THE RELATIONSHIP BETWEEN 21ST CENTURY EDUCATIONAL GOALS, TEACHING AND LEARNING ACTIVITIES, AND THE AFFORDANCES OF THE PHYSICAL ENVIRONMENT: A QUALITATIVE MULTI-CASE STUDY OF TWO HIGH SCHOOLS

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ABSTRACT

THE RELATIONSHIP BETWEEN 21ST CENTURY EDUCATIONAL GOALS, TEACHING AND LEARNING ACTIVITIES, AND THE AFFORDANCES OF THE PHYSICAL ENVIRONMENT: A QUALITATIVE MULTI-CASE STUDY OF TWO HIGH SCHOOLS

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For many in the educational world, the learning goals have shifted to include more so-called 21st century skills and include, among others, technology use, communication, critical thinking, problem solving, and collaboration (Rotherham & Willingham, 2010). To address this, researchers and policymakers have advocated for student-centered learning, however, too often we still find many activities taking place in schools that are primarily teacher-centered (Tan et al., 2006a). The issue may be that the physical environment is not conducive to student-centered learning activities.

Many architects, school administrators, and scholars believe that the physical environment can shape behavior and interactions, therefore having influence on the activities that take place (Bergsagel et al., 2007; Devlin, 2010; Jacobs & Alcock, 2017; Lippman, 2010a; Nair et al., 2009; Prain et al., 2014; Woolner, 2010). Additionally, there are many studies that shed light on how the physical environment is (or is not) conducive to the intended learning/teaching activities (Cardellino & Woolner, 2019; Gislason, 2009, 2010; Prain et al., 2014), however, these studies lack specific detail about how the educational goals inform the learning/teaching activities and shape the design of the physical environment.

This qualitative multi-case study investigated the relationship between the educational *goals*, the teaching and learning *activities*, and the affordances of the *physical* environment at two high schools. The results were gathered through observations, analysis of architectural plans,

review of school documents, and in-depth interviews with teachers and principals. This research focused on: (a) identifying the affordances of the physical environment and how they did or did not support learning/teaching activities intended to align with 21st century learning goals in traditional and flexible-plan physical spaces, (b) how learning/teaching activities varied between traditional and flexible-plan physical spaces, (c) how teachers adjusted from traditional physical spaces to flexible-plan physical spaces, and (d) to what extent and in what ways teachers' practice changed in flexible-plan spaces compared to when they were in traditional spaces.

Findings of this study suggest that flexible-plan spaces support student-centered learning/teaching activities since they are intentionally designed for this purpose. These activities aligned with the educational learning goals that included developing 21st century skills in students. The characteristics the flexible-plan spaces had in common were: (a) variety, (b) flexibility, (c) agility, (d) transparency, (e) comfort, and (f) technology integration. The learning/teaching activities in the flexible-plan spaces were multidimensional (many activities taking place simultaneously) and much more dynamic and fluid than in the traditional spaces. The learning/teaching activities in the traditional spaces were unidimensional (only one activity taking place at a time), and many of the learning/teaching activities were driven by the teacher. Additionally, teacher adaptation to flexible-plan spaces was really about learning to work collaboratively with other teachers since spaces are shared.

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CHAPTER 1

Introduction

The goals in K-12 education have changed over the past 100 years. The world transitioned from the industrial age where standardization and uniformity were desired, to a knowledge age where the emphasis was on accessing, understanding, and analyzing information, to the current creative age where the emphasis is on using knowledge in innovative and new ways (Pink, 2006; Sawyer, 2019; Tan et al., 2006b; Trilling & Fadel, 2009). To prepare students in the creative age, education is shifting to focus on innovation by developing skills that, in the past, were important but not a necessity for success. These skills are generally called 21st century skills (Dede, 2010a; Kay & Greenhill, 2011). The term is broadly encompassing and is typically used to describe skills that extend beyond simply learning subject-based content (Partnership for 21st Century Skills, 2009). To prepare students to be successful in life in the 21st century, schools must emphasize the development of skills, such as critical thinking, problem solving, and collaboration (Rotherham & Willingham, 2010). Students need to become "creators and empathizers, pattern recognizers, and meaning makers" (Pink, 2006, p. 1). Students not only need a depth of knowledge in disciplinary content but also need to think across disciplines to make connections between diverse and seemingly unrelated topics (Mishra et al., 2013; Sawyer, 2019). Additionally, since the world is changing at an accelerating rate, learning must become lifelong. Students today must develop learning skills that will extend well beyond K-12 and college (Thomas & Brown, 2011).

To support these new goals in education, many experts agree that a student-centered approach to learning is most effective (Kay & Greenhill, 2011; Rotherham & Willingham, 2010; Trilling & Fadel, 2009). The teacher's role in a student-centered learning environment shifts

from teacher to a facilitator. Instead of the teacher lecturing at the front of the classroom for the entire class period (teacher-centered), the teacher orchestrates and guides the learning activities (student-centered). "Student-centered learning environments provide interactive, complementary activities that enable individuals to address their unique learning interest and needs, examine content at multiple levels of complexity, and deepen understanding" (Land & Hannafin, 1996, p. 396). Because there is an emphasis on the individual in a student-centered learning environment, one typically would not expect to see students all doing the same activity at the same time. One would expect to see students doing different activities, such as building things, giving presentations, discussing an idea or topic, having a conversation with a teacher or outside expert, researching individually, or collaborating on an assignment in small groups.

Some school design architects, including myself, have begun imagining new ways to design the physical environment to better support student-centered learning activities. In the 1960s, a popular idea was to design schools with very few interior walls (open-plan) to allow for freedom of movement and flexibility in groupings (Bennett et al., 1980). In these open-plan schools, architects imagined that students would be engaged in learning activities that could fluidly change depending on the trajectory of the learning (Propst, 1972). Open-plan schools, however, had mixed reviews. Shortly after many of these schools were built, walls were put in to divide the open spaces into traditional classrooms (Dovey & Fisher, 2014). The reason was that teachers were not shifting their practice to student-centered learning, so problems with noise and distractions arose in the open spaces.

Today, some K-12 schools are being designed with a variety of flexible spaces and classrooms organized into small learning communities. These designs have a mixture of open and closed spaces for accommodating a range of activities and grouping students into various

sizes, while flexible openings and furniture allow the spaces to be easily reconfigured (Benade, 2015; Bergsagel et al., 2007; Nair, 2014; Nair et al., 2009). While there has been some research on these new designs, there is still debate about their effectiveness.

Statement of the Problem

For many in the educational world, the learning goals have shifted to include more so-called 21st century skills. To address this, researchers and policymakers have advocated for student-centered learning; however, too often we still find many activities taking place in schools that are primarily teacher-centered (Tan et al., 2006a). The issue may be that the physical environment is not conducive to student-centered learning activities. Some scholars have even theorized that the design of the physical environment suggests the type of learning that should occur in the space (Bautista & Borges, 2013; Bennett et al., 1980; Monahan, 2002). Monahan called this phenomenon *built pedagogy*. Most schools in the United States have a traditional egg-crate layout—identical sized classrooms aligned along a corridor. This design dates back to the industrial age when the goals of education were focused on uniformity and standardization, and learning was predominantly teacher-centered (Lippman, 2010b). Surprisingly, many new schools are still being designed in this way.

On the other hand, simply having a physical environment that is designed to support the goals does not necessarily mean that the intended learning activities will take place. One reason is that the design may be flawed and may not actually be conducive to the intended learning activities. Research on the open-plan schools in the 1960s revealed that noise and distractions were major problems to the design's effectiveness for student-centered learning (Costa, 2004; Higgins et al., 2005). Because some spaces were too open, noise would spread to other areas. If a group of students was engaged in discussion and another group of students was engaged in

quiet activities—both in an open area and without proper acoustical treatments—naturally, problems with noise distraction would arise.

Another reason why the intended learning activities may not happen is that teachers simply may not facilitate them. As part of a study, Cook (1973) visited 13 open-plan schools and found some instances in which, despite the intended design of the space for student-centered learning, teachers were primarily engaged in direct-instruction. Cook found that these teachers saw no benefit to open-plan spaces and desired to go back to teaching in classrooms with walls. In a recent study of a newer school design featuring openness and flexibility, Deed and Lesko (2015) found that teachers had to learn how to change their practice to align with the desired goals and the affordances of the physical environment. In the school they examined they noted "a continuous process of negotiation, evident in hybrid practice, as teachers made sense of how to respond efficiently and effectively to the affordances of open learning environments" (p. 229). These examples illustrate that physical space alone will not accomplish the educational goals. It is what happens—the teaching and learning activities—that makes the difference. However, without a physical environment that is designed to support the goals, the intended teaching and learning activities may be difficult to perform and therefore are not likely to occur.

Many architects, school administrators, and scholars believe that the physical environment can shape behavior and interactions, thereby influencing activities that take place (Bergsagel et al., 2007; Devlin, 2010; Jacobs & Alcock, 2017; Lippman, 2010a; Nair et al., 2009; Prain et al., 2014; Woolner, 2010). Additionally, there are many studies that shed light on how the physical environment is (or is not) conducive to the intended learning/teaching activities (Cardellino & Woolner, 2019; Gislason, 2009, 2010; Prain et al., 2014). However, these studies lack specific detail about how the educational goals inform the learning/teaching activities and

shape the design of the physical environment. Some of these researchers even treat the physical environment as if it were naturally occurring and neglect to understand the intended purpose of the design. Not knowing the intended purpose (the educational goals) makes it difficult to understand how it can support the learning/teaching activities. As previously mentioned, open-plan schools were specifically designed for student-centered learning. When teachers tried to do direct-instruction, issues with noise and distraction arose. More research is needed that addresses this tri-part relationship.

Purpose of the Study

This qualitative multi-case study explored the relationship between the educational *goals*, the teaching and learning *activities*, and the affordances of the *physical* environment—what I call the GAP triangle. Physical space itself is a form of technology, and it can be designed for specific goals. It provides the structure and setting for learning and teaching activities, but many complex relationships exist that cannot be isolated without losing their holistic relationship. It is necessary to understand the mechanisms of the GAP triangle in rich detail and in situ. The purpose of this study was to understand how the affordances of the physical environment and learning/teaching activities align in order to accomplish the educational goals. Additionally, previous research has shown that it can be difficult for teachers to adapt their practice to non-traditional spaces (Costa, 2004; Deed & Lesko, 2015; Gislason, 2009). I explored these relationships by examining two different schools that have both traditional and non-traditional (flexible-plan) spaces and that have similar 21st century learning goals.

To better understand the GAP triangle relationships and how teachers adapt to non-traditional spaces, this research focused on: (a) identifying the affordances of the physical environment and how they did or did not support learning/teaching activities intended to align

with 21st century learning goals in traditional and flexible-plan physical spaces, (b) how learning/teaching activities varied between traditional and flexible-plan physical spaces, (c) how teachers adjusted from traditional physical spaces to flexible-plan physical spaces, and (d) to what extent and in what ways did teachers' practices change in flexible-plan spaces compared to when they were in traditional spaces.

Research Questions

Based on the purpose and focus of this study, the research questions are:

1. a) What are the affordances of the physical environment, and how do they support (or not support) learning/teaching activities intended to align with 21st century learning goals in traditional and flexible-plan spaces? b) How do learning/teaching activities vary between traditional and flexible-plan spaces?
2. a) How do teachers adjust from traditional physical spaces to flexible-plan physical spaces? b) To what extent and in what ways has their practice changed in flexible-plan physical spaces compared to when they were in traditional physical spaces?

Significance of the Study

A challenge and opportunity for architects is creating physical spaces that are in alignment with the educational goals that may be extremely complex and that may even change over time. Additionally, teachers and administrators may find it difficult to work in new spaces that are different from what they are used to; therefore, it is important to understand the complex relationships between physical space and teaching and learning.

New schools based on traditional designs are still being built across the country today, and renovations are constantly being made to aging school facilities. If research shows that the physical environment influences teaching and learning activities and that flexible-plan schools

are more conducive to 21st century learning goals, it seems irrational to continue to spend money on buildings that have designs not conducive to student-centered learning. However, if no relationship exists, then any building and design will suffice, and money can be prioritized for other expenses that have more impact on teaching and learning. While underfunded school districts may not be able to afford new schools or significant modifications to their existing buildings, they can still have physical spaces that support 21st century learning goals. By understanding the affordances of the physical environment, some changes could be made with no to minimal cost. For instance, furniture could be rearranged in classrooms to better support the learning/teaching activities. Many ideas for this can be found by searching "classroom makeovers" on YouTube or Vimeo. Additionally, the function of spaces could be reassigned. For example, a traditional library could be repurposed as a makerspace to support project-based learning. These small changes can make a difference, and as funding becomes available, more significant changes can be made by prioritizing parts of the school building that have the most impact on the 21st century learning goals.

