility within the school (Lichtman, 2014). These leaders also modeled risk taking and experimentation in their own work with staff. They attempted a Twitter chat in lieu of a faculty meeting, they used a reflection tool to gather feedback, or they structured activities for staff based on choice. The hopes were that these endeavors would inspire teachers to try out new ideas with students, even if it meant straying outside of their comfort zones and making mistakes (Lichtman, 2014). Essentially, these effective leaders know that to innovate, they must be confident to delve into a new territory without any guarantee of success. Teachers, in turn, would feel a similar sense of trust that there would be no penalty for experimenting, particularly if the potential was great for student learning and preparedness for the 21st century (Wagner, 2012). The school leader plays a significant role in impacting the culture of an organization. The actions of an innovative role model serve to enhance the educational experience for staff and students.

Dintersmith (2018) elaborated on the characteristics of transformational leaders who serve to motivate staff to create an innovative vision of teaching and learning. These leaders

share a vision of what is possible and give urgent reasons for a need for change. They root their claims in outcomes for students, describing the necessary skills and mindsets for individuals in the real world. Such leaders trust teachers to make sound educational decisions and both permit and empower teachers to redesign a curriculum that is relevant and engaging (Dintersmith, 2018). Changing attitudes and behaviors does not happen instantaneously but involves challenges along the way, and sometimes progress may feel slow. The skillful leader, therefore, incorporates the same design-thinking process with the adult population that the teachers would be using with students. In other words, innovative thinking is iterative; participants travel through a cycle of experimentation, failure, and repetition (Couros, 2015). Finally, Dintersmith (2018) indicated that the innovative leader opens this learning process to the community, such as parents, institutions of higher education, and businesses. These connections may involve obtaining academic resources, providing authentic learning experiences that require solutions, or soliciting feedback on student work, among others. An inspirational leader can be seen as a key ingredient in moving a school forward with innovation.

Schmidt and Biniecki (2016) indicated that support from a teacher's department, school, and district leaders is the first and foremost element of strategically planning for change and innovation. An open environment must exist where key stakeholders have a willingness to change and be inclusive of others to join the efforts. Leaders and staff who lead these initiatives must communicate regularly on progress with regard to these changes.

Professional Development

In the modern era of education, students must develop several habits, and teachers need to be aware of their role in supporting students to reach these competencies. In addition to content acquisition, students need to be expert problem solvers, critical thinkers, communicators,

and collaborators (Wagner, 2008). Given the widespread access to information, students also must become adept at learning how to learn (Lichtman, 2017). The professional development teachers need to support students along this path involves a restructuring of priorities from the traditional model of education. Teachers must be trained in strategies that empower students to take ownership of their learning. Teachers need to see students as creators of understanding rather than consumers of content. Teachers should make careful note of each student's passions and work collaboratively with colleagues to set up conditions for interdisciplinary learning experiences (Lichtman, 2017; Wagner, 2008). According to Lichtman (2017), innovative teaching and learning begin by teachers changing the pedagogical approach, which will only work if teachers have appropriate professional development.

In a study of one private school's professional development program, Bernhardt (2015) sought to identify how organizations conceptualize and formalize professional learning around 21st-century education. Using a mixed-methods approach, Bernhardt tabulated professional development opportunities, collected survey data from faculty, observed numerous staff meetings, and interviewed participants to learn about the impact of professional development on their practice. He discovered that teachers at the school were eager to learn about new developments in education as long as they had an opportunity to practice these skills with students. Teachers in the study also reported that the more time they had to collaborate with colleagues on these ideas, the more beneficial the new learning would be to eventual student outcomes. It is interesting to note that whereas teachers were open to the notion of modern developments in education, they were not fully versed in 21st-century competencies from the start (Bernhardt, 2015). This fact illustrates that schools should provide the purpose and context for providing professional development on teaching and learning in the 21st century.

Connecting this research to practice, Dintersmith (2018) distinguished between schools "doing obsolete things better" and merely "doing better things" (p. 190). To establish an environment that supports innovation, schools must de-emphasize standardized tests and corresponding data. Supporting staff in creating meaningful learning experiences is more important. School leaders must put in place conditions that allow for 21st-century competencies and engagement with the real world. These efforts run counter to any system that focuses energies on implementing prepackaged curricula. Dintersmith supported the establishment of school makerspaces and STEAM labs, embedding design thinking and technology into students' academic experiences. He also advocated for and cited examples of students involved with internships and outside-of-school mentoring programs. Even a tweak of the traditional parent conference routine to incorporate student-led progress reports would have an impact on the culture of a school. These are practical examples of how schools can improve teaching and learning for students.

The entire notion of makerspaces is built on the premise that play-based learning is valuable for students of all ages. As data-driven academic achievement has permeated school systems, many advocate for a return to a more socialized, collaborative, play-based approach to teaching and learning. By their nature, makerspaces develop social-emotional skills such as persistence, empathy, imagination, and self-control (Fleming, 2015). These competencies serve to enhance the academic content rather than being a by-product of classroom activities. In addition, the learning that occurs in a makerspace inherently allows for student ownership and the exchange of ideas. More importantly, this open and social environment gives opportunities for curriculum integration (Fleming, 2015).

School makerspaces also foster a growth mindset among students, emphasizing experimentation, risk taking, and failure as key components of the learning process. Fleming (2015) reported that makerspaces allow students to demonstrate creativity in many ways. Participants brainstorm ideas, develop solutions to problems, and refine these ideas based on feedback from peers or teachers. Similarly, when students learn in this type of environment, they become more open to diverse perspectives of others, communicate more effectively, examine real-world implications for their work, develop originality, and realize the cyclical nature of the design process through trial and error (Fleming, 2015). Students who utilize the makerspace as part of their academic experience receive many benefits. The aforementioned skills are also those deemed essential for success in the job market and society. Levy and Murnane (2013) reported that employers are seeking individuals who are flexible thinkers, creative problem solvers, and empathetic collaborators.

Hands-on learning by doing promotes student learning in the integrated STEAM disciplines. Students also may acquire the ancillary benefits of learning how to use a variety of tools as well as engaging in the engineering and design cycle. More importantly, according to Clapp et al. (2017), students also develop agency and build character when they engage in maker-centered learning. Students learn to take ownership of the learning process, and their ideas become relevant on both a personal level and a larger scale within the community. Furthermore, students begin to see themselves more confidently, hopeful to make a difference in the world, solving important problems, and inspiring peers. Clapp et al. defined this interplay of maker capacities as looking closely, exploring complexity, and finding opportunity. These are the tenets of a student-centered project-based environment developed to support the needs of the 21st century.

Couros and Novak (2019) indicated a disconnect between what individuals believe students should know and be able to do and what is taking place in U.S. classrooms. Many curriculum and instruction practices are antiquated, and many professionals have yet to believe in the overdue need for change in education. Couros and Novak would ask teachers what they are doing for students that the students could be doing themselves. In other words, how are schools empowering and inspiring students to solve problems, think critically, and make a difference in the world? The researchers wondered to what extent educators are modeling this behavior, setting the conditions for success in the 21st century. The model of education still prevalent in schools was created more than a century ago, during an era of industrialization and standardization (Wagner, 2008). If students continue to matriculate through this system, they will cease to be prepared for change and challenge in the workforce. As a result, schools need to reexamine what it means both to achieve and fail. These credentials should no longer be based on standardized testing, but rather 21st-century competencies and authentic learning experiences (Couros & Novak, 2019; Dintersmith, 2018; Lichtman, 2017). These are the current tenets of school improvement efforts.

Couros and Novak (2019) highlighted four areas for school reform to support the needs of students: curriculum, assessment, time, and professional development. The ideal curriculum for the modern era should incorporate many of the elements of project-based learning, including student choice, reflection, and critique. Students should have multiple opportunities and means to create, represent, or express their learning, rather than being passive consumers of material. Assessment should be authentic and provide meaningful feedback to students en route to deepening their understanding. If teachers' goals are to prepare students for standardized tests, then they are doing students a disservice in determining what matters the most in the real world.

Rather, teachers should be creating opportunities around the principles and mindset of design thinking, where failure, feedback, and iteration are the norm (Couros & Novak, 2019).

Teachers often lament that they do not have enough time in the day or school year in which to cover all the content standards and assess students. It is, therefore, recommended that educators prioritize those standards that are the most essential and find ways to integrate subject matter across multiple disciplines. As a result, schools need to provide more meaningful professional development for staff. Many resources are available that information can be shared and accessed more easily across the globe (Couros & Novak, 2019). Case study research has supported this point throughout the last 20 years. Pan and Leidner (2003) examined several organizations through the turn of the 21st century and discovered a proliferation of knowledge sharing across the world. In order to remain viable, organizations relied on widespread communication and continuous learning in their respective fields. Successful organizations achieved what Pan and Leidner referred to as "expanding communities of practice" (p. 82). This research finding paralleled reforms in education.