Previous research has used case study as a way to understand the relationship between physical space and learning/teaching. This study extends previous research by looking at new cases that have not been studied before, but also by looking at them in a new way—through the lens of the GAP triangle. In this regard, this study adds to a body of knowledge in a domain that has limited but growing research.

CHAPTER 2

Literature Review

This study explored the relationship between the educational goals, the teaching and learning activities, and the affordances of the physical environment—the GAP triangle. To better understand the GAP triangle relationships and how teachers adapt to non-traditional spaces, this research focused on: (a) identifying the affordances of the physical environment and how they did or did not support learning/teaching activities intended to align with 21st century learning goals in traditional and flexible-plan physical spaces, (b) how learning/teaching activities varied between traditional and flexible-plan physical spaces, (c) how teachers adjusted from traditional physical spaces to flexible-plan physical spaces, and (d) to what extent and in what ways did teachers' practices change in flexible-plan spaces compared to when they were in traditional spaces.

In this chapter a review of the literature relevant to each of the components of the GAP triangle is presented. The section begins with the educational goal that many schools today have embraced—21st century learning. Since developing 21st century skills is an important educational goal, an exploration of those skills is presented, along with various frameworks for organizing the skills. Next, information is presented on learning/teaching activities—described as strategies—that scholars and experts have identified as being effective for developing 21st century skills. The student-centered learning strategies include personalized learning, problem-based and project-based learning, collaborative and cooperative learning, interdisciplinary learning, and teacher collaboration.

In the last section of the literature review, information is presented on the physical design of schools. This section begins with a brief history of how the organization of space in schools

has evolved, based on the educational goals. Next, the current designs—what I call flexible-plan spaces—that architects and educators have imagined for supporting student-centered learning in the 21st century are presented. Additionally, since many of these new schools are organized around teacher teams working together in a community, information pertaining to small learning communities (SLCs) is also presented. The chapter concludes with a review of the literature that addresses the relationship between physical space and learning. This includes studies related to building quality design features and open-plan schools.

Educational Goals in the 21st Century

The educational goals that many schools are focused on today are centered on students developing 21st century skills. The impetus for students to learn 21st century skills is driven by a rapidly changing world and advancements in technology (Dede, 2010a; Pink, 2006; Sawyer, 2019). Since developing 21st century skills is an important educational goal in schools, it is necessary to have clarity about what 21st century skills are and why they are essential. The difficulty with this, however, is there is not a common definition for what 21st century skills are (Suto, 2013), and many school organizations have used the term so ubiquitously that any meaning is almost lost. At the very basic level, 21st century skills could simply be considered the skills needed for working and participating in current society. So, in order to better define these skills, an understanding of how the 21st century is different from the 20th century is needed.

The world has become more connected and "flat" (Friedman, 2006, p. 5) due to new information and communication technologies that have changed how people live, work, and learn. People now have access to an abundance of information through the Internet and can easily connect with others throughout the world. This has made it possible for individuals to participate in a world economy, which has created new job opportunities; individuals can find

other people with similar interests to combine their knowledge and skills to create new ideas or products. On the other hand, it has leveled the playing field, making some jobs that were once abundant extremely competitive. Jobs that were once considered secure because of a limited talent pool have become fair game for people from impoverished areas of the world who now have access to the requisite education and training and are willing to work for less money (Friedman, 2006).

Advances in machine learning and artificial intelligence have also contributed to a rapidly changing world. Schwab (2016) defined this current era of technological advancement as the fourth industrial revolution. In this era, automation has become less expensive, and new technologies in robotics and 3D printing have made opportunities possible to go from mass production to mass customization, where customized products are created by machines and therefore are more cost effective. Knowledge-based jobs, such as bookkeeping, research, data entry, and customer service, are being replaced by computers having artificial intelligence, and it is not hard to imagine self-driving vehicles soon replacing long-haul trucking and peer-to-peer ridesharing. Computers and machines continue to take over routine tasks that were once held by people; therefore, there is no longer a need for schools to emphasize the subject-based memorization of facts in the 21st century. Dede (2010b) stated:

> 21st century education should prepare students for a world in which almost all types of routine cognitive tasks are done by computers and in which expert thinking and complex communications are the core intellectual capabilities by which people attain prosperity and economic security individually, as a region, and as a nation. These higher order performances are based on fundamental knowledge about how to do simpler types of work, so the shift needed is not to remove the learning of routine cognitive skills (such as

> basic arithmetic operations) from the curriculum. Rather, the fundamental change involves deemphasizing fluency in simple procedures as an end-goal of preparation for work and life (e.g., counting bills as a bank teller), instead using these routine skills as a substrate for mastering complex mental performances valued in the future workplace, such as advising clients about global investment strategies tailored to their individual situations. (p. 4)

These technological advancements are disrupting the job market. While many traditional jobs are being replaced by automation, new jobs are being created in emerging markets. The World Economic Forum (2020) identified seven professional clusters for future jobs including: (a) data and AI; (b) care economy; (c) green economy; (d) engineering and cloud computing; (e) people and culture; (f) product development; and (g) sales, marketing, and content. Students today will need to develop skills for jobs that do not even exist yet in these emerging markets. Furthermore, students will need to be flexible and adaptable with their skills since predictions indicate they may hold multiple jobs in different industries throughout their career (Dede, 2010b; Sawyer, 2019; Thomas & Brown, 2011).

21st century skills. Many people have weighed in on the discussion about what is important to learn in order to be successful in the 21st century. However, the evidence that indicates actual adult outcomes related to developing 21st century skills is limited and primarily correlational (National Research Council, 2012). Despite the limited causal evidence, many scholars, organizations, and business leaders have identified the skills that they believe are important for success in the 21st century. For instance, after conversations with hundreds of leaders in business and education, Wagner (2008) identified seven highly desired skills that are recommended for students to master in order to thrive in the 21st century workplace: (a) critical

thinking and problem solving, (b) collaboration and leadership, (c) agility and adaptability, (d) initiative and entrepreneurialism, (e) effective oral and written communication, (f) accessing and analyzing information, and (g) curiosity and imagination. The skills Wagner identified are very similar to skills identified in a survey of over 400 hiring executives conducted by the Conference Board, Corporate Voices for Working Families, the Partnership for 21st Century Skills, and the Society for Human Resource Management. The report identified five "applied skills in the 21st century workplace" that employer respondents identified as "very important" (Casner-Lotto & Barrington, 2006, p. 17). Those skills included: (a) professionalism/work ethic, (b) oral and written communications, (c) teamwork/collaboration, (d) critical thinking/problem solving, and (e) ethics/social responsibility.

One could argue that these skills were also important in the 20th century. Dede (2010a) addressed this point and called them "perennial" skills because they were important in the 20th century and are still important today. Others have also made this distinction (Kereluik et al., 2013; Lueders-Salmon, 1972; National Research Council, 2012; Rotherham & Willingham, 2010). For instance, the National Research Council stated that these skills are:

> important dimensions of human competence that have been valuable for many centuries, rather than skills that are suddenly new, unique and valuable today. The important difference across time may lie in society's desire that all students attain levels of mastery—across multiple areas of skill and knowledge—that were previously unnecessary for individual success in education and the workplace. (p. 15)

Dede (2010a) also added that today the value of these skills is more significant and therefore are highly desired by employers. Using collaboration as an example to illustrate this point, Dede stated that advances in technology and overall knowledge have increased the

complexity of the work that companies and organizations do; therefore, teams are needed comprised of people having different and complementary skillsets working in cooperation. Sawyer (2006) advanced this point by stating, "The most pressing problems that face our world are large in scale and complex in nature, far out of the realm of any one person to resolve—poverty, pollution, hunger, disease, armed conflict" (p. 42). Solving these complex and grand problems requires creativity and innovation that, according to Sawyer, are fueled by collaboration. Sawyer stated, "In the last 20 years, scholars of innovation have discovered that innovation is rarely a solitary individual creation. Instead, creativity is deeply social; the most important creative insights typically emerge from collaborative teams and creative circles" (p. 42).

Additionally, how people are collaborating is different today. In the 20th century, collaboration was typically face-to-face and done in a conference room. Dede (2010a) described collaboration today as being more nuanced than in the past:

> 21st century workers increasingly accomplish tasks through mediated interactions with peers halfway across the world whom they may never meet face-to-face. Thus, even though perennial in nature, collaboration is worthy of inclusion as a 21st century skill because the importance of cooperative interpersonal capabilities is higher and the skills involved are more sophisticated than in the prior industrial era. (p. 2)

As a practicing architect, I have experienced collaboration in this way. The digital tools used to draw a building are much more sophisticated today, and they both enable and require collaboration to occur. Building information modeling (BIM) software that stores the working architectural model online is used. Multiple team members can work simultaneously in this model serving as a digital workspace to collaborate. As an update is made in the model by one

team member, other team members—who may even be halfway around the world—can immediately see the changes. This allows for instant coordination between the architects and the various engineering disciplines (e.g., structural, mechanical, electrical, plumbing, civil, etc.). Each team member works in a coordinated effort contributing to the same model that resides in the cloud; therefore, communication becomes essential to avoid conflicts. Since changes in the model are real-time, everyone needs to be moving in the same direction. Communication also takes on various forms. It might include emails, instant messages on platforms such as Slack, phone calls, video conferences, adding revision bubbles and notes inside the model, and occasionally, a face-to-face meeting in a conference room.

Frameworks for 21st century skills. Since there has been much discussion about what constitutes a 21st century skill, organizations and experts have identified frameworks for classifying 21st century skills. Dede (2010a) compared frameworks from the Partnership for 21st Century Skills (P21), the North Central Regional Education Laboratory (NCREL), the Metiri Group, the Organisation for Economic Co-operation and Development (OECD), and the National Leadership Council for Liberal Education and America's Promise (LEAP). Dede found consistency between the frameworks and identified the P21 framework as being the most detailed and widely used. In reviewing other frameworks, Dede compared and contrasted them to the P21 framework.

Since the P21 framework is often cited and used by schools, it is worth describing in some detail. The framework is organized into four main areas including: (a) key subjects and 21st century themes; (b) learning and innovation skills; (c) information, media and technology skills; and (d) life and career skills.

The first part of the framework, *key subjects and 21st century themes,* emphasizes skill mastery and a deeper level of understanding by using interdisciplinary 21st century themes applied to the subject areas that are traditionally taught in schools (e.g., math, science, English, and social studies). The 21st century themes are: global awareness; financial, economic, business, and entrepreneurial literacy; civic literacy; health literacy; and environmental literacy (Partnership for 21st Century Learning, 2015).

The second part, *learning and innovation skills,* includes the 4Cs that are commonly stated as 21st century skills including: critical thinking, communication, collaboration, and creativity. These skills are not new but are especially relevant in the 21st century where the world is hyper-connected, and the problems faced are becoming more complex and "wicked" (Rittel & Webber, 1973, p. 160). Critical thinking is the ability to analyze information objectively to make an informed and rational decision. Critical thinking is also paired with problem solving and involves examining information from multiple perspectives to determine the best solution. Communication is defined as articulating thoughts and ideas to others effectively by various means (e.g., oral, written, and nonverbal). Communication also involves listening in order to decipher meaning and then responding appropriately. Collaboration is defined as effectively working with others to achieve a specific goal and includes being flexible in one's thinking and being open to new ideas and approaches. Lastly, creativity is paired with innovation and is defined as being able to create new ideas through a variety of techniques. Creativity involves thinking about things in different and novel ways in order to contribute a new perspective (Partnership for 21st Century Learning, 2015).

The third part of the P21 framework, *information, media*, *and technology skills,* addresses digital literacies and the use of technology. The literacies include having both functional and

critical thinking skills related to information, communication, and technology (ICT). Information literacy involves accessing and evaluating information. Information literacy also involves appropriately using information and managing information from multiple sources. Media literacy involves analyzing media for credibility, understanding, and knowing how messages can be interpreted in different ways. Media literacy also involves using tools for the creation of media and understanding how a diverse audience may interpret the message. Lastly, ICT literacy refers to the use of technology as a tool for gathering, managing, and communicating information. All three literacies also identify the importance of knowing about and considering ethical and legal issues regarding access and use (Partnership for 21st Century Learning, 2015).

The fourth and last part of the framework, *life and career skills,* is related to skills for daily life and the workplace. Life and career skills include: (a) flexibility and adaptability, (b) initiative and self-direction, (c) social and cross-cultural skills, (d) productivity and accountability, and (e) leadership and responsibility. Flexibility and adaptability are defined as the ability to adapt to change, whether it is in career or life, and being flexible to differing perspectives, views, and beliefs. Initiative and self-direction are defined as managing goals and time, being able to work without supervision, and being a self-directed learner. Social and cross-cultural skills involve knowing how to interact with others, respecting differences, and being able to work effectively on a diverse team. Productivity and accountability involve being able to manage projects and produce results in a timely and efficient manner and being accountable for the results. Leadership and responsibility involve guiding others towards a common goal and being responsible to the interests of the community (Partnership for 21st Century Learning, 2015).