Individual schools and school systems have operationalized educational practices and processes according to a mission and set of values. Educational leaders have made decisions about which content to teach when, how students' progress is measured, which students are enrolled in which classes, how the physical plant is organized, and how the schools fit within the context of the greater community. Because researchers know more about how students learn and how the nature of work has changed, a better system of education is needed. If schools do not change, then, similar to an ecosystem, their very survival is threatened (Lichtman, 2017). Lichtman (2017) stated that changes will inevitably happen; it is merely a matter of how much educational leaders will want to embrace them to control their own destiny. School leaders need

to create and disseminate a strong message as to why and how these reforms will occur and benefit students. They should address what they want students to know and be able to do, sometimes referred to as the Portrait of a Graduate, coupled with a vision of what world-class teaching and learning looks like. These leaders intentionally share concrete examples of transformed learning throughout the community. According to Lichtman (2017), this leader essentially becomes "brand champion" (p. 26).

Case Studies of School Reform

Throughout 3 months, Lichtman (2014) included more than 60 public and private schools in a qualitative case study. Lichtman (2014) interviewed more than 600 teachers, administrators, students, parents, and other stakeholders on the characteristics of teaching and learning in their schools. Many of the questions focused on the themes of change and innovation, including the successes and challenges of these efforts. Participants were asked how their respective schools have changed over time. They were also asked to identify the skills they felt were needed for success at that time. The results revealed instances of schools' adaptations to the needs of students in the 21st century (Lichtman, 2014).

Lichtman (2014) identified pockets of student engagement characterized by increased movement, dialogue, and collaboration in the classroom. Teachers facilitated student-to-student discourse and refrained from talking at students. Teachers in these classrooms exhibited dispositions of lifelong learning, examining student perspectives on the subject matter and allowing choice-based assignments. Students appreciated the fluidity of the classroom, not having merely to take notes or answer questions from a teacher's lecture. Students also described the personal qualities that they hoped to develop and refine in school: persistence, confidence, resilience, patience, creativity, empathy, and self-control (Lichtman, 2014). In turn, the teachers

designed learning experiences around meaningful topics or problems and leveraged the power of technology as a learning tool. Teachers in these settings balanced academic content with the aforementioned skills, providing challenges that required a design-thinking approach.

Lichtman (2014) witnessed several instances of schools changing traditional practices in accordance with developments in the real world. New courses, new departments, and new projects emerged. Examples included outdoor laboratories, STEM positions, and community problem solving. Again, teachers were viewed as colearners with students rather than mere dispensers of information. Schools that transformed in this manner began to integrate subject areas, including the arts, making STEAM learning a priority. Traditional subject areas no longer operated in silos. The schools expanded on students' passions and connected learning to the real world. One such school went as far as eliminating Advanced Placement courses, replacing them with a plethora of electives based on students' and teachers' interests, such as an art-engineering lab (Lichtman, 2014).

Lichtman's (2014) research summarized these trends within the context of 21st-century learning. In these instances, schools served as the locus of individuals meeting, yet the learning could take place in any setting. Whether expeditionary or virtual, learning was seen with fluidity, which is in direct contrast to traditional models of education. Students were creators of learning rather than consumers. They utilized design thinking to solve real-world problems. Finally, Lichtman (2014) described these schools as self-correcting, meaning that stakeholders regularly reflected on progress and adjusted their course as needed. Students, teachers, administrators, and families alike demonstrated empathy and mindfulness throughout the learning process. The research clarified that many schools have begun transforming operations and practices in support of innovation.

Dintersmith (2018) spent a year traveling through all 50 states researching teaching and learning in schools. In these qualitative case studies, Dintersmith conducted more than 200 school visits, led more than 100 community forums, and participated in almost 1,000 meetings with individuals, small groups, and large teams. Similar to earlier studies, Dintersmith also identified pockets of 21st-century excellence that had potential for the future of education, yet had not quite reached the scale of significant educational reform. The research provided key takeaways. First, it became clear that all students would benefit from hands-on learning by doing. Second, schools would attain more equitable outcomes for students by engaging them with meaningful real-world problems. Third, many high schools want to move toward a more innovative approach, yet they feel hamstrung by the pressures brought on by the college admission process and standardized testing. In fact, those schools that have thrived have sought to develop student potential rather than ranking student accomplishments. Dintersmith's research showed that innovative schools created the conditions to empower students rather than dictating scripted programming and curriculum.

Dintersmith (2018) summarized innovation in schools into four areas, captured by the acronym PEAK: purpose, essentials, agency, and knowledge. Purposeful student work involves examining problems in the local or greater community that have meaning to students. Through their learning experiences, students seek to make a difference in the world. It is regular and customary to have public displays of student work for examination and feedback. The essentials of learning are those 21st-century skills that have been described throughout earlier research: collaboration, creativity, communication, and critical thinking. Students demonstrate resilience, grit, perseverance, and flexibility in the face of challenges. Student agency refers to having voice and choice in their work. Students are empowered to set goals and monitor their progress,

knowing they are supported by an educator who is also willing to learn throughout the process. These are also specific elements of project-based learning. Finally, student knowledge is seen through the lens of their creations. Because students are invested in the learning process and their product, they are more likely to retain what they have learned over time (Dintersmith, 2018). As defined above, the major themes of purpose, essentials, agency, and knowledge do exist in innovative environments.

Mehta and Fine (2019) described the educational experience in three schools based on more than 750 hours of classrooms and meetings, plus more than 300 interviews of students, teachers, administrators, parents, and other educational stakeholders. In their qualitative case studies, they sought to identify instances of what they referred to as deeper learning (Mehta & Fine, 2019). According to these researchers, deeper learning resides at the crossroads of three major themes: mastery, identity, and creativity. Mastery refers to students acquiring skills and key understanding in academic areas as well as the 21st-century dispositions for success, such as critical thinking, collaboration, and communication. Identity means that students are engaging in work that has personal meaning and is relevant to their lives or their community. Creativity describes the conditions by which students are demonstrating what they are learning as opposed to merely taking in information from the teacher. Examples have included student-created films, debates, plays, or periodicals (Mehta & Fine, 2019). Both teachers and students who experience deeper learning in the classroom understand this notion of students as producers (not consumers) and teachers as facilitators (not purveyors of knowledge). In practice, teachers provide precedents of meaningful work on topics and give appropriate feedback to students throughout their learning experience.

In their research in U.S. high schools, Mehta and Fine (2019) found that nearly two decades into the 21st century, it is rare to find deeper learning in core academic classes of mathematics, English, science, and history. The reality has been that teachers continue to operate in their roles in the manner they experienced as students a generation ago. Furthermore, the schools studied continue to structure the day in siloed short blocks of time and have expectations of specific curricular demands on these core teachers. The overall environments continue to draw in external pressures related to competition in the college entrance process (Mehta & Fine, 2019). Interestingly, the characteristics of deeper learning were happening in classes in the fine and visual arts and in extracurricular activities. Results from interviews revealed high levels of student interest and engagement in these choice-based areas, whereas the benefits to students had not permeated the mainstream curriculum. According to Mehta and Fine, many individuals in these school communities wanted to break away from an antiquated educational model but had not nearly reached the desired future state. Although deeper learning, as defined above, is a desired state for all students, it has yet to permeate all classrooms, creating the need for more innovative approaches.

Methodological Framework

Case studies are useful in attempting to learn both how and why a current experience is occurring. The behavior of the individuals involved cannot be manipulated, and, therefore, a case study provides insight into events taking place at present (Rowley, 2002). Case studies examine evidence from documents, interviews, observations, and various artifacts and serve to investigate contemporary phenomena in their existing environments (Bogdan & Biklen, 2007; Rowley, 2002; Schell, 1992). Schell (1992) contended that case studies are especially useful in learning from observing phenomena unfolding in a given environment.

At the same time, case studies have been criticized on several aspects as a research method. Flyvbjerg (2006) refuted five common misconceptions about the value of case studies in support of this approach.

1. First, case studies provide specific knowledge about a situation within a context, and although generalizing such research is difficult, the facts do provide insight into why a phenomenon is occurring. Essentially, these facts demonstrate a level of expertise on the topic (Flyvbjerg, 2006).
2. Contrary to some beliefs, case studies can indeed contribute to a body of scientific research in a field. Although not all case studies can be generalized for future research, some strategically chosen studies can provide sufficient insight into a problem. This is not uncommon in the field of education (Flyvbjerg, 2006).
3. It is generally understood that case studies produce hypotheses. However, case studies also can be used as a valid approach to testing those hypotheses and establishing a theory.
4. Case studies have been thought to reflect bias, that is, a predetermined outcome on the part of the researcher. However, when done well, case studies report the observations and facts and allow the researcher the opportunity to indicate that preconceived notions were, in fact, wrong.
5. Finally, critics have declared that case studies are difficult to summarize. To that point, the astute case-study researcher would merely indicate that the particular case is complex and multifaceted, which is also true in education (Flyvbjerg, 2006).

Qualitative case studies in the social sciences in general, and education in particular, examine survey data as evidence to explain a phenomenon. Jansen (2010) indicated that such

surveys are strong components of the explanatory phase of the study and often reveal patterns that help the researcher arrive at a hypothesis. Furthermore, Bogdan and Biklen (2007) advocated for using descriptive survey data as an important way to arrive at and state conclusions of the qualitative research.