Dede (2010a) concluded that the various frameworks for 21st century skills are complementary and stated that "groups developing conceptualizations of 21st century skills have built sufficiently on each other's ideas to avoid a 'Tower of Babel' situation" (p. 14). Kereluik, Mishra, Fahnoe, and Terry (2013) also compared frameworks but found there to be too much diversity, so they created a "framework of frameworks" in an effort to see the "big picture" (p. 133). They analyzed 15 frameworks, including the P21 framework, and synthesized their findings into three major categories: foundational knowledge, meta knowledge, and humanistic knowledge, with each having three subcategories (Table 1). They stated that "each of these major categories can be seen as what we need to know, how we act on that knowledge, and the values we bring to our knowledge and action" (p. 131). The major categories effectively describe and group the subcategories in a novel way, but the subcategories are similar to the skills identified in the P21 framework; therefore, Dede's assertion that the various frameworks are complementary makes sense.

Table 1.

Framework of 21st Century Learning Frameworks.

Major Category	**Subcategory**
Foundational Knowledge	• Core Content Knowledge • Digital & Information Literacy • Cross-Disciplinary Knowledge
Meta Knowledge	• Problem Solving & Critical Thinking • Communication & Collaboration • Creativity & Innovation
Humanistic Knowledge	• Life Skills, Job Skills, & Leadership • Cultural Competence • Ethical & Emotional Awareness

Adapted from Kereluik, K., Mishra, P., Fahnoe, C., & Terry, L. (2013). What knowledge is of most worth. *Journal of Digital Learning in Teacher Education*, *29*(4), 127–140.

21st Century Learning/Teaching Activities

To develop 21st century skills, students need to be engaging in school activities intentionally designed for this purpose. Many scholars agree that using only a teacher-centered approach is not adequate for developing 21st century skills, and instead, student-centered instructional strategies need to be embraced (Bell, 2010; English & Kitsantas, 2013; Rotherham & Willingham, 2010; Savery, 2006). Student-centered learning is a broad and often overused term to describe educational practices that center around the student as an active participant in their learning. It is rooted in *constructivism*—an epistemology about learning that means understanding comes from within the learner. The learner constructs meaning based on previous knowledge and experiences (Bodner, 1986). Kain (2003) explained:

> In teacher-centered approaches, judgments about appropriate areas and methods of inquiry, legitimacy of information, and what constitutes knowledge rest with the teacher. By contrast, student-centered approaches derive from constructivist views of education, in which the construction of knowledge is shared and learning is achieved through students' engagement with activities in which they are invested. (p. 104)

Scholars have recommended various student-centered strategies that emphasize learning both content and developing 21st century skills. Each strategy can be achieved through various learning/teaching activities. Some of the more popular strategies that will be explored further are: (a) problem-based and project-based learning, (b) collaborative and cooperative learning, (c) interdisciplinary learning, (d) personalized and individualized learning, and (e) teacher collaboration. There are other student-centered learning strategies such as inquiry-based learning (Lazonder & Harmsen, 2016), phenomenon-based learning (Symeonidis & Schwarz, 2016), experiential learning (Wurdinger, 2005), and active learning (Auster & Wylie, 2006). However,

these learning strategies share resemblances to those previously mentioned and therefore have a similar range of learning/teaching activities.

Regardless of which student-centered learning strategy is used, the learning/teaching activities taking place in a school are much more dynamic and fluid than a teacher-centered approach. Instead of students passively listening to the teacher lecture, students are active and engaged (Lea et al., 2003), and "student-centered learning environments provide interactive, complementary activities that enable individuals to address their unique learning interests and needs, examine content at multiple levels of complexity, and deepen understanding" (Land & Hannafin, 1996, p. 396). With student-centered learning, students are moving fluidly between a range of activities and may not all be engaged in the same activity at the same time. The learning environment has organization and structure which can be described through concepts of dimensionality. Dimensionality can be unidimensional or multidimensional, with the latter being compatible with student-centered learning. These concepts relate to classroom characteristics such as grouping patterns and task structure. In unidimensional classrooms, students are typically working on the same activities, whereas in multidimensional classrooms students are working on a range of different activities and may even be working at different paces (Schunk, 2011).

Personalized learning. Every student has different characteristics, interests, and learning needs; therefore, personalized learning is an instructional strategy where learning is unique for each student. The teacher functions as a facilitator and guides each student along an individual learning path, and each student may be at different paces with their learning (Rand Corporation, 2017). "With personalized learning, individuals approach problems in their own way, grasp ideas at their own pace, and respond differently to multiple forms of feedback"

(Scott, 2015, p. 4). With personalized learning, there is an emphasis on mastery. Before students move to the next level with their learning, they must demonstrate competency. Since personalized learning is tailored to the student's learning needs and interests, increased learning and engagement are reasonable outcomes (Twyman, 2014). This approach to learning may also involve collaborative learning as students work together on a particular project or goal. Learning in this manner can still be personalized as students work on aspects of the project that address their interests, skills, and learning needs (Scott, 2015).

With personalized learning one may expect to see students working on different tasks, therefore each student may be learning in different spaces. Students may look to find a setting where they can learn or perform best. That might be a quiet nook if they want to read or study, or it could be a workspace with resources if they are working on a project. Students may also be working collaboratively on a project in a group.

Problem-based and project-based learning. Both problem-based and project-based learning have been widely adopted by schools as effective instructional strategies across multiple disciplines for students to learn 21st century skills. Sometimes the terms are used interchangeably, but they are two distinct yet complementary strategies (English & Kitsantas, 2013). Both strategies are student-centered because the learning activities are centered around and initiated by the student. The teacher serves as a facilitator for the learning and will guide the student as necessary.

Problem-based learning goes beyond solving well-defined problems found in textbooks, such as word-problems traditionally found in mathematics textbooks. Barell (2010) stated that problem-based learning "encompasses a rethinking of the entire curriculum so that teachers design whole units around complex, 'ill-structured' problematic scenarios that embody the major

concepts to be mastered and understood" (p. 178). An ill-structured problem does not have a finite and simple answer. One example would be the impact the media has on a presidential election. Addressing these types of problems requires students to question, find answers, evaluate options, and draw conclusions. This type of learning requires the student to be self-directed and self-regulated. The teacher facilitates learning by providing guidance and feedback (Savery, 2006).

Project-based learning starts with a complex question that students solve through creating a product or performance. Sometimes the work is completed independently, but usually students work on projects in teams, much like adults do in the workplace. A project is usually sustained for a period of time and is meaningful and relevant to the student, which results in a deeper understanding of the topic or theme (Bell, 2010). Project-based learning is similar to problem-based learning in that both engage students in an iterative process of questioning, investigating, interpreting, and applying what they have learned. Both strategies foster the development of 21st century skills, such as problem-solving, critical thinking, collaboration, communication, creativity, and lifelong learning (Bell, 2010; English & Kitsantas, 2013).

With problem-based and project-based learning one might expect to see a wide-range of activities taking place within a school. One might observe a class discussion about a question or problem rather than the teacher simply presenting facts. Also, one might observe students working individually and in groups as they are researching, analyzing, planning, and debating. An observer might see the teacher moving around the space working with individuals or small groups; students might be gathering materials and supplies and building products either individually or in teams; and, students might be giving presentations or performances. Because the learning is student-centered, each student may be working on something different and may be

at different points along the path. An outside observer might see the learning/teaching activities as being chaotic.

Collaborative and cooperative learning. Being able to work in a team is an essential skill in the modern workplace (Wagner, 2008). Schools have embraced collaborative and cooperative learning so that students develop the interpersonal skills for working together towards a coordinated goal. Often the terms collaborative and cooperative are used interchangeably, but there is a distinction. Panitz (1999) stated that cooperation is about having a structure or method for interacting with others in order to accomplish an end goal, and the process is usually facilitated by the teacher. In contrast, collaboration is fundamentally more student-centered because it is a "philosophy of interaction" (p. 3) where group members have a shared responsibility for working together to build consensus. Based on Panitz's definition of cooperative learning, Laal and Laal (2012) provided an illustrative example of a cooperative learning activity:

> In the cooperative model the teacher maintains complete control of the class, even though the students work in groups to accomplish a goal of a course. The teacher asks a question and provides additional articles for the students to read and analyze, beyond the text, then asks the students to work in groups to answer the question. The groups then present their results to the whole class and discuss their reasoning. The students do the work necessary to consider the material being covered but the teacher maintains control of the process at each stage. (p. 494)

Panitz (1999) further defined collaborative learning as being more than an instructional strategy and described it as a way that groups work together to achieve a goal. To be effective with accomplishing a task or goal, members must work cooperatively. They must communicate

with and respect others' perspectives, and they must learn to negotiate and leverage each other's strengths to build consensus for the best solution or path forward. Laal and Laal (2012) provided an illustrative example of a collaborative learning activity:

> In the collaborative model groups would assume almost total responsibility for answering the question. The students determine if they had enough information to answer the question. If not they identify other sources, such as journals, books, videos, the internet, to name a few. The work of obtaining the extra source material would be distributed among the group members by the group members. The group would decide how many reasons they could identify. The collaborative teacher would not specify a number, but would assess the progress of each group and provide suggestions about each group's approach and the data generated. The teacher would be available for consultations and would facilitate the process by asking for frequent progress reports from the groups, facilitate group discussions about group dynamics, help with conflict resolution, etc. The students develop a very strong ownership for the process and respond very positively to the fact that they are given almost complete responsibility to deal with the problem posed to them and they have significant input into their assessment. (p. 494)

Cooperative and collaborative learning provide opportunities for students to develop and hone collaboration skills while also learning about the subject matter. Cooperative and collaborative learning are frequently used with problem-based and project-based learning (Bell, 2010; Savery, 2006).

Interdisciplinary learning. Interdisciplinary learning brings together knowledge from two or more different disciplines. Students learn to make connections across disciplines by focusing on themes, phenomena, or problems in the world. Most domains of real-world

knowledge application are ill-structured and therefore cut across disciplines or subjects (Spiro et al., 1992). Nelson (1974) notably stated, "Everything is deeply *intertwingled*. In an important sense there are no 'subjects' at all; there is only all knowledge, since the cross-connections among the myriad topics of this world simply cannot be divided up neatly" (p. 45).

Learning across disciplines or subjects leads to deeper learning—the process of applying knowledge to new situations—because the emphasis is on a holistic understanding and the application of knowledge (National Research Council, 2012). In this sense, students are learning adaptive knowledge in an ill-structured domain. Drawing from cognitive flexibility theory, Spiro et al. (1992) stressed the importance of "multiple juxtapositions of instructional content" for learning in ill-structured domains (p. 65). What is being learned must be looked at from different perspectives and in different contexts. With interdisciplinary learning, students "are more likely to acquire integrated perspectives and solution-focused strategies, rather than content-specific knowledge derived from a single discipline" (Ivanitskaya et al., 2002, p. 108). Shoemaker (as cited in Gardner et al., 2003) described interdisciplinary learning as being integrated and:

> organized in such a way that it cuts across subject-matter lines, bringing together various aspects of the curriculum into meaningful association to focus upon broad areas of study. It views learning and teaching in a holistic way and reflects the real world, which is interactive. (p. 5)

Interdisciplinary learning can be implemented in different ways. It may involve creating a thematic unit in a class that draws on different disciplines (Gardner et al., 2003), or it may involve integrating disciplines into completely new classes or programs (Gero & Zach, 2014). In this latter version, teachers with different content specialties may work in collaboration (team teach) to deliver the curriculum (Jones, 2010).

Teacher collaboration. Teachers are typically isolated from one another. They teach to students in their own classroom (Lortie, 1975). While they may plan with other teachers or meet with their professional learning community (PLC) group on a weekly or a monthly basis (DuFour & Eaker, 1998; Hord & Sommers, 2008), classroom teachers typically do not teach alongside other teachers. The basic premise of teacher collaboration is that when teachers are working together and sharing information, they can achieve things more effectively than doing them alone. Additionally, teachers can learn from each other, which makes them better teachers. In this manner, they are leveraging the social capital of the team rather than just their own human capital (Leana, 2011).

Each teacher constructs their own private meanings about teaching and learning, and they each accumulate knowledge and expertise about their individual role within a school. However, if teachers keep their private meanings to themselves, then the school—which is an organization—does not learn. When teachers share their private meanings with each other, their knowledge becomes accessible to the organization, and collective meanings are formed. Dixon (1999) used the analogy of the private office, the hallway, and the storeroom to describe this process. The private office (or classroom) is where private meanings are formed. Hallways are where people physically interact with each other—therefore, they can share their thoughts and ideas for others to challenge and critique. Meanings that the organization share in common are saved in the storerooms and become norms, strategies, and assumptions, or, "the glue that holds organizational members together and allows them to act in concert with each other" (Dixon, 1999, p. 49).