Summary

This research is grounded in Lewin's (1951) theory of organizational change combined with notions of transformational leadership and school reform. Based on case studies in schools across the country, in addition to specific studies on innovation in education, evidence supports pockets of improved teaching and learning to meet the needs of students in the 21st century. The research cited innovations with project-based learning, real-world curriculum, technology, and makerspaces. In each of these studies, researchers provided examples of students engaged in more hands-on learning-by-doing experiences compared to a traditional model of education marked by teacher lecture. In addition, broader examples of reforms in schools, through curriculum design, distributed leadership, and professional development, have generated optimism that the model of U.S. education will adapt to the times, preparing students for a future much different from the past. The next chapter highlights the methodology and design of the study in support of innovation in schools.

Chapter 3

Methodology

The purpose of this qualitative case study was to determine how a school can create a culture of innovation in teaching practices to support the needs of students in the 21st century. The goal was to determine the decisions and strategies undertaken by a group of educators at one school to foster a culture of innovation, authenticity, and meaningful learning. This study also examined the conditions within the organization that helped to bring about innovation, creativity, collaboration, and curriculum integration.

The literature review from Chapter 2 described studies that have taken place across the country during the last 2 decades. The information included an extensive analysis of major themes that supported innovative practices. Although the literature presented other case studies, there was no concluding recipe for how other schools can develop a culture of innovation. In particular, there had never been a related research study done in the public-school district under study. This study focused on one of eight K-8 schools in a Massachusetts district, and the goal was to be able to translate or replicate practices from this school district-wide. This chapter describes the study undertaken at the school.

The study district was beginning to develop practices with the potential to transform teaching and learning to meet the needs of students in the 21st century. Within the district, some schools had established physical makerspaces, and some had not. Some staff had participated in professional development on project-based learning, and some had not. Other variations among the schools included administrative changes, decision-making structures, cultural factors, and collaborative opportunities. To date, no study had been conducted within the district on the impact of school-based innovative reforms on student learning. This study examined the quest of

the study school to enhance the educational experience for children through a collaborative approach to curriculum and instruction.

This chapter restates the problem to be investigated, as well as the research questions associated with the study. Following is a description of the methodology and specific design of the study. The chapter continues with identifying the sample population of individuals involved in the study, followed by a description of how the data were collected and then analyzed. The chapter concludes with ethical considerations for this study before the segue into Chapter 4.

As stated earlier, this case study examined how one K-8 school in Massachusetts developed a culture of innovation. The district is deemed a high-achieving school district by traditional measures, yet has witnessed gaps in achievement over time. There have been pockets of innovation in various classrooms across the district, but the district has yet to establish a systemic effort to modernize its curriculum and instruction. Staff at the study school had begun to rethink teaching and learning structures to support the needs of students. This case study addressed the following research questions:

Q1. How do teachers collaborate on designing curriculum and examining student work?

Q2. How do teachers adapt curriculum standards and experiment with alternate methodologies?

Q3. How does a school and district administration support project-based and interdisciplinary approaches to teaching and learning?

Q4. What resources are available to staff for this type of professional development?

Description of the Methodology

This case study utilized a qualitative approach. Qualitative studies serve to bring about meaning for specific occurrences (Bogdan & Biklen, 2007). In particular, this study was

designed to understand how one school enhanced the educational experience for students in K-8 and fostered a climate of collaboration, continuous improvement, and visionary thinking among school adults. Stake (2000) indicated that qualitative studies lend themselves to exploring various phenomena. Qualitative research questions are framed in the manner above, that is, around the extent to which circumstances are occurring, in order for the researcher to learn deeply about the specific topic (Patton, 2002). In this case, the research effort was to learn how a school developed a culture of innovation. This case study sought answers to the four research questions posed in the introduction to this chapter.

Qualitative studies are also useful in examining phenomena in their natural contexts (Denzin & Lincoln, 2003), and in this case, the setting was the specific public school. Qualitative studies also seek to understand social processes within these settings (Esterberg, 2002), and this methodology also applied to the innovative measures taking place at the school. Furthermore, qualitative research studies involve the researcher actively (Creswell, 2013); the researcher compiled and analyzed the data throughout the study.

A qualitative approach provided the optimal methodology for this study because the goal was to elicit feelings and experiences of the participants, the school staff, in their natural work environment. Alternatively, quantitative research would not be beneficial because in quantitative research, a much larger population is studied, and the research might not be conducted within the natural setting, the school. Qualitative research incorporated into the analysis the thorough details from interviews and observations (Creswell, 2013) and illustrated the real experiences of the participants. This study included direct quotations, specific actions, and phenomena within the course of a school year that served to bring about innovative teaching and learning in the study school.

Design of the Study

The primary methodology for this research was a qualitative case study. Case studies are used when the researcher seeks to examine a process, program, or series of events among individuals or groups (Stake, 2000). In case studies, researchers amass information in a variety of ways throughout the course of a defined period of time. The case for this study was one school in Massachusetts, a public school serving approximately 800 students in K-8. The research in this study involved data collection from interviews, observations, field notes, and documentation provided by staff at the school level. Field notes, in particular, are extremely useful in providing rich contextual details of the occurrences throughout the research experience (Phillippi & Lauderdale, 2018).

Creswell (2013) indicated that case studies are valuable research methods when there are several ways to gather and interpret the data. This study incorporated interviews and specific actions from staff members at the school, thereby contributing positively to the overall body of data gathered. These actions included establishing regular STEAM team meetings, experimenting with project-based learning in classes, sharing student work publicly, engaging in tuning protocols to refine curriculum planning, engaging in formalized professional development, reconfiguring physical spaces, and developing a parent–community database of experts in the various academic fields, among others. In essence, the case study provided an in-depth description of how the teachers, specialists, and administration at this school developed and enhanced a culture of innovative teaching and learning through their deliberate actions.

Yin (2014) described five elements of case studies that support appropriate design of the research.

1. Case studies typically include “how” or “why” questions in the context of specific phenomena. In this case, the researcher sought to understand how a particular school reformed its teaching and learning practices to align with 21st-century competencies in support of all students.
2. Case studies articulate a clear purpose. The purpose of this case study was to determine how a school can create a culture of innovation in teaching practices by identifying the actions of the staff in pursuit of innovative curriculum and instruction.
3. Case studies are centered around a unit of analysis (Yin, 2014). The unit of analysis for this study was one K-8 school in Massachusetts. Data were collected from employees at this school in an effort to learn about progress that staff and students made with regard to innovation.
4. Case studies are effective when they connect the data obtained to the original research questions posed at the outset of the study. Following the observations and interviews, some patterns began to emerge from the data, and these patterns answered the research questions. Specifically, this study was designed to understand the impact of collaborative structures, curriculum integration, professional development, and administrative support for innovation.
5. Finally, case studies describe future steps or actions that logically flow from the findings of the research. This case study revealed important information for other schools seeking to modernize its practices around teaching and learning. The study-school model set forth ideas for future recommendations and additional research on this topic (Yin, 2014).

Sample and Population

The population for this study was the faculty and staff from one K-8 school in a public-school district in Massachusetts. Serving nearly 800 students, the school employs approximately 120 full- and part-time staff members and has an administrative team of one principal and two vice principals. The K-8 school has an array of offerings in the arts and physical education, in addition to the core academic curriculum. All K-8 classes across the school district are heterogeneously grouped, and, therefore, each school employs curriculum specialists to provide support to teachers in differentiated instruction and direct intervention to students based on their individual needs.

This study involved a sample subset of the school faculty and staff. Research for this study was conducted with a group of 14 educators from this school. This group included one building administrator (the principal), four curriculum specialists (technology, mathematics, library, and enrichment and challenge), two teachers from the arts (music and visual art), three middle-school teachers (from the mathematics, science, and social studies departments), three elementary-school teachers (from first, third, and fifth grades), and one special educator.

There were specific reasons for using this particular group of educators for this study. Patton (2002) described purposeful sampling as a qualitative research strategy that will yield significant information based on the individuals selected for the study. With the exception of the building principal, this particular group of educators organically formed what is known as the school STEAM Team. In so doing, they had self-identified as having either a keen interest or a modicum of experience on the topic of curriculum integration and innovative teaching and learning. Creswell (2013) reaffirmed the practice of choosing specific individuals who have the knowledge and desire to contribute to the overall research study. Bernard (2002) further

indicated that the selected participants in a qualitative case study should be able to describe their lived experiences and actions openly and thoughtfully. Having this stipulation is an important component of purposeful sampling (Palinkas et al., 2015). As such, the criteria for participation in this research included being an active and willing member of the school STEAM Team.

Instrumentation and Protocol for Data Collection

Yin (2014) asserted that case study research is more effective with a variety of avenues from which to gather evidence. Multiple data sources add to the richness of the story. The data for this study were collected from three major sources: individual interviews, field notes from observations, and specific documentation of student work. Following the data collection process, the researcher integrated the bodies of evidence to create a more comprehensive account of the case. This compilation of data sources is known as triangulation and represents a key component in seeking to understand phenomena in qualitative research (Stake, 2000).

Seidman (2013) stressed the importance of interviews in qualitative research to gain a strong understanding of the experiences of the participants in the study. Working closely with the staff at the school enabled in-depth analysis of individuals' ideas and attitudes toward innovative teaching and learning. With regard to field notes from observations, Phillippi and Lauderdale (2018) asserted such notes are a crucial component of the research process. Observations and related field notes provided detailed reporting of events and conversations taking place within the school studied. Finally, the documentation collected provided concrete evidence of adaptations to curriculum or other formalized processes in operation at the school.