Ronfeldt et al. (2015) conducted a study involving 336 schools and over 9,000 teachers to understand how different forms of collaboration improve teacher performance and student

achievement. The researchers found that at schools with higher levels of collaboration, students performed better in math and reading, and the teachers' practices improved. They investigated two possible mechanisms for understanding how collaboration influences student achievement. The first is the *individualistic* mechanism, which means that teachers who actively engage in collaboration learn from their peers and therefore improve their individual performance as teachers. The second is the *collectivist* mechanism. In this explanation, a school develops a highly collaborative environment where collaboration becomes a norm. Students may achieve gains because they develop learning skills from all teachers who are highly collaborative and not necessarily from a single teacher who has improved their individual practice.

Physical Design of Schools

In the section, the physical design of K-12 schools is reviewed starting with a brief history of how they have evolved. Next, the literature on new school designs for student-centered learning is covered. This relates to the two cases in this study since they both feature new designs. The literature on small learning communities (SLCs) is also covered. An SLC is an organizing structure for a school which can include its physical design but also addresses how students and teachers are grouped, roles and responsibilities, and culture. Lastly, literature pertaining to the relationship between physical space and learning is reviewed.

Brief history of school design. The concept of school has existed since ancient times. Most children in that era did not attend formal schooling but learned from their parents, elders in their community, or peers. Those who were privileged attended school but primarily learned to read, write, and count (Carr, 2014). In the United States, education evolved over three general periods: the agrarian colonial period (1650-1849), the Industrial Revolution (1850-1949), and the information age (1950-present;(Tanner & Lackney, 2006). School first manifested during the

agrarian colonial period as the one-room schoolhouse. One teacher supervised a small multi-aged group of students. Learning was self-paced and focused on the memorization of facts. Around this time, Lancasterian schools emerged in urban areas as an attempt to educate the poor and larger populations of students (Tanner & Lackney, 2006). Formal learning in the agrarian colonial period focused primarily on learning things that related to homelife or typical day-to-day activities of that time. Schools were designed like churches; the teacher was placed at the front of the room in full view of students who sat at desks aligned in rows and bolted to the floor (Lippman, 2010b).

The Industrial Revolution (1850-1949) marked a shift in education with school designs based on a factory model. "Factories created to produce things led to factories to produce learning" (Tanner & Lackney, 2006, p. 6). Administrators during this time viewed themselves as business executives, adopted business values, and ran their schools like business organizations (Callahan, 1962). In this model, the teacher was in control of the learning, and knowledge was transmitted to the students (Bautista & Borges, 2013). Nair (2014) called these schools "cells and bells," noting that "students occupy cells called classrooms until the bell rings, and then they move on to another cell" (p. 2). Nair stated that this model of school was best for teacher-centered instruction where teachers disseminated information to students. "Like widgets on conveyor belts being ferried past factory workers to be prepared for sale, students in the original modern school were prepared in different subject areas by different teachers in different rooms, which were connected by long corridors" (Nair, 2014, p. 8).

Many K-12 schools today still feature traditional physical designs having identically-sized classrooms aligned along corridors—the egg-crate layout. This design is based on the factory model that is over a century old (Nair, 2014). In this model, the teacher is in control of

the learning (teacher-centered), and knowledge is transmitted to the students (Bautista & Borges, 2013). While this design may have worked well in an industrial era when the purpose of school was primarily for preparing students for a manufacturing-based economy, this design is no longer relevant today (Nair, 2014; Sawyer, 2006; Tanner & Lackney, 2006). Traditional plan schools are unidimensional, students are typically working on the same activity simultaneously.

The information age (1950-present) marked another shift in educational ideals but had a limited impact on the physical design of school. Tanner and Lackney (2006) stated that this era, which is still unfolding today, marks a new cultural paradigm and "requires a global economy with unpredictable, accelerated, differentiated, diverse, and miniaturized markets based on industries such as electronics, molecular biology, space sciences, computer science, and telecommunications" (p. 11). Additionally, "corporations are more fluid; transnational; team-oriented; downsized and flatter; customer-, quality-, and service-oriented; knowledge-driven; and entrepreneurial" (Tanner & Lackney, 2006, p. 11). Learning changed to focus more on the student as an active participant; however:

> while teachers' and students' desks and chairs were unbolted from the floor and science laboratories were designed so that students could conduct their own experiments, students' furniture continued to be arranged in rows facing the teacher at the head of the room. (Lippman, 2010b, p. 81)

The point that Lippman made was that while things changed within the classroom, the notion of a classroom itself did not change. Teachers still taught in isolated rooms that were organized by subject or age.

In response to the cultural and technological changes of the early part of the information age, open-plan schools emerged in the 1960s and 1970s. These schools were designed to

facilitate a student-centered approach to teaching and learning (Bennett et al., 1980), but some considered this design to be a failure (P. Bennett, 2012; Hammer, 2012; Mcdonald, 1997). The new design did not cause learning to change. Teachers continued to teach students through direct instruction; therefore, problems with noise and distractions arose due to the wide-open spaces. Shortly after the construction of many of these schools, walls were built to isolate classrooms from one another, essentially reverting the design back to the cells-and-bells industrial model of the previous era.

New school designs for student-centered learning. Today, architects and educators are imagining and building schools designed for student-centered learning that feature flexibility and a variety of spaces (Benade, 2015; Bergsagel et al., 2007; Lippman, 2010b; Nair, 2014; Nair et al., 2009; Tanner & Lackney, 2006). These new plans are designed to facilitate a wide range of activities that are congruent with constructivist learning theories, but because they have flexible and varied spaces, teacher-centric activities, such as direct-instruction, can still take place.

Some argue that these new designs are simply the open-plan designs that emerged in the 1960s and 1970s that are now seeing a resurgence in popularity (Shield et al., 2010). In an article in the Canadian newspaper *Globe and Mail*, Hammer (2012) stated that "a handful of architecture firms are dusting off old ideas [open-plan designs] and re-inventing them for a generation of students destined for an Internet-saturated workplace" (para. 5). Despite having some similarities, there are differences between the open plans from the 1960s and 1970s and the newer designs today that need to be recognized. Many of the open plans were too open, whereas the designs today feature a variety of open and closed spaces and zones for different activities (Benade, 2015; Bergsagel et al., 2007; Nair, 2014; Nair et al., 2009). The new designs are multidimensional—designed to facilitate a diverse range of activities that could happen

sequentially or simultaneously—which may include both student-centered and teacher-centered learning learning/teaching activities. This is an important distinction. Traditional school designs—having egg crate layouts—were intentionally designed for teacher-centered learning. Open-plan school designs were intentionally designed for student-centered learning. The flexible-plan school designs of today are designed to be flexible and accommodating to both teacher-centered and student-centered learning.

Deed and Lesko (2015) offered another distinction: "while previous attempts at openness were a reaction against power, alienation and authoritarian control, current versions appear to be more generative than revolutionary" (p. 218). Additionally, technology has triggered an openness to architecture and education through "loosening the constraints of time and space" (Deed & Lesko, 2015, p. 218). The newer designs are flexible, variegated, and adaptable to allow for multiple activities. Benade (2015) described them as:

> new technology-rich flexible learning spaces, characterized by large open spaces, permeable boundaries and diverse furnishings emphasizing student comfort health and flexibility. Open design encourages flexibility in learning and teaching (citing Chapman, Randell-Moon, Campbell & Drew, 2014), and allows collaborative, team teaching. (p. 10)

Complicating the distinction of the new designs is the terminology used to describe them is inconsistent. Some still call them open-plan designs (Gislason, 2009), or open-school architecture (Alterator & Deed, 2013; Deed & Lesko, 2015). Some are now calling them "next generation learning spaces" (NGLS; (Fraser, 2014). However, the term NGLS can be applied to just an individual classroom. The New Zealand Ministry of Education started calling them "modern learning environments" (MLEs) and then changed the term to "innovative learning

"environments" (ILEs; (Benade, 2015). Benade used the term "flexible learning environments," which are "characterised by large open spaces, permeable boundaries and diverse furnishings emphasizing student comfort health and flexibility" (p. 10).

I prefer Benade's (2015) term because it includes the word flexible, which succinctly captures the intended function of these new designs. Not to complicate the distinction of these new designs further, I introduce a new term, *flexible-plan spaces,* for the purpose of this dissertation. I use this term because it specifically addresses the design of physical space. Adding *plan* to flexible implies that the physical plan or design is what is flexible. It also relates to open plan but gives a distinction to these new designs. I also use the term *space* instead of environment to clarify that I am talking about the tangible (physical) elements of the environment.

Small learning communities (SLCs). Some who apply the concept of flexibility to a grouping of classroom spaces in order to support student-centered learning and teacher collaboration have used the term small learning communities (SLCs; (Bergsagel et al., 2007; Nair et al., 2009), or simply learning communities (Lippman, 2010b; Nair, 2014). The concept of an SLC, however, includes more than just the organization of physical space. Among other things it includes norms for how students and teachers are grouped together (Levine, 2010), it defines teacher roles and responsibilities (Sammon, 2008), and it addresses changing school culture (Oxley, 2001). A traditional plan school could embrace the concepts of an SLC without making changes to the physical design. For this study, expanding on the concept of an SLC is worthwhile as SLCs describe how people are organized in a school, and the two cases in this study use this concept for grouping teachers and students.

An SLC is a smaller unit in a larger school that is considered a home base by a group of students and teachers (Sammon, 2008). They can be arranged around many different organizational types, such as academies, house plans, career pathways/clusters, mini-schools, or magnet programs (Blanchard & Harms, 2006). Research indicates there may be many benefits of a well-run SLC including increased student achievement, improved teacher attitudes, and improved teacher satisfaction (Cotton, 2001). Many of these benefits stem from the main purpose of reducing a larger school down to smaller units, which is personalization; students and teachers are better able to develop sustained and meaningful relationships (Darling-Hammond, 2002).

Much of the literature about SLCs addresses only the way they are organized and structured but neglect to describe their physical design. Additionally, much of the focus in the literature stems from the issue of size. Simply being small, however, does not guarantee the success of an SLC (Cotton, 2001). Nair (2014) suggested the most important condition is community and described an effective SLC as having a variety of learning spaces organized around a commons space instead of a central corridor. All spaces in the SLC can be used for learning and provide opportunities for a range of learning activities and groupings. Varied spaces can foster both formal and informal interactions (Bergsagel et al., 2007). Having a range of spaces allows teachers to leverage the ideal space for whatever learning activity they are doing at a particular moment. For instance, two teachers team teaching could start a lesson in a classroom space but could break-out individuals or groups to adjacent common spaces depending on the particular task and the students' needs. These common spaces feature a variety of hard and soft furnishings, which closely resembles a community gathering space like a coffee house.

Relationship Between Physical Space and Learning

There are relatively few studies related to the effect physical space has on learning, but the research base is continuing to grow. Additionally, school design is complex. As with any type of architecture, there are an infinite number of ways to design a school, and the nuances of design could vary considerably; therefore, it is extremely context sensitive. Physical space—a component of the school environment—has many aspects and interacting variables; therefore, studies range in types. Through reviewing the literature, three general types of studies that relate to the effect physical space has on learning were found: building quality, design features, and non-traditional school designs. This latter group includes open-plan and flexible-plan school designs.

Building quality. Building quality relates to aspects of a school building, such as its condition, age, thermal comfort, and lighting that contribute to its physical quality. Durán-Narucki (2008) conducted a study of 95 elementary schools in New York City and found that students attending school buildings in disrepair attended school less and had lower grades on standardized tests. While this study is insightful, the reason building condition affects attendance is still not understood. There could be other variables at play. The researcher acknowledged this as best as possible by controlling for confounding variables related to socioeconomic status and ethnicity. Additionally, this study looked only at building condition (state of repair or disrepair) and excluded other aspects that contribute to building quality such as aesthetics and comfort.

Uline and Tschannen-Moran (2008) examined building quality more broadly by measuring teachers' perceptions of building condition, attractiveness, and space adequacy. School climate was used as the mediating variable with building quality and was measured

through a survey. State standardized test scores were used to represent student achievement. They also acknowledged confounding variables and controlled for socioeconomic status. Uline and Tschannen-Moran stated that even though there is a growing body of research pertaining to building quality and student achievement, little is known about the mechanisms of the relationship. Using school climate as a mediating variable allowed the researchers to understand how the relationship works. The study, however, did not examine the aspects of building quality, especially since they used teachers' perceptions for their measure. Both the Durán-Narucki (2008) and Uline and Tschannen-Moran (2008) studies are limited because they focused only on specific conditions related to building quality and did not acknowledge any characteristics of the school design.