Interviews

Individual interviews play a large role in qualitative case study research (Patton, 2002). Interviews provide a window into a person's perspective on a topic, as well as evidence of the

person's lived experience. Merriam (1988) indicated that interviews allow the researcher to obtain rich data that can enhance the study and generalize the results. Stake (2000) concurred that interviews also support the volume of data collected from other sources, thereby increasing the credibility of the findings.

For this study, 14 individuals were interviewed. Interviewees represented a broad spectrum of the school staff, from administrators to specialists and elementary- to middle-school teachers. These participants were interviewed once each during the course of the 2019–2020 academic year at the school, and each interview lasted approximately 30–45 minutes. These interviews took place at the beginning of the study, around January 2020. Since much of the teacher's innovation work has been underway since the start of the school year in September 2019, the January interviews represented the halfway point in the school year and provided ample evidence of work underway as well as upcoming goals for the remainder of the school year ending in June 2020.

Each participant received an identical set of interview questions, each of which was open ended to generate uninhibited yet detailed responses (Bogdan & Biklen, 2007; Merriam, 1988). As seen in the APPENDIX, the interview questions examined both the participants' attitudes and experiences with the major focus questions of this research. Respondents were asked to elaborate on collaborative efforts, curriculum redesign, administrative support, and professional development related to project-based learning or innovation.

Field Notes

Field notes from observations also play a large role in qualitative case study research. Field notes serve to illustrate events that are taking place in a detailed, realistic manner (Mulhall, 2003). Observations and related field notes at the school took place throughout the 2019–2020

school year. In particular, the school STEAM Team met formally once per month during a 50-minute district-established block on Friday afternoons known in the district as Teacher Collaboration Time. Collaboration meetings were facilitated by two teacher-leaders among the group (the enrichment and challenge specialist and the visual art teacher), and minutes from these meetings were shared with the entire school. There was an understanding that these meetings are always open invitations for any interested staff to attend. Furthermore, the district's collective bargaining agreement stipulates that Friday Teacher Collaboration Time is the purview of aligned staff and, therefore, cannot be organized or controlled by any nonaligned administrator.

Observations for this study also took place informally in classrooms. Staff from the STEAM Team identified instances of project-based learning and other collaborative experiences, and these settings provided an opportunity for additional data gathering. This research examined student work processes and products in classrooms. The research also highlighted the planning that educators undertook to execute a project-based experience for students.

Documentation

Whereas field notes from observations and individual interviews were the main vehicles for collecting data, this study also included an examination of relevant documents pertaining to processes and outcomes at the school. This study gathered and examined teacher-created project plans as well as students' written reflections from specific learning experiences. Documentation also included minutes from the school STEAM Team meetings, identifying agreements and commitments of the participants to carry out innovative projects in their classes. In general, all of this information served to corroborate individual feelings from interviews and occurrences during observations.

Data Analysis Procedure

The first step in the data analysis process was to gather data already obtained as part of this researcher's normal role as a curriculum coordinator for the Enrichment & Challenge Support program in the public-school district under study. These data date back to the beginning of the 2019–2020 school year, September 2019, and included several field notes from observations and documentation from the school STEAM Team and instances of student work related to this team. These data ultimately were combined with the data obtained from interviews and further observations once the official permissions were granted and the research proposal was approved.

Creswell (2013) described six formal steps that a researcher should undertake to analyze qualitative data.

1. First, the researcher organizes all the information. This includes typing notes from observations and interviews, as well as naming and sorting any electronic files or photos.
2. The second step is to read and view all of these data, potentially noting initial impressions or ideas.
3. The researcher then codes the data. Coding involves applying a strategic term to aspects of the data. This term connects to themes or questions that provide context for the research (Creswell, 2013).
4. The codes are then used to develop themes that evolve into a story line supporting all the details of the environment and phenomena.
5. This story line is embedded in a narrative expressed either chronologically or as a compilation of themes.

6. Finally, the researcher interprets the results. This analysis will focus on the lessons learned from conducting the study, as well as the ability to transfer this knowledge to future studies. In this case, this researcher sought to learn how a school developed and supported a culture of innovation with regard to its teaching and learning operation. Results then may be generalized to other schools seeking to learn from the process.

It was important that this research was both valid and reliable. In a qualitative study, validity refers to the extent to which the data represents the researcher's intention (Drost, 2011). In other words, validity corresponds to the degree of honesty in the data. For this study, participants being interviewed responded to questions directly related to the research questions defined at the outset. Observations and documentation also reflected instances of teaching and learning at the study school.

Reliability refers to the extent to which a study can be replicated (Drost, 2011). Reliability corresponds to the consistency of the research findings throughout time. The goal of this study was to generalize the ingredients for innovation in schools, so that other educational organizations may benefit from this research.

Furthermore, Creswell (2013) recommended a data analysis process called bracketing. This means that the researcher was cognizant of his own personal experiences and biases related to the topic. It was important to rely solely on the data obtained through the research process, rather than inserting any personal beliefs and instances from this researcher's vantage point as a curriculum coordinator in the school district. A technique to support the bracketing process included sharing field notes and interview notes with the designated participants and stakeholders before the official analysis began to make sure the information obtained was correct.

Ethical Considerations

It is important to note that all participants involved in this study were described under a pseudonym. Each participant provided written permission to be interviewed and was aware of the purpose of this research. Signed informed consent was gathered before interviews, and no formal data collection occurred before Institutional Review Board approval. Participation was entirely voluntary, and all information provided was maintained in strict confidence. All data gathered were stored securely so that this researcher is the only party privy to accessing the information.

Summary

Within the context of four research questions, this chapter described the methodology and design of the research study. This chapter also provided information on the specific sample and population involved with the research. The instruments for collecting data, as well as the procedures for analyzing the data, were explained, providing details as to how this study could be accomplished and potentially replicated by others seeking to learn about how schools innovate. Chapter 4 elaborates on the results obtained during this qualitative case study.

Chapter 4

Results and Discussion

Overview

The purpose of this qualitative case study was to examine how a school can create a culture of innovation in teaching practices. A secondary purpose was to identify strategies and decisions undertaken at this school that support innovation, creativity, collaboration, and curriculum integration. The participants in the study were 14 educators from one school in Massachusetts. The major themes that emerged from the data were collaboration among adults; curriculum adaptation, delivery, and outcomes; administrative and community support; and professional development. This chapter describes the participants and presents the results according to the four themes. A discussion of the findings follows in the context of the research questions posed at the outset of the study.

Participants

The participants in this study collectively self-identified as their school's STEAM Team and volunteered for both this ad hoc group and involvement in this study. All 14 participants were interviewed in their school setting during agreed-upon available times. Table 1 describes the roles and experience of the study group.

Table 1

Participant Profiles

Name	Role	Years of experience	Years at study school
Cameron	Principal	16	1

(continued)

Name	Role	Years of experience	Years at study school
Ishmael	Grade 8 science teacher	8	6
Rose	Grade 7 science teacher	9	4
Gerry	Grade 7 social studies teacher	28	19
Michaela	Grade 5 teacher	1	1
Brynne	Grade 3 teacher	25	25
Noa	Grade 1 teacher	27	14
Shayla	Music teacher	4	4
Denise	Art teacher	10	9
Hailey	Librarian	7	1
Thore	Curriculum specialist	10	7
Luanna	Technology specialist	5	1
Mia	Math specialist	8	8
Valerey	Special educator	5	5

Coding

Interviews were examined line by line as described by Fraser (2004). This technique involved listening attentively to each participant, writing the responses, and examining the answers closely. The purpose of this process was to connect responses from participants to

determine appropriate similarities (Fraser, 2004). Blair (2015) described this method as open coding. During this process, various codes emerged from the narratives of the interviews, and these codes were then grouped into themes. Open coding in this manner allows the researcher to formulate meaning across the entire interview process (Blair, 2015). Essentially, the coding of interviews moves the research from specific individual experiences to broad concepts related to the study (Dierckx de Casterlé et al., 2012). Table 2 shows the codes that were applied to the interviews in this research and emergent themes.

Table 2

Themes and Codes

Theme	Codes
Theme 1: Adult collaboration	Collaboration
	Advice
	Motivation
Theme 2: Curriculum adaptation, delivery, and outcomes	Projects
	Innovation
	Benefits to students
	Standards
	Autonomy
	Motivation
	Resources

(continued)

Theme	Codes
Theme 3: Administrative and community support	Administration
Theme 4: Professional development	Professional development Resources

Triangulation

Using the same process from the interviews, this researcher also analyzed notes from several meetings of the STEAM Team, informal educator meetings, and classroom observations. The set of codes in Table 2 served as a guide for conceptualizing the details that emerged from witnessing these experiences firsthand. Blair (2015) described this phase of coding as a priori or template coding, as the themes that already had emerged during the interview process were applied to these other methods of data collection.

Results

Four questions guided this study: How do teachers collaborate on designing curriculum and examining student work? How do teachers adapt curriculum standards and experiment with alternate methodologies? How does a school or district administration support project-based or interdisciplinary approaches to teaching and learning? What resources are available to staff for this type of professional development? As a result of conducting interviews, observing meetings and classes, and examining documents pertaining to educator collaboration and student work, a plethora of information emerged related to the research questions. The major themes described in the sections that follow illustrate how the study school supported a culture of innovation through teaching and learning.

Theme 1: Adult Collaboration

Whereas the 14 participants in this study compose the STEAM Team at their school, this group did not begin with that many members. The idea arose from a natural collaboration between one classroom teacher and one curriculum specialist. The study school district provided what is known as teacher collaboration time every Friday afternoon 1:40 p.m. to 2:30 p.m., thereby shortening the academic day for students by these 50 minutes compared to the other days of the week. By contract, teachers have full control over how they spend that time period, and as such, this time may not be coordinated by any administrator.

One of these founding members, the art teacher, Denise, indicated that her initial goal was to connect teachers who shared a similar passion for innovating in the classroom. This educator also had heard from colleagues at other schools in the district of instances of project-based learning and an increasing receptivity to hands-on learning by doing on the part of students and teachers alike. Her goal was to try to set forces in motion for the sharing of ideas at this school, which by its nature, was both physically and virtually isolated from the other schools in the district.

The first official meeting of this team had seven attendees. At this time, they viewed curated examples of project-based learning at other schools in the district and identified three future readings on student-centered learning. They expressed a general desire to enhance teaching and learning at their school. One early participant, a seventh-grade social studies teacher, Gerry, noted she felt her school was falling behind others in the district and felt the school and district leaders were not prioritizing a 21st-century vision for education at this school.

Subsequent STEAM Team meetings had increased attendance, with between 10 and 15 staff each time. Staff at a later meeting decided to work in partners to develop a project-based

learning experience for their students. Pairs of educators committed to collaborating in the 4 weeks following the meeting and would report their progress at a future collaboration time. Pairings included Rose, a middle school science teacher, and Luanna, the technology specialist; Gerry, the middle school social studies teacher, and Thore, a curriculum specialist; Shayla, a music teacher, and Denise, the art teacher, who shared the same second-grade homeroom; and Noa, a first-grade teacher, and Valery, a special educator.

Rose, the science teacher, indicated that she was eager to enhance a project she had not yet fully developed, with the addition of a technological component that could be accomplished only in collaboration with a specialist in web design. For example, Rose's students had created miniature ecosystems, yet had not formally documented their work, and were not able to examine all of their peers' projects. Partnering with Luanna to create a project website that housed all the students' work would elevate the overall quality of the experience. Furthermore, both the art and music teachers expressed an interest in helping students see the connections between their disciplines and worked to coordinate their schedules so that they could plan a project focused on both the visual and performing arts in tandem.

These STEAM Team members committed to collaborating on a curriculum-related project and subsequently shared their successes and challenges with colleagues at another meeting. From this point forward, opportunities for additional staff to join the group were set in motion. An open invitation to the STEAM Team school-wide generated more interest: "All staff are welcome and encouraged to join the STEAM Team to inspire and be inspired by your colleagues, regardless of your experience with STEAM pedagogy." Michaela, a fifth-grade teacher and newer member to the learning group, commented that she was intrigued by some of the ideas she had heard staff talking about informally. She decided to join as a way to partner

with colleagues with the hope of refining her teaching practices in a more creative manner. Furthermore, an examination of documents and email announcements revealed that all subsequent STEAM Team meetings reiterated the message of the purpose of the group and its inclusivity. For example, in a March 2020 communication, already well into the school year, the invitation read, "STEAM team is a group of educators who are excited about sharing ideas around the topics of technology, project based learning, authentic learning experiences, and student empowerment. The group is open to all staff!"

STEAM Team meetings at the study school began bimonthly and, with momentum around collaboration on project-based learning, evolved into regular monthly meetings in the middle of the school year. Beginning in January 2020, the team expanded their collaboration. Thore, the curriculum specialist deemed the de facto leader of the group, noted that the educators needed more time to share their ideas for hands-on and project-based learning and design thinking. He wished to provide opportunities for staff to talk about not only projects happening, but also ideas about what *could* happen. The evolution of this process, therefore, resulted in weekly meetings, that is, every Friday afternoon from January through March, alternating between a general STEAM Team meeting and what came to be called the Project Study Team.

The purpose of the Project Study Team meeting was to provide a space where a single teacher presents a project and seeks feedback from colleagues on completing, executing, or revising the project vision. During the Project Study Team meeting, participants utilize a project tuning protocol, a structured format for presenting an idea and receiving targeted feedback on a guided question around implementation. During the first such iteration, Rose, the seventh-grade science teacher, sought better ways for students to document their progress during the various stages of their ecosystems projects. As part of the protocol, following the description of the

dilemma, the presenting teacher isolates from the group and listens to the ideas of others. Upon reflection at the end of the session, this teacher indicated that during that period of solitude, she found it wonderful to focus purely on listening to others' suggestions rather than having to interject her own comments. This endeavor was so successful that another colleague in attendance, Ishmael, the eighth-grade science teacher, asked if he could present his project idea for feedback at the next Project Study Team meeting.

Importantly, although the theme that emerged from the research primarily pertained to collaboration among adults, selected middle-school students were also incorporated into the project-tuning protocol during the Project Study Team meetings. More is written on the origins of this phenomenon in the professional learning theme. Pertaining to collaboration, students who were about to experience these projects firsthand were seen as equal partners in the planning of instruction. The students who participated in these meetings provided meaningful feedback to the teachers from their perspective, and their ideas were subsequently included in the planning and execution of the work.

The second Project Study Team meeting took place on the Friday afternoon prior to the school's vacation week, February 14, 2020, and had 13 participants, some of whom stayed beyond the allotted time to continue to discuss teaching and learning experiences. For this tuning protocol, Ishmael, the eighth-grade science teacher, sought to make his "rocket" project more student centered and engaging than in previous years. Using the structured model of clarification and feedback, Project Study Team members and two eighth-grade students provided kind, specific, and helpful feedback to guide the teacher in planning for this project. Team members offered alternatives to the packet of materials and described how the chemistry involved in launching the rockets could be both safe and challenging. A discussion ensued around making

the rocket launch experience somewhat competitive for students, and the eighth-grade students present agreed that incorporating this element would increase their motivation. Ishmael indicated that he was initially quite nervous to present this project openly and publicly in front of colleagues and students. However, he said the advice provided was incredibly helpful and the overall experience was worth the risk of making one's teaching practice visible. He left feeling encouraged and expressed that the meeting helped define the school's culture of continuous improvement.

Theme 2: Curriculum Adaptation, Delivery, and Outcomes

Teachers at the study school are aware of the curriculum demands in each content area imposed by district and state standards. Several interviewees shared both physical and virtual binders of the curriculum, pacing guides, and materials needed to cover standards throughout the school year. These teachers also indicated during their interviews that students would benefit from deeper learning experiences that integrate the curriculum or focus on fewer standards. They stated they did not have the time to address this volume of curricula, it would be in their students' best interest to see the connections across content areas, and "less is more" would allow students to learn more deeply. Teachers expressed that much of the fact-based content is readily accessible, so they would rather devote their energies in the classroom to designing learning that is meaningful and engaging. As a result, many project-based learning experiences have emerged, both individually and collaboratively, at this school.

At the beginning of the school year, Thore, the curriculum specialist, and Denise, the art teacher, earned a grant to purchase a 3D printer, with the hopes of learning its properties and uses and eventually determining how to incorporate the tool into student work products. They dedicated several hours of common planning time together prior to launching the project. Their

initial planning centered on 3D printing as one of many options for students to design and create, as the one device seemed insufficient for the output from a class of 20 students. Only a few students could use the printer at one time, so everyone else would have to create using a different medium. The sculptures the few sixth-grade students made using 3D design were successful enough to warrant further exploration of this technology, and the teachers dedicated significant time on their own to enhance their understanding of how to use CAD software and 3D printers on a larger scale.

Expressing a convincing sentiment that this school's resources were paltry compared to other schools in the district (some of which have operational makerspaces or mobile technology carts), the members of the STEAM Team asked for their allotment of funding to be put toward developing a 3D printing lab. The goal was to have four 3D printers to allow whole classes to utilize the technology for projects. One such project related to the sixth-grade mathematics unit on ratios. Students would be creating 3D printed cars with the goal that the cars needed to be able to pull a load of a designated weight up a hill. Essentially, the objective was for students to understand why ratios matter, to optimize car performance. Students would have to determine optimal gear ratios among the teeth components of the axle. Students would calculate the ratio of the driven gear (receiving force) to that of the driving gear (pushing force). A higher ratio would provide more torque; a lower ratio would generate more speed. Their designs would then be applied to pull a 1 kg weight the fastest. In addition to operating with ratios, students would need to learn basic circuitry to power the car with a battery. Students were observed being highly engaged in this project. Follow-up interviews with Thore confirmed that students who were seen to have difficulty within the regular classroom setting, particularly during traditional

mathematics instruction, appeared to flourish when given these opportunities to learn by doing in this hands-on fashion.

Another project, first gleaned through the interview process and then observed firsthand, involved seventh-grade students in social studies. Students were learning about ancient civilizations as part of their curriculum. Gerry, the teacher, decided to make the learning more relevant by having the students investigate various problems facing civilizations today, as a way to understand the challenges facing ancient civilizations. Such issues included overpopulation, sanitation, and health, among others. Students would be creating videos to support taking action on these modern phenomena and present the videos to the greater community. Designing and printing a stop-motion camera holder using the 3D printer became necessary to assist in the students' creations, so Thore collaborated as the curriculum specialist.