Design features. Design features are characteristics that relate to a school's overall design, such as types and sizes of spaces, connections, and interior and exterior transparency. Tanner (2000) identified 39 design patterns (features) based on school design theory. Tanner observed 14 schools and ranked their patterns, and found that four patterns—pathways, outdoor space, technology for teachers, and overall impression—were statistically significant predictors of student achievement as measured by students' state standardized test scores. In the United Kingdom, a similar study by Barrett et al. (2013) examined design features that the researchers identified as 37 factors grouped under five principles. Several of the design features were similar to Tanner's study, such as pathways, light, and climate control. Differing from Tanner, Barrett et al. conceptualized achievement as learning progression and measured students' entry and exit test scores for reading, writing, and math. The researchers found that light, choice, flexibility, connection (pathways), complexity, and color were significantly correlated to learning progression. The only feature found to be significant across both studies was connection

(pathway). This illustrates a problem in the field of school design, which is, there is not agreement on consistent design features that represent effective school design. Taurens (2008) suggested this is because of the context-specific nature of architectural design. Both studies attempted to identify characteristics of design that lead to positive student outcomes, but studying them in this manner isolated the characteristics from each other. The relationships as a system are still not fully understood. For example, should architects consider maximizing each design feature, or is getting the right combination more reasonable?

Non-traditional school design studies. Past researchers examined non-traditional school designs by considering the overall plan. Their studies included both open-plan schools from the 1960s and 1970s and the more recent flexible-plan schools. Researchers either compared open-plan schools to traditional-plan schools, connected the design to student outcomes, or identified design features as effective or ineffective. Grapko (1972) conducted a comparison study between two elementary schools, one traditional design and one open-plan, in Ontario, Canada. Both schools were similar in socioeconomic status and ethnicity. Grapko looked at differences in behavior and student achievement using four different measures: a) a test for students to determine their behavioral characteristics, b) a survey administered to teachers to rank each student's behavioral characteristics, c) standardized test scores, and d) I.Q. test scores. Grapko found that students performed better on standardized tests in the traditional school; however, teachers in the open-plan school were able to rate the behavioral characteristics of students better, implying that they were able to develop stronger personal connections.

Around the same time, Edwards (1973) conducted a study comparing two open-plan schools to a traditional school in British Columbia. Edwards, however, did not compare student achievement but instead looked at the interactions and behaviors of the students and teachers.

The premise was that since open-plan schools are purposefully designed for learning that is individualized, personalized, and independent, the patterns of movement and interactions should be different from a traditional school. Edwards found that the role of the teacher was more prominent in the traditional school and that student movement and interactions were more prevalent in open-plan schools. Similarly, Durlak and Lehman (1974) looked at how the space influenced learning activities. These studies are noteworthy since they compare the settings of these two types of school designs. These studies highlight how different physical designs relate to student outcomes and student and teacher behaviors. However, the studies do not adequately address differences in teacher beliefs and professional development.

Costa (2004) conducted a case study of an open-plan school that was modified to create a variety of enclosed and open spaces similar to the new flexible-plan schools. Through observations and teacher interviews, the researcher concluded that open-plan spaces required changes in teaching practices and that the space created auditory challenges that teachers had to overcome. This study helps us to understand how flexible-plan schools work, but the researcher did not address teacher beliefs. Specifically, were their beliefs congruent with the espoused pedagogical values of a flexible-plan school?

Gislason (2009) also found challenges with noise in another case study of an open-plan school. Through observations and interviews, Gislason found the open-plan design worked well because the teachers embraced practices congruent with the design. The teachers made use of the inherent advantages of open spaces, which facilitated working in teams. Shield et al. (2010) pointed out that issues with noise cannot be treated the same between traditional and open-plan schools. The intended activities need to be considered for each type of space.

Deed and Lesko (2015) conducted a case study to understand teachers' adaptations to an open-plan environment that was designed for a range of formal and informal learning activities and increased levels of community and autonomy. The researchers found teacher adaptation to this new environment was complex. The space required new practices and a "continuous process of negotiation" (p. 229) for the teachers to be effective. These case studies highlight the aspect that open-plan schools are designed for a specific way of teaching. If teachers are not teaching in the way that the design intended, then problems such as distractions from noise disturbance are exacerbated.

Summary

In summary, a review of the literature relevant to each of the components of the GAP triangle was presented. The educational goals that many schools are focused on today are centered on students developing 21st century skills. Various frameworks for classifying 21st century skills were identified. Next, information was presented on learning and teaching strategies scholars and experts have identified as being effective for developing 21st century skills. Student-centered learning strategies included personalized learning, problem-based and project-based learning, collaborative and cooperative learning, interdisciplinary learning, and teacher collaboration. Information was also presented on the physical design of schools. The next section presents the theoretical framework that was used as a lens for interpreting the findings from this study.

CHAPTER 3

Theoretical Framework

In this chapter the theoretical framework is established by first defining physical space as a technology. As a technology, physical space can be designed with certain goals in mind. I use the concept of affordances to describe this relationship. Since this study explores the relationship between the educational goals, the teaching and learning activities, and the affordances of the physical environment, I present a framework for exploring these relationships that I call the GAP (the educational *goals*, the teaching and learning *activities*, and the affordances of the *physical* environment) triangle. To better understand the GAP triangle relationships and how teachers adapt to non-traditional spaces, this research focused on: (a) identifying the affordances of the physical environment and how they did or did not support learning/teaching activities intended to align with 21st century learning goals in traditional and flexible-plan physical spaces, (b) how learning/teaching activities varied between traditional and flexible-plan physical spaces, (c) how teachers adjusted from traditional physical spaces to flexible-plan physical spaces, and (d) to what extent and in what ways teachers' practices changed in flexible-plan spaces compared to when they were in traditional spaces. Previous research shows that it has been difficult for teachers to change practice or adapt to new physical spaces (Alterator & Deed, 2013; Costa, 2004; Deed & Lesko, 2015; Gislason, 2009). Thus, I included institutional theory and the concept of institutional isomorphism to better understand why this has been a problem.

Physical Space as a Technology

Physical space can be framed as a technology that can be purposefully designed to facilitate certain learning activities based on the educational goals. A technology does not have

to be an independent component but can be a system made up of sub-components (Arthur, 2009). The physical design of a school can be observed in this manner. It organizes all the things (furniture, computers, 3D printers, books, project materials, etc.) and people (teachers, students, administrators, etc.) to form a system with the primary goal being to foster learning. In a sense, it could be viewed as hardware that runs the software—the learning/teaching activities (Nair, 2014). The system is dynamic as people and things can move around, but the space influences how they interact. The nature of these interactions can be described by drawing from the concept of affordances (Norman, 2002). Affordances in this context are all the action possibilities that the space provides, whether perceived or not.

Schools have many different types of spaces: classrooms, art rooms, music rooms, makerspaces, administration offices, gymnasiums, cafeterias, libraries, etc. Additionally, schools have design features, such as welcoming entrance areas, views to the outside, and comfortable seating. They also have organizational structures such as learning suites (two classrooms connected together) or SLCs. All these various components of how a school can be designed are called *design patterns* (Bergsagel et al., 2007; Moore & Lackney, 1994; Nair et al., 2009; Tanner, 2000). A design pattern is a way to bring order to the physical environment. The patterns by themselves, however, are isolated features or components. A school is comprised of these various features and components, but simply having them does not guarantee the success of a school. The configuration of the patterns is important as Hiller (2007) stated:

> how the rest of the building is available as a configuration from a space, as shown by an 'integration value' is one of the most marked types of differentiation between spaces. Configuration, it seems, does after all turn the building into a system of differentiated

parts, not in a machine-like sense, but in a quite unique, architectural sense. (pp. 302-303)

The layout and sequencing of design patterns make a difference. For instance, a design pattern at one school might not work well at another. Or, a certain pattern may not work well in conjunction with others or may not work well unless it is combined with others. If the definition of technology previously mentioned is used, a school could be looked at as being a system that is made up of many subcomponents—in this case, design patterns. How the design patterns are configured creates a system where the whole is greater than the individual parts.

Concept of Affordances

Affordances are the possibilities for action between a person and an object or a person and the environment. However, affordances are perceived by a person based on their background, beliefs, and previous knowledge (Norman, 1999, 2002). For instance, a teacher whose pedagogical beliefs are teacher-centric may not perceive all the affordances of a space designed for student-centered learning. Additionally, the physical space can communicate its pedagogical intent by its layout and design. Monahan (2002) used the term *built pedagogy* to describe this phenomenon, suggesting that the physical space actually affects the pedagogy. Van Note Chism (2006) reinforced this idea by stating that "the ways in which a space is designed shape the learning that happens in that space" (p. 22). The space has affordances, which can directly or indirectly affect behavior and learning activities. Prain et al. (2014) described this as "features in the environment that prompt and sustain an agent's or team's goals, where primary affordances such as increased visibility and larger space enable secondary affordances such as reconfigured group sizes" (p. 8).

Goals, Activities, Physical Environment (GAP) Triangle

Physical space can be designed for a specific purpose, but much of the literature is written in a way that takes physical space for granted. The assumption is that physical space has always been there and that you just make do with the space. Learning activities are adapted to whatever physical environment already exists. In order to understand better how the affordances of the physical space support the teaching and learning activities, the intended purpose and desired educational goals must be considered. I have created a framework for exploring the relationship between the educational goals, the teaching and learning activities, and the affordances of the physical environment that I call the GAP triangle (Figure 1).

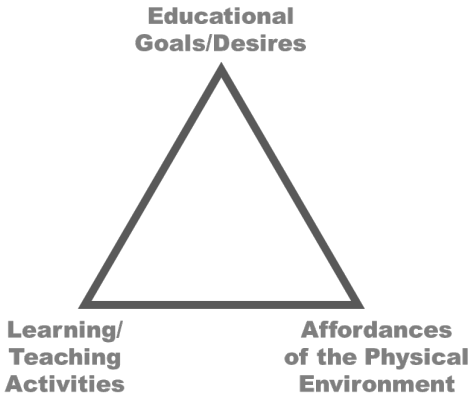

Figure 1. GAP triangle.

Educational goals. These are the things that a school is striving to achieve. They include a school's beliefs about learning and their goals and desires for education. For instance, a school may believe that getting teachers to collaborate with each other increases social capital. Teachers learning from each other and tapping into each other as resources make them better at their practice. Empirical evidence supports this notion (Leana, 2011). Their desire then may be to have teachers work together, co-teach, form PLCs, etc. As previously noted, many schools today are focused on having students learn 21st century skills, such as critical thinking problem-

solving, collaboration, leadership, agility, adaptability, initiative, entrepreneurialism, effective oral and written communication, accessing and analyzing information, curiosity, and imagination (Wagner, 2008).

Learning/teaching activities. These are all the activities that happen in a school to achieve the educational goals. Learning and teaching involve some form of activity that *always* takes place in physical space—even reflecting and thinking takes place in a physical space. We are bound to our physical bodies and therefore exist and learn in physical spaces. Active learning activities may include a group discussion, building something, collaborating with others, etc. Passive activities may include listening to a teacher, reading, watching a video, etc. The educational goals suggest that certain learning/teaching activities are taking place in a school. For instance, if a broad desire is for student-centered learning, then you would not expect to see a lot of teacher lecturing happening. You would expect to see students driving their learning by doing different things.

Affordances of the physical environment. The physical environment can be viewed as a technology. It can support certain types of activities taking place. It influences how people move through space and how they interact with each other through two dimensions: structure and setting. It provides the structure and setting for interactions. As such, it has affordances that can make certain activities easier or more difficult to do; it structures activities. Transparency and openings between spaces allow for activities to flow from space to space. Solid walls block distractions (visual and auditory). Additionally, the physical environment has psychological effects that can set the mood for an activity. For instance, the color red incites avoidance that impedes performance on cognitive tasks. Blue and green are calming and beneficial for creative performance (Elliot & Maier, 2014). High ceilings elicit more creative and expansive thinking,

while low ceilings elicit more focused and reflective thinking (Meyers-Levy & Zhu, 2007). In this sense, physical space can provide a setting for a particular activity.

GAP triangle relationships. Both learning/teaching activities and the affordances of the physical environment are at the base of the triangle and support the educational goals. They both need to be in alignment in order to provide a strong foundation for the education goals. Typically, the affordances of the physical environment are completely ignored. The focus of much writing on educational reform is about only activities that need to take place to achieve the desired goal. The traditional classroom is seen as a fixed variable; it has always existed and cannot be changed. It is assumed that all activities take place only in the classroom and perhaps other specialty areas of a school (art room, gymnasium, library, etc.). It is almost as if the traditional school is a naturally occurring thing in the world—that nature provided it for us. However, the physical environment can be designed for a specific purpose. The traditional school was designed—more than a century ago—to take the one-room schoolhouse and replicate it along a corridor to provide for mass education (Lippman, 2010b; Nair, 2014). The goal at that time was to mass produce learning through compartmentalizing subjects and students by age. The design of the physical environment provided the structure for this type of organization and supported learning that was primarily teacher-centered. This worked effectively and efficiently when the learning goals were straightforward and linear. Today, however, the world is much more complex and ill-structured. Educators need to think outside-the-box and realize that it is not just about focusing on the learning/teaching activities, but that the physical environment that gives structure and setting to the activities can be completely reimagined.