Another project took place in third grade. In an interview and follow-up observation, Brynne, the third-grade teacher, indicated that third-grade students at the study school were learning to perform calculations and operations with decimals in their math class. As an opportunity to enhance this unit, Brynne, math specialist Mia, and librarian Hailey designed a learning experience that would be highly useful for the school, a redesign of the learning space in the library. Students took measurements of all the furniture in the library and then had to convert these measurements to millimeters. Millimeters are the standard unit in the Tinker CAD software that would be used to 3D print the objects. The goal was to be able to print scale models of the library shelving units, tables, and chairs to manipulate the layout in three dimensions. Groups of students would be making suggestions on reconfiguring the space to building administrators and other staff based on their creations. The educators involved reported high levels of student motivation, including significant academic challenges with this endeavor.

Simultaneously, Denise, the art teacher, and Noa, the first-grade teacher, obtained additional grant funding to purchase miniature robots. For this project, young children would be using block coding to mobilize these robots; as Luanna, the technology specialist indicated, there is potential for more sophisticated levels of coding for students in higher grades. The objective for the work is for students to create shapes based on the pathways the robot moves. This objective connects directly to their math curriculum in developing an understanding of the properties of shapes. The integration with art allows them to add personal expression to the robots' moves, as the devices come with markers that trace along the paths. These students also have opportunities to compare the writing they do as part of their language arts curriculum with the coding commands, thereby enhancing their overall understanding of language.

Thore, the curriculum specialist, described in an interview plans for an upcoming project with sixth-grade students involving pure design thinking, that is, having students work through the stages of empathy, definition, ideation, prototyping, and testing. The project was titled "Build a Better Fidget" and involved students ultimately designing a device that would meet the movement needs of students. To develop their ideas, the middle school students would need to interview students in the lower grades to gain insight into what types of tools help them focus. Throughout the process of design, the sixth-grade students would be getting feedback from various teachers as well, including the school's occupational therapist.

As the project progressed, observations of the students' work revealed a high level of engagement and thinking. Students were seen discussing ideas with one another, questioning design techniques, defending their thinking, modifying plans, and concentrating on the details of their work. During the process, some students noted that their peers like to slap the frame of the doorway and, therefore, sought to create other ways for allowable movement in the hallway.

Other students learned that some fourth-grade students wanted or needed whole-body exertion and, therefore, sought to design other hallway accommodations that allowed for such movement. Their idea was to create a handprint wall that students would push against. Other third-grade students described a stick that elongated and contracted, yet it was noisy. The sixth-grade students, therefore, sought to replicate that experience without the distracting sound. Another example of students' work involved an under-the-desk roller made of ball bearings, whereby a student could still spin the device while looking up at the teacher. All ideas demonstrated a level of innovation, corresponded to the principles of design thinking, and supported the needs of individuals.

Fifth-grade teacher Michaela described in an interview an innovative adaptation to the energy unit within the science curriculum. With the assistance of Thore, the curriculum specialist, students would be designing windmills to meet various specifications. Using the engineering and design process, students prototyped and tested windmills with different sizes, shapes, and numbers of blades. Observations revealed a high degree of student engagement and conversation as students sought to improve their windmill designs and outperform their peers.

The STEAM Team teachers involved in each of these projects expressed a flexibility in their role with deciding how best to instruct their students. They felt a degree of autonomy and ownership over their role as curriculum planners, even within curriculum mandates. The more they experimented, and the more they witnessed how favorably the students responded, the more eager teachers were to continue innovating and sharing with colleagues. Furthermore, observation revealed that students conveyed both a sense of purpose and enjoyment to their work as they engaged in these experiences.

Theme 3: Administrative and Community Support

Notably, four participants in this study, the principal, librarian, technology specialist, and curriculum specialist, were new to their roles this school year, with three also new to this school and two new to the district. Their openness to collaborate with and learn from one another as they navigated their new employment contributed to the unique nature of this work. It is unclear to what extent this study would have been undertaken if each of these individuals' predecessors were still employed by the district. During the interview phase of this study, these four participants noted that their newness to their respective positions helped contribute to a culture of experimentation, flexibility, and collegiality. These professionals were learning as they went along, and they felt that their uncharted paths were representative of the type of learning experiences they would want students to have as well; the challenges were real. They also felt they could be on the cusp of proliferating improvement in both the school and the district, by transforming teaching and learning to incorporate and model key 21st-century competencies, such as collaboration and creativity. They envisioned their school as a world-class institution.

The aforementioned potential reconfiguration of the library space is one example of how this team began to collaborate. Thore, the curriculum specialist, and Luanna, the technology specialist, share this space with Hailey, the librarian, and thinking about how their work overlaps was natural. At the same time, the library space at this school was traditionally used by several classes throughout the course of the week, and an extensive book room was frequented by the literacy department. Cameron, the new principal, had to navigate the politics from numerous stakeholders laying claim to a limited amount of space.

From the beginning of the school year, Cameron embraced a scheduling opportunity that emerged throughout the district, called What I Need blocks. What I Need blocks allow students

in the middle grades to choose among several elective-type experiences based on their interests and circumstances. The impetus for these blocks of time arose from the need to support students in literacy and math, but the scheduling also created opportunities for social-emotional learning and guidance. As an extension of these opportunities, members of the STEAM Team created time and space for students to delve deeper into project-based learning during What I Need blocks. As a result, some students opted for 3D design and coding classes that were not traditionally part of the school day, but rather only offered outside of school hours or even outside the school building. Cameron indicated that he wanted to expose more students to hands-on learning by doing, and his hope was that ultimately these periodic instances would be woven into the core curriculum.

During the winter of 2020, the STEAM Team, led by Thore, the curriculum specialist, approached the principal to ask permission to design an experience for the whole school staff at an upcoming faculty meeting or series of meetings. Based on an exchange of ideas observed at one of their scheduled meetings, their idea was to set up a series of stations with various choices of activities. These activities included empathy interviews, design sketching, 3D printing, coding, and robotics. Each STEAM Team member would serve as a station captain and provide teachers with information and inspiration for topics and resources that may spark interest to utilize with students. Cameron, the principal, supported this initiative and scheduled a series of these sessions at three faculty meetings to give staff more time and more choice in their own learning. In an interview, Cameron indicated he wanted to capitalize on motivated teacher leaders whose philosophies aligned with his, yet allow for empowerment and school improvement from the bottom up, rather than from the top down.

In examining documents and email communication to staff regarding the planning for these faculty meetings, the organic approach to staff development was evident. The team called their series of learning experiences the "STEAM Table," whereby staff would choose from a menu of topics about various technology and design thinking tools and tips and learn more about these resources directly from a STEAM Team member. The communication pertaining to their planning meeting read, "If you have something that you would like to present at the workshop, come join us. If you are simply curious about STEAM Team and have been all year, come join us." In his interview, Cameron noted some of his principal colleagues in the district were reluctant to yield faculty meeting time to new initiatives given the number of priorities already being addressed within the school system. Cameron indicated that other colleagues were intrigued by the notion of teacher-led staff development, and other principals were particularly curious about the STEAM Team that essentially emerged on its own. As a 1st-year principal in the district, Cameron felt he was empowering and building capacity among staff and, therefore, growing a culture of innovation.

In addition to support from building administration, the parent community was overwhelmingly supportive of these innovative efforts involving project-based learning and interdisciplinary studies. Thore, the curriculum specialist, described this community support in his interview. During the previous school year, Thore and a now-retired colleague had invited parents to provide students with feedback on specific projects. In so doing, they became increasingly aware of not only the professional expertise within the community, but also the desire of parents to participate in the educational experience of their children.

During the 2019–2020 school year, Thore shared that he developed a "parent–guardian expert database" to serve the purpose of strengthening the home-to-school connection through

teaching and learning. The premise was that students would be more engaged in authentic project-based learning and that adults in the community had professional experience coinciding with the learning in school. Parents and guardians with diverse experiences could provide feedback to students en route to their learning or could come into the school to give context to the curriculum. This community partnerships database was generated from a Google form that automatically populates a spreadsheet. Members of the STEAM Team would vet the responses and communicate to staff when they found potential connections and interest to link the adults to the students.

Theme 4: Professional Development

The transformation of teaching and learning toward multidisciplinary project-based learning is neither intuitive nor simplistic. Professional support and resources from the administration and community are crucial, and structures must be in place to support staff growth and development. A commitment to lifelong learning in an ever-changing environment is critical to the success of innovation efforts. During the interview process, the STEAM Team staff reported participating in and benefiting from significant amounts of individual and collective professional development throughout the 2019–2020 school year.

The most significant professional learning occurred when both the curriculum specialist, Thore, and seventh-grade science teacher, Rose, visited the High Tech High K-12 network of schools in San Diego, California, in November 2019. These educators and other colleagues from the study school district obtained a grant in order to pursue this opportunity. The High Tech High network promotes project-based learning, curriculum integration, and collaborative design as its core model of instruction. These participants observed elementary, middle, and high school classes; met with teachers and administrators; and participated in structured project-based

activities or simulations as part of their immersive experience. The educators in this study described how inspired and motivated they were coming back to their Massachusetts school with ideas of developing a culture of empowering students. This trip provided the impetus for their desire to have the STEAM Team meet more often than originally planned.