If the affordances of the physical environment are ignored, then the educational goals are teetering on the single support of learning/teaching activities. Teachers and students may be

doing activities in physical environments that are not conducive to those activities. The physical environment can make it easier or more difficult to do a certain activity. Conversely, the physical environment may be designed to have affordances that support the education goals, but teachers and students are not doing the right activities that lead to achieving them. The physical environment does not dictate in a deterministic way how people behave and what they do. It only provides the structure and support for it. If teachers and students don't know how to use the space and are not doing the right activities, then the education goals are only teetering on the affordances of the physical environment. Examples for this are the open-plan schools in the 1960s and 1970s. The physical environment was designed for student-centered learning goals, but teachers were still teaching in traditional teacher-centered ways. Since the physical space was not conducive to entirely teacher-centered instruction, many problems manifested such as noise, distractions, discipline issues, etc. (Shield et al., 2010).

Circling back to the concept of affordances, physical space can support or constrain certain activities, but these affordances are perceived differently based on an individual's beliefs and background. A learner interacts with physical space through activities (tasks) that can be self-directed or structured by the teacher. The role of the teacher in this setting is as a facilitator for learning, and learning happens through activities. Students can be engaged in many types of activities, such as listening to the teacher lecture, reading, writing, thinking, reflecting, small group work, being engaged in a whole-class discussion, working on a project, collaborating with others outside of the class, giving a presentation, or taking a test. School architecture is purposefully designed to support a function; therefore, it can be viewed as an educational technology that affords or constrains these activities. The design and layout of the physical environment can influence how people interact with it in a *probabilistic* way. While many

activities may happen in a space, certain activities are more likely to happen than others based on the design (Devlin, 2010; Strange & Banning, 2001).

Institutional Isomorphism

While organizational theory seeks to explain why there is diversity in structure and behavior in organizations, institutional isomorphism seeks to explain the tendency of organizations to resemble institutional norms (DiMaggio & Powell, 1983). In organizational fields that are well-established—such as the construct of school as an organizational structure—there is a tendency towards homogeneity, not diversity. DiMaggio and Powell (1983) offered:

> In the initial stages of their life cycle, organizational fields display considerable diversity in approach and form. Once a field become well established, however, there is an inexorable push towards homogenizations. (p. 148)

The construct of school as an organizational structure is well-established. For instance, in high school, subjects are neatly organized and taught in 45-minute classes, students are evaluated on tests, students progress through grades each year, teachers teach in rooms isolated from other teachers, classrooms have rows of desks that face a teaching wall, etc. So even though there have been new ideas for the design of school—physically and programmatically, there still is pressure for the institutional norms and practices to remain the same. Since previous research shows that it can be difficult for teachers to change practice or adapt to new physical spaces, the concept of institutional isomorphism can be used as a lens to understand why.

Huerta and Zuckerman (2009) found that charter schools have difficulty achieving new forms of schooling because of existing norms and bureaucratic rules that dominate in traditional school settings. Even though the "decentralized and autonomous nature of charter schools allows them to operate free from bureaucratic controls to challenge and redefine institutional

classifications," it still is difficult for them to overcome the institutional norms that have persisted in traditional school settings (Huerta & Zuckerman, 2009, p. 415).

Applying this to new physical spaces seems fitting. Similar to charter schools, there has been difficulty changing teacher practice in new flexible learning spaces that are intended to give teachers the ability to teach in a way that is more student-centered and supports 21st century learning goals. As previous research with open-plan schools has shown, teachers do not necessarily change their practice (Costa, 2004; Durlak & Lehman, 1974; Edwards, 1973; Grapko, 1972). Since institutional isomorphism is the tendency of an organization to resemble institutional norms, it could help explain why it is difficult for new practices to emerge.

There are three mechanisms of isomorphic change: coercive isomorphism, memetic processes, and normative pressures. Coercive isomorphism means that "organizations are increasingly homogeneous within given domains and increasingly organized around rituals of conformity to wider institutions" (DiMaggio & Powell, 1983, p. 150). This suggests that the prevalent teacher-centric and cells-and-bells layout influences expectations around practice, such as having a front-of-the-room area where the teacher stands to lecture. These traditional designs are the institutional norm. Just look at any movie that depicts a classroom—rows of desks facing a teaching wall. Even the recent Stephen Spielberg movie, *Ready Player One*—set in the future—shows a scene where students are sitting at desks in rows facing a teaching wall. The only difference is that the desks have built-in digital displays.

> Mimetic processes also contribute to the tendency of organizations to resemble institutional norms. Instead of embracing a new organizational structure, organizations may simply *mimic* more traditional and well-established organizational structures. Mimetic processes happen when there is uncertainty. DiMaggio & Powell (1983) stated:

> Uncertainty is also a powerful force that encourages imitation. When organizational technologies are poorly understood, when goals are ambiguous, or when the environment creates symbolic uncertainly, organizations may model themselves on other organizations. (p. 151)

If new flexible-plan schools are designed to support the 21st century educational goals, teachers' practice may still not change if there is uncertainty about what the learning/teaching activities should be. In other words, if there is not any effort to define what learning and teaching should look like in these new spaces, and to provide professional development and support for teachers, then they may still practice in traditional ways.

Lastly, normative pressures for isomorphic change are rooted in professionalization. DiMaggio and Powell (1983) define professionalization as "the collective struggle of members of an occupation to define the conditions and methods of their work" (p. 152). Teaching is a well-established profession. While university teaching programs may vary in quality, their approach is similar. There are expected practices and norms in the profession. For example, teachers are expected to be subject content experts and are not really trained for teaching collaboratively and interdisciplinary. These normative pressures could make it difficult for teachers to change their practice to be more aligned with 21st century educational goals.

Summary

In summary, the theoretical framework was established by first defining physical space as a technology that can be designed with certain goals in mind. The concept of affordances was used to describe the possibilities for action in a space that are perceived by a person based on their background, beliefs, and previous knowledge. Since this study explored the relationship between the educational goals, the teaching and learning activities, and the affordances of the

physical environment, I presented a framework for exploring these relationships that I call the GAP triangle. Lastly, I included institutional theory and the concept of institutional isomorphism to better understand why changing practice or adapting to new physical can be difficult for teachers. The next section presents the methodology of the study and includes information on the research design, data collection, and data analysis.

CHAPTER 4

Methodology

The purpose of this study is to understand how the physical environment shapes the learning/teaching activities that are intended to support 21st century learning. Physical space is designed and can be arranged in many ways that make its relationship with the educational goals and learning/teaching activities complex. Despite the multiple possibilities for arranging physical space in schools, the predominant model for over a century has been to compartmentalize the primary learning spaces into classroom boxes and align them along corridors—the egg crate. This is the traditional model that most people have experienced and expect to see in a school. Because this model is so engrained in society, teachers may not know how to use spaces that differ from this model to their full potential.

To understand this phenomenon in greater detail, the study for this dissertation is qualitative using a case study methodology. Two high school cases were studied that feature both traditional spaces and non-traditional, flexible-plan spaces. Even though the physical space varies between the cases, both institutions have similar educational goals regarding 21st century learning. By holding the educational goals constant, the relationship between the affordances of physical space and the learning/teaching activities can be explored. Cross-case analysis was used to identify similarities and dissimilarities across the cases in order to point to generalizations about the theoretical propositions. This research focused on: (a) identifying the affordances of the physical environment and how they did or did not support learning/teaching activities intended to align with 21st century learning goals in traditional and flexible-plan physical spaces, (b) how learning/teaching activities varied between traditional and flexible-plan physical spaces, (c) how teachers adjusted from traditional physical spaces to flexible-plan

physical spaces, and (d) to what extent and in what ways teachers' practice changed in flexible-plan spaces compared to when they were in traditional spaces.

Research Design

The intent of this dissertation study was to understand in greater detail the complex relationship between learning/teaching activities and physical space based on the overall educational goals; thus, a qualitative approach to research was appropriate. In quantitative research, individual parts of a phenomenon are typically looked at in isolation and therefore can be controlled (Merriam, 2001). Because there is little research in this area, one cannot entirely know what all the parts are and what their relationships are to the phenomenon. Creswell (2013) noted that qualitative research is used when a problem or issue needs to be explored and a more detailed and complex understanding is needed. As previously noted, sometimes there are problems when schools adopt non-traditional physical spaces. Teachers sometimes have difficulty changing their practice to facilitate learning/teaching activities for which the spaces are designed and that are congruent with the educational goals. Alternatively, there may be flaws in the design of the physical space that lead to problems with facilitating certain learning/teaching activities. For instance, too much open space may cause student distractions. To understand this phenomenon there is a need to explore the actual mechanisms at work, so using a qualitative approach allows one to examine it in greater detail and in all its complexity.

The study of physical space is inherently context-specific; people can be in only one place at one time physically. While the physical spaces between schools could have similar designs, different people occupy them and may use the spaces in different ways. Thus, a qualitative approach is needed that is context-specific—the context may have influence on the phenomenon. Case study research is used to understand a phenomenon in all its complexity and

within a real-world context (Yin, 2014, p. 16). Additionally, Yin stated that case study research is particularly useful for answering how and why questions (p. 10). Because little is known about the relationship between physical space and learning/teaching in general, and even less within the context of flexible-plan spaces, this type of questioning is appropriate when trying to understand the inner workings of something. By questioning open-endedly how it is working and why certain relationships exist, a better understanding of the nature of this phenomenon within its context can be achieved.

A case can be either intrinsic or instrumental (Creswell, 2013; Stake, 1995, 2005, 2006). An intrinsic case is used when the focus is on the case itself; perhaps it is particularly unique. The case is studied to understand its unique characteristics and not necessarily how it may inform other cases. Conversely, instrumental cases are examples that represent broader issues or problems. The case is used to understand something else. Stake (2005) noted that when there is little interest in the particular case, that multiple cases can be used to understand the broader issues or problems that the cases represent. Collectively, the cases can be compared and contrasted in order to draw generalizations to theoretical propositions. The intent of this dissertation study was to understand in greater detail the issues and problems surrounding physical spaces designed for 21st learning goals. Therefore, two cases were selected that are instrumental and best represent the overall issue.

Position of the Researcher

In qualitative research, the researcher is the main instrument for collecting and analyzing data; thus, inquiry is influenced by the researcher's background and belief systems (Creswell, 2013; Merriam, 2001). Therefore, researchers need to position themselves—what Creswell called "reflexivity" (p. 47), by stating their background and beliefs and how they may influence

their interpretations of the data. My background is particularly influential to this study because I am a practicing architect with 20 years of experience designing schools. I also was involved with the design of Bloomfield Hills High School (BHHS), one of the case studies under investigation.

Based on my professional experience working with many schools, my belief is that physical space does influence the learning/teaching activities. I also believe that transforming physical space can be a catalyst for changed practice, but it certainly does not guarantee that practices will change. I have witnessed teachers who struggle to change their practice to be congruent with the intended design of the physical space and the overall educational goals. These beliefs have been shaped by designing traditional schools early in my career to designing more innovative flexible-plan schools in recent years. The company I work for, Fielding International, designs schools around the world to support learning/teaching activities that are congruent with 21st century learning goals. Our clients come to us expecting to get a non-traditional and innovative design. Because of this focused experience and our clients' expectations, I have a biased belief that schools physically organized around SLCs and that have design features, such as flexibility, variety, and transparency, are more effective for 21st century learning. As a researcher, I am aware of this bias, and in this study, I strove to remain impartial in my observations and interpretations.

While I have this bias, my professional background provides a particular strength for this research, which is a knowledge of and sensitivity towards the design of physical space. As I stated before, much of the previous research in this domain does not emphasize the importance of the physical design, nor adequately describes the physical space in detail. As a trained architect, I am able to interpret floorplans and diagrams that depict how physical space is

organized. Nuances in the design of the physical space can have significant effects on how it influences the learning/teaching activities and on shaping interactions. This background has aided my interpretations of the data in regard to the particulars of the physical environment and how it structures and provides a setting for the learning/teaching activities.

Sampling and Cases

A qualitative methodology was used in this multi-case study to develop a conceptual theory rather than a descriptive account of the phenomenon under investigation. As such, sampling was theoretically oriented, and the cases were purposefully selected. Purposive sampling is an appropriate approach in case study research and qualitative research in general because the intent is to understand an issue or problem in great depth. Samples are needed that best represent the issue or problem and that can provide the most insight (Merriam, 2001; Stake, 1995). The purpose of this study is to understand the relationship between physical space and learning/teaching activities based on the overall educational goals. Since I was interested in schools that are designed for 21st century learning, the variable of educational goals was held constant. I sampled only schools that purported their goals to include developing 21st century skills in students.