Rose and Thore indicated that they found their last planned activity on the trip, a project-tuning protocol, the most powerful instance of professional development. The key component of the protocol was involving two third-grade students from High Tech Elementary in the planning process with their teacher on an upcoming project for their class. Reflecting about the protocol during their debrief, these educators indicated that they often had asked students for feedback after a project or assignment but never had thought of soliciting student opinions *before* launching the work. This inspirational nugget of professional learning transferred directly back to their school, as they replicated the project tuning protocol subsequently in their setting.

Another direct transfer of professional learning from the High Tech High network to the study school involved a whole-school project devoted to Black History Month. Inspired by her learning in California, the seventh-grade science teacher, Rose, led efforts at the study school to create a visual alphabet of Black history, highlighting significant contributions to society both past and present. This collective project crossed all grade levels K-8, with each homeroom researching and creating a letter to be on display as part of the whole alphabet, analogous to what she witnessed during her trip. Among the goals of the endeavor were to work together as an entire school community to create a work of art recognizing the importance of Black History Month, highlighting the important contributions of Black individuals past and present, and challenging stereotypes. Throughout the process, staff at the school indicated how engaged the students were in making decisions and creating their unique representations. Furthermore, the

products added a flair to the physical space, suggesting a school that supports equity, high-quality student work, and community. Through observation of this public exhibition, Rose was able to help propel an entire school forward through an innovative, creative, and cultural learning experience based on her professional development.

In addition, Hailey, the librarian; Luanna, the technology specialist; and Thore, the curriculum specialist, described how they contacted and visited another local school district in Massachusetts that had significantly transformed space and culture. As these three participants shared space in the study school's library, they sought to see how a prominent local school was able to utilize the physical plant for a combination of library circulation, makerspace activities, and professional meeting space. These individuals met with administrators and teachers from another district to learn how to redesign learning to meet 21st-century demands.

The members of the school's STEAM Team not only understood their role in facilitating professional development for their colleagues, but also modeled their personal learning throughout the course of the school year. In interviews, they indicated how current research in the field of education guided their learning over time, and they discussed literature from prominent figures in both Massachusetts and nationally. To a person, the participants indicated that they felt much could be gained by connecting their work to other professionals in the field, and they sought to model lifelong learning for their colleagues.

Discussion

This research helped to provide an explanation for how a particular school developed and then enhanced its culture of innovative, 21st-century teaching and learning. The information obtained during the data collection process served to describe a series of events that collectively moved the school forward in modernizing and authenticating staff practices. Although there is no

distinct recipe for a school system or leader to follow, certain ingredients evidently must be in place, operating simultaneously to change cultures and impact student learning.

The study school demonstrated a commitment to actively engaging students in their own learning and advocating for themselves and others. The STEAM Team members promoted an atmosphere of safe risk-taking among students, as well as a growth mindset for students and teachers alike. Staff sought to integrate curriculum areas as much as possible, and they strove to share student work openly and publicly. The school staff experimented with the logistics of physical space and scheduled time periods, knowing that trade-offs existed anytime the conditions were altered. In addition, based on the prior experiences in other settings, the new principal fully supported these ideals and empowered the staff to continue to adapt curriculum and instruction in accordance with students' needs.

All participants described the desire and need for strong levels of collaboration among the adults. The middle school science teacher indicated that the project-tuning protocol conducted by the Project Study Team represented much more than merely empowering students in curriculum design processes (which in and of itself is impactful), but rather provided the seeds of a movement to make collaboration a regular part of an educator's role. Curriculum specialists reiterated that by participating in these collaborative project-planning sessions, the school is essentially creating a symmetry between how adults learn and how teachers want students to learn.

The research also showed how to deepen the curriculum for students through a project-based approach. Whereas the methodology casts a wider net for students' access to high-quality teaching and learning, the outcomes far exceeded staff expectations of what students are capable of when given the chance to create. As more students engaged in hands-on learning by doing,

they experienced learning in more authentic ways, offering their voice and reflection throughout the learning process. Students also utilized modern technology more typical of that from professional fields outside of the school walls. They developed skills and knowledge that not only extended curriculum standards, but also enhanced their repertoire of soft skills, such as communication, adaptability, perseverance, and problem solving.

The school or district administration could have chosen to draw a line that would prohibit this level of autonomy and experimentation among staff. The leadership could have sought more consistency of practice among the eight schools across the system. Instead, the building leaders allowed teacher leaders to engage in similar engineering and design practices in their curriculum planning, such as empathy, prototyping, and iteration. This freedom from failure empowered the staff to realize their full potential as professional educators in much the same way as these teachers were seeking with students.

Further, the school and district needed to provide ample resources to support and sustain this work. The study school system invested in human capital development in addition to physical equipment that would be necessary to implement more project-based learning. The notion that professional learning is ongoing became evident during the research process. While the team members were experiencing significant amounts of success with student achievement, in many ways they were learning on the job, a feeling simultaneously exhilarating and frightening. Nonetheless, the participants felt supported and enriched to continue refining their model.

Summary

This qualitative case study involved gathering evidence from interviews, team meetings, elementary- and middle-school classes, and student work products. Through a close examination

and triangulation of the data, four themes emerged to help answer the four research questions posed at the beginning of the study. The 14 participants in the research study were actively involved in enhancing the culture of teaching and learning at their school, each from a different vantage point. However, the interconnectedness of their work served to highlight a storyline of how a particular school innovates to meet the educational demands of the 21st century. In particular, the major elements of collaboration, curriculum integration, leadership support, and professional learning emerged throughout the study. Details within each of those four categories appeared in tandem as necessary indicators of school improvement.

Chapter 5 builds on the themes that emerged from this research to develop recommendations for future schools engaging in this type of work. Practical implications and considerations for school and district leaders are discussed, as well as ideas for future research on innovation in schools.

Chapter 5

Conclusions and Recommendations

This chapter is divided into five sections. The first section summarizes the study, followed by conclusions by research question. Limitations of the study are identified, followed by recommendations for practice. The final section describes implications for future research.

Summary of the Study

The purpose of this qualitative case study was to determine how a school can create a culture of innovation in teaching practices. In addition, this study sought to identify strategies and decisions undertaken at this school that support innovation, creativity, collaboration, and curriculum integration. Chapter 2 provided an in-depth review of the literature related to innovation in schools. A significant body of research was found and reviewed on the history of U.S. education and the need for transformation based on the characteristics of modern society. Advances in technology, increases in globalized communication, and changes to the nature of employment have had implications for how schools educate children today (Wagner, 2008, 2012). Research on the psychology of change and examples of changes to the educational operation in schools were reviewed (Bidwell, 2001; Levy & Murnane, 2013; Lunenberg, 2010; Reich, 2017). This particular study focused on one school in a large suburban district where the conditions for change were ripe. Chapter 3 described the methodology of this study. Based on interviews, field notes from observations, and examination of documents, this study gathered significant amounts of information from 14 individuals employed at the school who were fully immersed in the school's evolution. Chapter 4 elaborated on the findings from this school spanning the year. Four common themes emerged from the data that helped to answer the research questions posed at the outset. Conclusions from these research findings can be drawn as

to how this school developed a culture of innovation. This chapter describes the conclusions that emerged from the data.

This study spanned the 2019–2020 school year in a Massachusetts K-8 school. This researcher sought to determine the decision-making processes and actions taken by teachers, specialists, and administrators within this school that would enhance teaching and learning for students. Fourteen staff members from this school participated in the research study. This researcher interviewed each of the participants, who included elementary classroom teachers, middle-school subject-specific teachers, teachers of the arts, various curriculum specialists, and school administrators. Each adult was asked the same set of questions, which are included in the APPENDIX. Throughout the study, numerous classes and meetings were observed to record what the students were experiencing and what the adults were planning. In addition, several documents that summarized teachers' meetings or represented planned projects were gathered and examined. Based on each of these sources of data, this researcher developed themes that continued to emerge. The themes described in the results chapter helped to answer the research questions posed at the outset of the study.

Conclusions

Based on this research, this school evidently developed a culture of innovation. Conditions were in place that aided the school's progress, as well as several decisions made by key stakeholders throughout the school year. Through extensive research, conclusions can be drawn to answer each of the research questions offered at the start of the study.

Conclusions to Research Question 1

How do teachers collaborate on designing curriculum and examining student work? Collaboration among staff members is essential to supporting a culture of innovation. Built-in

structures must exist to allow teachers and related staff the time to share practice, plan learning experiences, examine student work, and reflect on dilemmas of practice. For innovation to flourish, teachers cannot work in isolation. In the case of the study school, a dedicated time for collaboration existed on the schedule every Friday afternoon, whereby students were released earlier than on other days of the week. Collaboration was also enhanced by the existence of curriculum specialists, whether in the area of technology, mathematics, library, or in general instruction. These individuals serve as capacity builders, and are deemed nonevaluative peers, a designation that clarifies their role is to support teachers rather than supervise them. These specialists possess a skill set that includes specialized knowledge in various content areas, pedagogical expertise, and strong emotional intelligence to help transform teachers' practice in an inspirational and nonthreatening way.

Although the existence of curriculum specialists is advantageous to enhancing collaboration, participation from classroom teachers is essential. Those who have the most direct contact with students daily, and those whose very role of planning and carrying out learning experiences ebbs and flows with the vagaries of the operations in schools, must be fully involved in decision-making and processes. Classroom teacher participation in STEAM Teams, project-tuning protocols, and the like provide the strongest catalyst for innovation and change within the school.

Important also, collaboration was consistent throughout the course of the school year. The professionals made commitments to one another around planning learning experiences and followed through with their agreements. They prioritized reflecting on their practice and how they could improve upon their collaboratively designed work. This level of collaboration corresponds directly to what Goddard et al. (2007) described as effective for both student

achievement and school culture. Furthermore, Lichtman (2017) described the necessity of staff collaboration for innovation to occur in schools.

Conclusions to Research Question 2

How do teachers adapt curriculum standards and experiment with alternate methodologies? The teachers involved in this study believed that curriculum is not static, but rather ever evolving in accordance with the world. These teachers did not ignore state standards and district mandates, but rather figured out ways to address the standards in a more efficient and relevant manner. The individuals in this study integrated curriculum areas so subjects were not seen in isolation. They made connections across content areas and, in so doing, were able to provide deeper learning experiences than merely breadth of coverage. By utilizing a project-based learning approach, the teachers could design learning built on key knowledge, understanding, and success skills for the 21st century. Students had voice and choice, were reflective, offered critique and revision, and made their work public.

As a result of project-based learning, students were actively engaged in authentic learning. These experiences were enhanced by student participation in the decision-making around project design. Guided by collaborative structures, teachers adapted a static siloed curriculum and brought joy to learning, as evidenced by the student work products and reflections. These findings are supported by the research described earlier by Boss and Larmer (2018), where students were engaged in problem solving around issues in their community. Further, Dintersmith (2018) showed how students engaged experts in the field to connect their learning to the real world. This is a key component to developing a culture of innovation.

Conclusions to Research Question 3

How does a school or district administration support project-based or interdisciplinary approaches to teaching and learning? The high degree of collaboration combined with rethinking of how to deliver a multifaceted curriculum were able to sustain momentum throughout the course of the school year because the building principal provided significant support for these efforts. The principal had significant influence over the culture, climate, and logistical operation of the school. In this case, the principal granted staff the permission to experiment and fail. He trusted that the educators could work together to do what is best for students and use their professional judgment to make decisions within the classroom. By providing opportunities for staff to learn together and share their thinking publicly, the principal essentially grew a cadre of teacher leaders.

As a new principal, he did not enter the role making sweeping changes within the school, but rather sought to listen to and learn from the staff who preceded his tenure. Yet, based on his experience in other school districts, the principal did possess a vision for 21st-century teaching and learning, and the work of the STEAM Team connected to and coincided with his greater vision of authentic learning and innovation. The principal also allowed for creativity with regard to the physical space within the building. In a school district with other schools being renovated or rebuilt, the study school could have been at a disadvantage with regard to its facilities. In supporting a culture of innovation, the principal allowed interested staff to rethink the use of the library to include 3D printing, to build up mobile makerspace resources, and to beautify the building with student work products.

These observations correspond to the earlier research of Orphanos and Orr (2014), who described the importance of the role of the principal in enhancing the school's culture. Their

work similarly represented a paradigm of distributed leadership among collaborative structures. In addition, Lichtman's (2014) research foreshadowed the impact of the school leader in that without the necessary support, innovative teaching and learning would not occur.

Conclusions to Research Question 4

What resources are available to staff for this type of professional development? Collaboration, flexible curriculum, and leadership support were strengthened by a commitment to ongoing professional learning. Led by members of the STEAM Team, staff at the study school with a wide variety of professional experience sought continuous improvement as lifelong learners. Their belief was that if they expected students to take risks, communicate effectively, and critique one another's work, then they as adults needed to model this behavior as well. Through faculty meetings, the Project Study Team, and use of structured protocols created by experts in the education field, this team of adults developed a culture of safe risk-taking, curiosity, and a willingness to experiment with project-based learning among themselves and were highly transparent in developing these plans.

Professional development at the study school was job embedded and constant. The STEAM Team established the role of educators as designers of learning and brought in both students and other adults to aid the process. For example, parents and other experts in various fields were brought in to provide feedback to students or give talks on the connection between curriculum content to professional work outside of school. Through an interwoven collaboration of educators, students, and parents, the school supported continuous growth and adaptation to the needs of the 21st century. These findings correspond to the earlier research of Bernhardt (2015), who described the need for staff development around 21st-century competencies. Described

earlier, Fleming (2015) and Lichtman (2017) also stressed the importance of continuous educator learning to move a school's culture forward.

Limitations

This study provided numerous examples of decisions made and structures put in place to support a growing culture of innovation. However, these instances represent just one school in a large district composed of eight such K-8 schools. Conditions specific to this school allowed for the proliferation of innovation, not the least of which was the coincidence of having a new principal, new technology specialist, new librarian, and new curriculum specialist all at once. This team naturally collaborated as they learned about the school, and three of them shared the same space daily.

In addition, this particular school might have benefited from observing what had taken place in other schools in the district. Several of the other schools had attempted to organize some form of collaborative team structure as well as create physical or mobile makerspace resources. Staff at the study school could have learned the successes and challenges of the other schools and, therefore, could have avoided pitfalls or obstacles that arose as well as capitalizing on any favorable circumstances. As a result, the conclusions drawn from this study may be somewhat limited to this particular school environment, and replicating the transformation of the school culture in a different setting may be difficult.

Recommendations

This research and the evidence gathered on how a school can develop a culture of innovation yielded recommendations for school and district leaders moving forward. School personnel must commit to engaging students in meaningful authentic work; they must make learning relevant to students. This involves a close inspection of the curriculum and opportunities

to integrate content areas with natural connections. In addition, schools must create opportunities for students to display their work publicly. These exhibitions elevate the importance of students' work and also give recognition to students. Relatedly, the school must involve the parent–guardian community, not only when sharing student work products, but also in developing connections to professional work in the field, bringing about greater relevance of content learning to children. A school that innovates should include students of all ages in decision-making, especially when designing projects. When the school models a culture of critique and revision among the adults, the transition to students becomes more natural.

Underlying all these efforts within the daily operation of the school is the importance of leadership. School and district administrators must establish the conditions for the professional staff to be successful. Leaders must protect time for adults to collaborate and support professional development as an ongoing practice. The leader must demonstrate a level of trust in staff to design learning experiences that meet the needs of all students and allow teachers to experiment with new ideas and share them with colleagues. Finally, the school leader must possess a vision of 21st-century teaching and learning that is responsive to the needs of children and helps prepare them as creators of knowledge.

Implications for Future Research

This case study answered several questions about how a school can develop a culture of innovation. The study also helped to raise other questions that may warrant future research. Given that the study school transformed its library into a space that included a 3D printing lab and mobile maker resources, investigators might be curious about the future of school libraries. To what extent is the school library utilized solely for traditional purposes around books and

research? Given the proliferation of technology, how may schools begin to rethink both the layout and purpose of school libraries?

A second theme that emerged pertains to project-based learning as an instructional model. How do school staff who employ this pedagogical approach measure success, and how do they make decisions around which academic standards to cover and which to integrate with other content areas? More research needs to be conducted on the benefits of project-based learning as the primary driver of curriculum and instruction.

Finally, given research on the impact of instructional coaching, more in-depth studies could take place on the use of curriculum specialists in the model described at the study school. The specialists played a prominent role in supporting teachers to develop innovative curriculum experiences for children, collaborating with them continually throughout the school year. This leads to the question of how many and what type of specialists schools could afford to employ, and what skills they need to possess as instructional leaders.

Summary

This qualitative case study examined the teaching and learning practices and structures in one K-8 school in Massachusetts during the 2019–2020 school year. Based on the need to adapt curriculum and instruction to meet the needs of all students in the 21st century, this study examined how a school created, developed, and refined a culture of innovation in teaching practices. Given the need for students to become adept at communication, collaboration, creativity, and critical thinking, staff and administrators at the study school set in motion a series of continuous events that sparked educator interest and student motivation. Through a project-based learning approach, the school helped students and teachers enjoy the learning process individually and collectively.

Through a series of interviews, observations of classes and meetings, and gathering of student work and lesson plans, this researcher identified four factors that enabled an innovative culture to flourish at this school. These ingredients for innovation were a high level of collaboration, a conscious effort to integrate and connect curriculum, a supportive leadership structure, and opportunity for ongoing professional learning. Based on a preponderance of evidence among these four themes, the study school developed and then improved upon an innovative school culture. Teaching and learning thrived at this school. Its staff and students are representative of 21st-century education.

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APPENDIX

Interview Questions

1. What was your original interest in the STEAM Team?
2. What are you most excited about as part of the STEAM Team?
3. What new collaborations have emerged as a result of your participation?
4. What projects or innovative curriculum are you currently involved with?
5. What do you feel are the benefits to students of engaging in project-based learning?
6. How do you balance the demands of the curriculum with innovative approaches to teaching and learning?
7. How much autonomy do you feel you have to innovate with curriculum and instruction?
8. To what extent do you feel supported by administrators to carry out your work effectively and/or try new instruction or resources?
9. What professional development have you had on project-based learning? What professional development do you want/need? To what extent is this available?
10. What suggestions do you have for colleagues and leaders regarding implementing elements of project-based learning?