In order to understand the degree to which physical space supports the learning/teaching activities based on the overall educational goals, I purposefully sampled for maximum variation. Miles and Huberman stated that "sometimes this strategy involves 'a deliberate hunt for negative' or disconfirming 'instances or variations' of the phenomenon" (as cited in Merriam, 2001, p. 63). A rival theory is that physical space does not influence the learning/teaching activities and that these activities could take place in any space. Therefore, I selected cases that feature both new flexible-plan spaces for 21st century learning and traditional layouts. Stake

(2006) noted that it is important to "show how the program or phenomenon appears in different contexts" (p. 27). Physical space is the context for the phenomenon of this study. By holding the educational goals constant, I was able to explore in greater detail how the learning/teaching activities differ across a variation of physical spaces.

The two cases selected are located in southeast Michigan. The reason for this is that they are in close proximity to me, which made it easier to access; thus, I was able to spend more time with these cases. Stake (2005) stated that this is a valid reason for selecting cases and noted that a case should be selected that closely represents the phenomenon under investigation and that provides the most learning potential—"that may mean taking the one most accessible or the one we can spend the most time with" (p. 451). Stake also stated that in some situations, selecting cases with a higher potential for learning can be superior to representation. The cases that I selected had a high potential for learning because of their close proximity, but they were also good representations of the phenomenon. The cases have physical design features similar to other schools located around the world that are newly designed for 21st century learning.

As previously noted, BHHS was designed by Fielding International, my employer. I was involved with the project and am intimately familiar with how the design evolved based on the school leadership's educational goals. Yin (2014) stated that personal experience with a case can strengthen the study by providing another source of evidence. Yin gave the example of a study by Zigler and Muenchow (1992) about the federal Head Start program. Zigler was the program's first director. As such, Zigler had personal experience with the program and was able to provide insider insight on the research (p. 119). Similarly, my experience with the design of BHHS provided another source of evidence that helped with triangulation.

Unit of analysis. The school as a whole, bounded by its physical environment, was the unit of analysis. However, in order to investigate in greater detail the learning/teaching activities across a range of spaces, two subunits of analysis were selected: a flexible-plan area—organized as an SLC—and a traditional area where teachers are grouped based on grade level or subject. These subunits were selected to better understand the learning/teaching activities related to a group of teachers and students. In particular, an SLC is designed to form strong relationships between the teachers and students who belong to the community. The learning/teaching activities that take place in the SLC typically involve this group of teachers and students. However, an SLC is embedded within the overall school and shares its policies and norms. Members of an SLC interact with members of the other SLCs within the school in shared common and specialty spaces that all teachers and students use, such as a library, gymnasium, or cafeteria. Yin (2014) noted that it is important that the subunit of analysis is then related back to the larger unit of analysis in which it is embedded (p. 55). In order to understand the complexities at these different scales, the subunits studied at each school were compared and contrasted in the context of the overall school. Similarities and differences between the two subunits gave insight as to how they related to the school as a whole.

Case #1: Bloomfield Hills High School. Bloomfield Hills High School (BHHS) is a public school located in Bloomfield Hills, Michigan, and serves approximately 1,650 students in grades nine through twelve. This case represents a school that has been designed with physical spaces to support 21st century learning, but a small portion of the school still features traditional classrooms aligned along corridors. The school has seven SLCs that are grade-level specific serving grades nine and ten. Each SLC is focused on interdisciplinary learning with science, math, English, and social studies. Each SLC features a central common space with learning

studios organized around the perimeter. Teachers within the SLC share a teacher collaboration room that is used for planning and resources.

The new school opened in August 2015 and was a major addition to the old high school. Several of the existing wings to the old school were only moderately renovated and still feature traditional classrooms. One of the 21st century SLCs and one of the traditional wings were selected as the nested units for analysis. Having been involved with the design of this school, I have an intimate knowledge of how the physical spaces were designed in response to the educational goals.

Case #2: Milan High School. Milan High School (MHS) is a public school located in Milan, Michigan, and serves approximately 1,000 students in grades nine through twelve. This case also represents a school that features both traditional and flexible learning spaces. A 23,000 square foot addition was added to the school in 2012. This addition was designed for 21st century learning and features flexible learning studios, common areas, and transparency between spaces. The new addition operates as an SLC for students in twelfth grade and is called the Milan Center for Innovative Studies (MCIS). It is a program designed for interdisciplinary and project-based learning. The rest of the school has traditional classrooms and corridors. The new addition, along with one traditional wing of the school, were selected as the nested units for analysis. This school was designed by the architecture firm, Fanning Howey.

Data Collection

Multiple sources of information are typically used in case study research (Creswell, 2013). Therefore, I used a variety of data collection techniques to better understand the relationship between learning/teaching activities and physical space based on the overall educational goals. The data collection process was inductive and was guided by the emerging

theory; therefore, leads emerged that required further exploration. Yin (2014) noted that it is important to stay adaptive when conducting case study research. Not everything goes as planned, and modifications to the research design were necessary and done with care. Yin further stated that it is important to "balance adaptability with rigor—but not rigidity" (p. 75). For this study, I remained adaptable and flexibly used multiple techniques for gathering evidence for each of the variables.

Yin (2014) identified six sources of evidence that are commonly used in case study research: documentation, archival records, interviews, direct observation, participant observation, and physical artifacts (p. 106). All these sources were used to some extent for this study. The main variables of this study were the educational goals, learning/teaching activities, affordances of the physical environment, and teacher adaptation—how teachers adjusted to flexible-plan physical spaces and to what extent and in what ways did their practice change. Table 2 indicates what sources were used for gathering data related to the four variables under investigation.

Table 2.

Sources of Evidence Matrix.

	Document-ation	Archival records	Interviews	Direct observation	Participant observation	Physical artifacts
Educational goals	x		x			x
Learning/ teaching activities			x	x	x	x
Affordances of the physical Environment	x	x	x	x	x	
Teacher adaptation			x			

Educational goals. Data for the educational goals related to 21st century learning were gathered by reviewing school documents found online or directly requested, by interviewing school administrators and teachers, and by finding physical artifacts within the school (e.g., posters displayed in the school).

Learning/teaching activities. Data for the learning/teaching activities were gathered through both direct and participant observations, and by interviewing school administrators and teachers. Additionally, physical artifacts of student work observed during my visits gave evidence of the type of learning/teaching activities that were taking place.

Affordances of the physical environment. Data for the affordances of the physical environment were gathered through both direct and participant observations, interviews, and by reviewing documents and archival records. I observed how certain features of the spaces were used for specific learning/teaching activities. I interviewed school administrators and teachers to find out how they are using the spaces. I reviewed documents found online that described the features of the physical environment. Lastly, I analyzed archival records of architectural floor plans to determine features that support different learning/teaching activities.

Teacher adaptation. Data related to how teachers adjusted to flexible-plan physical spaces and to what extent and in what ways their practice changed were gathered through interviews with teachers and school administrators. I was able to observe their practice, but since this study was not longitudinal, I was not able to compare how they adapted over time.

I visited each site multiple times from September 2019 through December 2019. During each visit, I spent several hours either observing learning/teaching activities in the various spaces or interviewing teachers and school administrators. Because of the close proximity of the cases, I was able to make return visits as needed to fully gather all the evidence. If I observed

something that was unique or interesting at one site, I was able to visit the other site to see if there were any similarities or differences.

During each visit, I embedded myself in an area of the school and made both direct and participant observations. For direct observations, I typically sat or stood somewhere around the perimeter of the space and made notes of the learning/teaching activities and the ways in which teachers and students used the spaces. I also occasionally walked between areas and peeked into spaces to get a quick glimpse of what was happening. In the flexible-plan spaces, observing in this manner was easy to do and minimally obtrusive because many of the spaces had transparency. I circulated through the common area of the SLC—observing learning/teaching activities that were happening in that space—and also peeked through the glass into the adjacent classroom spaces to see what was happening in those spaces. By doing this, I was able to get a good sense of all the various learning/teaching activities happening in the SLC at any given time.

Where appropriate, I observed as a participant by interacting with school administrators, teachers, and students. I asked probing questions to better understand what I observed. For instance, during one of my visits to BHHS, I walked the entire school with the assistant principal, and we observed and discussed what was happening in the various areas. During a visit to MHS, the students in the MCIS presented their projects in what they call a "symposium." About 20-25 student teams of three to four students were stationed at tables spread throughout the common space and in some of the classroom spaces. Other students and teachers in the school were invited into the MCIS to see the students' final product of a month-long project. The project was as a public awareness campaign for a social issue that each student team chose. For instance, one team chose depression as their social issue. They produced a poster with information and statistics, created a website and an informational video about the issue, and

designed t-shirts that they wore for their campaign. I—along with the other students and teachers—circulated around the tables and listened to the students as they pitched awareness about their social issue. I interacted with them by asking questions about their project and also how they worked together as a team.

Across both cases, I interviewed 12 participants: two principals, one assistant principal, and nine teachers. I used a semi-structured interview guide (Appendix) to ensure that I covered all questions; however, I remained flexible in the order of my questioning to allow the discussion to flow naturally. Some of the interviews were conducted in-person. For those, I used an audio recording application on my iPhone designed for recording interviews. It was difficult to coordinate a meeting time for an in-person interview for a few of the participants, so I conducted those interviews by video conference using the software platform Zoom, which allowed me to record the audio. Each interview was recorded and lasted between 20-60 minutes. I collected over eight hours of audio recordings and sent each audio file out for professional transcription. When the transcriptions were returned, I read through each transcription while listening to the audio file to check for accuracy. Only minimal revisions were required. During this review process, I also became more familiar with the data which helped during analysis.

To ensure the protection of human subjects, a proposal for this study was submitted to Michigan State's Internal Review Board. The study was determined to be exempt since it took place in established educational settings and did not adversely affect students' opportunity to learn. The interview participants were provided with a consent form that included the purpose of the study, information about confidentiality, a statement of voluntary participation, and the option to withdraw from the study at any time. Each participant was asked for their permission to record the interview.

Data Analysis

The data were analyzed inductively through a constant comparative method. Using Stake's (1995, 2006) qualitative case study approach, analysis of the data was ongoing, using iterative and recursive processes. As I collected data, I compared it across the various sources in an effort to organize and categorize it based on the main variables of this study: educational goals, learning/teaching activities, affordances of the physical environment, and teacher adaptation—how teachers adjusted to flexible-plan physical spaces and to what extent and in what ways their practice changed. The data sources included documentation, archival records, interviews, direct observation, participant observation, and physical artifacts. Analysis was ongoing and took place simultaneously when the data were collected. This approach is consistent with the recommendation by Merriam (2001) who stated:

> the final product is shaped by the data that are collected and the analysis that accompanies the entire process. Without ongoing analysis, the data can be unfocused, repetitious, and overwhelming in the sheer volume of material that needs to be processed. (p. 162)

Since the GAP triangle is a lens to understand the relationships between the educational goals, the teaching and learning activities, and the affordances of the physical environment, they also served as a priori categories using a holistic coding method (Saladaña, 2016). The data was sorted into these three macro chunks. Additionally, a fourth macro-level category—teacher adaptation—was used for chunking data related to how teachers adjusted to or adapted to flexible-plan spaces. These categories were used to sort the data during and after collection. Consistent with Stake's (1995, 2006) qualitative case study approach, as I collected data I identified patterns and made notes that I later revisited as further data were collected. This

method was inductive as I searched for similarities and connections within and across the categories. I looked specifically at the data for explanatory and inferential patterns that could lead to emerging themes related to the GAP triangle. Pattern coding used in this way is useful "as a stimulus to develop a statement that describes a major theme, a pattern of action, a network of relationships, or a theoretical construct from the data" (Saladaña, 2016, p. 236).

The educational goals were analyzed through the triangulation of documents, interviews, and physical artifacts. For example, I looked on each school's website to see if they posted any mission and vision statements or documents about 21st century skills. When I visited each school, I made note of any posters that were displayed showing the school's educational goals. This evidence was compared with data from the interviews.

The learning/teaching activities were analyzed through the triangulation of interviews, direct and participant observations, and physical artifacts. For example, I asked teachers what learning/teaching activities they do with students throughout the day and throughout the year. Since teachers could state one thing but actually do another, I corroborated the findings from interviews with direct and participant observations. I observed the type of learning/teaching activities that they said they do. If I did not observe them during my site visits, I looked for evidence through physical artifacts instead. An example was seeing a student project or the arrangement of furniture. Seeing many projects suggested that learning is more student-centered. If all the rooms in a SLC were arranged with chairs facing a teaching wall, then it suggested a more teacher-centered approach to learning. Together, these findings gave an overall picture of the type of learning/teaching that took place.

The affordances of the physical environment were analyzed through the triangulation of documents, archival records, interviews, direct observations, and participant observations. For

example, I looked for any documents that described the design intent as affordances for the spaces. Additionally, I reviewed floor plans (archival records) for each of the schools to determine if there were any other affordances that I could infer as a trained architect. These findings were compared with data from interviews—I asked teachers how the physical environment either supported or constrained learning/teaching activities. I also compared their responses with data from observing how the spaces were actually used.

Lastly, how teachers adapted to flexible-plan physical spaces and how their practice changed were analyzed primarily through interviews. I asked teachers to reflect on their experience moving into flexible-plan spaces and how they adjusted to new learning/teaching activities. I triangulated the findings across the responses from all teachers and by asking school administrators to comment from their perspective.

Trustworthiness (Reliability and Validity)

Qualitative researchers typically use the term *trustworthiness* in lieu of *reliability* and *validity* because the main instrument for data collection is the researcher. In quantitative research, reliability refers to the consistency of the measures. If subsequent measures were made, then similar results would be expected. Validity refers to how well a measure represents what it is trying to measure. A valid measure depicts what is happening in reality.

The analogs to reliability and validity that qualitative researchers are concerned with establishing are credibility, transferability, dependability, and confirmability. Credibility refers to the confidence in the truth and accuracy of the findings. Transferability refers to how applicable the findings are to other contexts. Dependability refers to how consistent the findings would be if another researcher was to replicate the study. Confirmability refers to the neutrality of the findings and controlling for bias from the researcher (Guba, 1981).

Strategies recommended for strengthening credibility are triangulation, prolonged engagement, and member checks (Guba, 1981; Merriam, 2001; Shenton, 2004). In terms of triangulation, I was able to corroborate the data by gathering it through multiple sources recommended by Yin (2014) for case study research. The sources included documentation, archival records, interviews, direct observation, participant observation, and physical artifacts. I used a constant comparative method to analyze the data across the sources of information that led to my findings. Additionally, personal experience with the phenomena under study can strengthen the analysis by adding another source of information for triangulation (Yin, 2014, p. 119). My prior involvement with BHHS provided an additional source of information since I have insight on to how the physical design evolved and was intended to work.

Prolonged engagement allows the researcher to develop familiarity with the case and to build trust with the participants (Shenton, 2004). This strategy helps the researcher fully understand the culture of the organization and ensures that responses from participants are truthful. I made multiple visits to each site from September 2019 through December 2019. During the first visit, I met with the principal and toured the spaces under observation to get a lay of the land. I also introduced myself to the teachers and explained the purpose of my study and what I would be doing. This helped to establish rapport with the participants so that there was familiarity with me and what I was doing during my subsequent visits. I did not start interviewing the participants until after my first visit.

Guba (1981) stated that "the process of member checks is the single most important action inquirers can take, for it goes to the heart of the credibility criterion" (p. 85). However, Stake (1995) warned that a problem with doing member checks is that sometimes the members do not take the time to review draft writing that is sent to them. In an effort to maximize the

amount of feedback from the participants, I made them aware of this at the beginning of the study and asked for their commitment. After the initial interview with each participant, I sent them a transcript by email and asked them to review it to determine if it accurately reflected their comments and thoughts. I also asked if they wanted to add anything else. I received responses from eight of the 12 participants. Most of the respondents simply replied by stating the transcript was an accurate reflection of their responses. Three of the participants replied by adding some clarification and/or more detail to their responses. I also performed occasional member checks by making tentative interpretations of the data and then going back to the source to ask if the interpretations were plausible. While I was not able to get all participants to review their transcript, I was able to get responses from all participants to my tentative interpretations during the follow-up visits. For instance, I asked questions about what I observed, and I asked if my interpretation of something was accurate.

For transferability, providing thick descriptions of the cases allows readers to match the findings to their own situations, and thus, make a determination for how applicable the findings transfer (Merriam, 2001). This is done by providing sufficient background and contextual information about the cases (Shenton, 2004). Therefore, I provided background data about each of the schools, such as demographics and student performance, and I provided background information about each of the participants, such as their area of specialty and how long they have been teaching. Additionally, using a multi-case design with instrumental cases that have maximum variation subunits (traditional spaces and flexible-plan spaces) helps transferability by actually showing how the findings were applicable in different contexts within and across the two schools (Merriam, 2001).

To help with dependability, Guba (1981) recommended establishing an audit trail that shows the processes for data collection and how interpretations were made along with the pertinent documentation. In this chapter, I detailed my research methods in an effort to expose the processes of this study. I also recorded the interviews with all the participants and had them transcribed using a pseudonym to protect their identity.

Confirmability is established by showing neutrality and addressing any bias that the researcher may have interpreting the data. This is done through reflexivity—stating the researcher's position at the outset, which I previously did in this chapter (Creswell, 2013; Merriam, 2001). Additionally, thick description allows the reader to understand the context and data in rich detail to better assess the interpreted findings of the researcher. This can be accomplished by using extensive direct quoting from the participants alongside the interpreted findings so that the reader can make comparisons (Patton, 2002).

Since I was involved with the design of BHHS, there may be additional concern about personal bias—the concern being that findings are presented with a positive spin to reflect positively on my employer. However, my study is not designed to prove how effective a particular architectural design is for learning. Rather, I am trying to better understand the complex relationship of the GAP triangle (the relationship between the educational goals, the teaching and learning activities, and the affordances of the physical environment) through a qualitative study. I am not evaluating the effectiveness of the design, but rather trying to better understand what is happening in these physical spaces. Architects rarely get a chance to study extensively how people actually use the spaces they design. After a project is finished, they move on to the next project. The fees they receive for design do not support spending time on extensive research. This study is intended to gain a better understanding of how these spaces are

used for learning and teaching in order to inform future research and design. I have presented the findings in a way to simply show what is happening. Since evaluative, "better/worse" findings have not been made, the research design itself reinforces neutrality and therefore strengthens confirmability.

Summary

This multi-case study used a qualitative research methodology to understand in greater detail the complex relationship between learning/teaching activities and physical space based on the overall educational goals. Two instrumental cases were purposefully selected, and the data were analyzed inductively through a constant comparative method. The data sources included documentation, archival records, interviews, direct observation, participant observation, and physical artifacts. Trustworthiness was established through triangulation, prolonged engagement, member checks, thick descriptions, providing an audit trail, and establishing neutrality. The results of the study are presented in the next chapter.

CHAPTER 5

Results

In this chapter, the findings are presented based on analysis of the data. This study followed a qualitative case study methodology for gathering the results to understand the phenomenon under investigation—the relationship between the educational goals, the teaching and learning activities, and the affordances of the physical environment at two high schools: Bloomfield Hills High School (BHHS) and Milan High School (MHS). Data were collected through reviewing documentation found on the schools' websites, reviewing archival records of architectural drawings, conducting individual semi-structured interviews with the participants, performing direct and participant observations, and discovering physical artifacts during site visits. Using Stake's (1995, 2006) qualitative case study approach, analysis of the data was ongoing, using iterative and recursive processes.

To better understand the GAP triangle relationships and how teachers adapt to non-traditional spaces, this research focused on: (a) identifying the affordances of the physical environment and how they did or did not support learning/teaching activities intended to align with 21st century learning goals in traditional and flexible-plan physical spaces, (b) how learning/teaching activities varied between traditional and flexible-plan physical spaces, (c) how teachers adjusted from traditional physical spaces to flexible-plan physical spaces, and (d) to what extent and in what ways teachers' practice changed in flexible-plan spaces compared to when they were in traditional spaces.

The intent of this study was to reveal what is happening at these two high schools regarding the relationship between the educational goals, the teaching and learning activities, and the affordances of the physical environment. The results are presented using thick description,

along with an emphasis on directly quoting the participants where appropriate. In a qualitative study, these techniques contribute to strengthening trustworthiness because they provide the reader with the analysis alongside the collected data so that they can evaluate for themselves the plausibility of the researcher's assertions.

While these two cases alone do not provide a strong base for generalization, the intent is to provide enough detail for the reader to validate from their own naturalistic generalizations. Naturalistic generalizations are generalizations formed by personal experiences (Stake, 1995). In this manner, the reader can "look under the hood" to see what is happening and compare the findings from this study with their own experiences and/or with other case studies. These two cases add to a growing body of research about the relationship between the physical environment and learning/teaching, through the lens of the GAP triangle.

The findings from each case are presented separately so the reader can understand their unique context and full complexity without being "mangled in a cross-case analysis" (Stake, 2006, p. 39). For each case, the components of the GAP triangle, along with teacher adaptation to flexible-plan spaces, are analyzed. Following the presentation of the results for the individual cases is a cross-case analysis that considers both commonalities and differences across the cases regarding the GAP triangle relationships. The research questions are directly addressed in the cross-case analysis. Lastly, miscellaneous findings beyond the GAP triangle that were considered noteworthy are listed as ideas and recommendations for further study.

Case #1: Bloomfield Hills High School

The results for this case are organized into seven sections: (a) a background description of BHHS to provide an overall context; (b) a description of the physical spaces that were included in the study; (c) a brief description of the participants; (d) an analysis of the 21st century

learning goals; (e) an analysis of the learning/teaching activities; (f) an analysis of the affordances of the physical environment; and (g) an analysis of teacher adaptation to flexible-plan spaces.

Background. BHHS is a public school located in Bloomfield Hills, Michigan, and serves approximately 1,650 students in grades nine through twelve. It opened in August of 2015 as a merger of two existing high schools in the district: Andover and Lahser. Enrollment in the district was steadily declining, and the facilities at both high schools needed repairs and upgrades. Instead of sinking money into the existing aging facilities, the district decided to build a new school facility on the Andover site. My employer, Fielding International, was selected in 2010 to design the school. I was a key member of the design team and worked on the project from start to finish.

The initial plan was to demolish the existing Andover High School building to make room for a new building; however, the district needed to pass a bond referendum to fund the construction. To show the community that they were being fiscally responsible, they decided to keep and lightly renovate a portion of the existing building and build a major addition on to it. The portion they kept was built in the mid-20th century and contained traditional classrooms. While there was some cost savings with this approach that helped pass the bond referendum with the community, the principal of the school stated that they regret not being able to build a completely new building or to fully renovate and transform the existing traditional classrooms into flexible-plan spaces. The result is that the school has both traditional learning spaces and flexible-plan spaces.

During the design process, many stakeholders were engaged to gather input for the design. The goal was to design a school that supported 21st century learning. The strategy for

doing this was to create small learning communities that would each serve between 100-150 students. The school's website states:

> Our state-of-the-art facility is designed around learning communities to help personalize learning for all students grades 9-12 in a collaborative environment. The building is designed to support the highest levels of student engagement and academic success.

The school has seven SLCs in the new addition that are grade-level specific serving grades nine and ten. Each SLC is organized for interdisciplinary learning with classes for science, math, English, and social studies. Most classes for grade 11-12 take place in the traditional portion of the building, which is loosely organized into subject-based SLCs.

Construction for the selective demolition and major addition to Andover High School began in spring of 2013. During the two years the new school was under construction, the students and teachers from Andover moved to Lahser. In anticipation of the new flexible-plan spaces, students and teachers were grouped into SLCs, and new flexible furniture was brought into the traditional spaces. This allowed the teachers to start working in teams in a more collaborative manner.

The school district, Bloomfield Hills Schools, serves over 5,400 students (K-12) in the Bloomfield Hills areas. Bloomfield Hills is an affluent suburb of Detroit. Students in the district are primarily White (73.34%), followed by Asian American (9.61%) and African American (8.21%). The percentage of economically disadvantaged students is low (10.8%). The graduation rate is nearly 95%, and most students continue on to post-secondary education (*MI School Data*, n.d.). According to the school's academic profile found on their website, BHHS enrolled 1,741 students in grades 9-12 in 2019-2020 (Bloomfield Hills High School, n.d.). BHHS ranks 1,111 out of 17,245 high schools (93.56 percentile) nationally and 32 out of 650

high schools (95.08 percentile) in Michigan in the 2019 *U.S. News* Best High Schools rankings. The rankings are based on six measures: college readiness, college curriculum breadth, reading and math proficiency, reading and math performance, underserved student performance, and graduation rate (*U.S. News* High School Rankings, 2019a). In general terms, BHHS is known to be academically high performing and an overall good school. There were not any measures found that determine how effective BHHS is regarding 21st century learning goals.

Description of spaces. Two areas of the school were observed: an existing wing of the original Andover High School that had traditional classroom spaces, and an SLC for a group of 10th grade students that was called 10b. The 10b SLC was part of the new construction and that had flexible-plan spaces. The traditional area featured classroom spaces that were aligned along a corridor, and the corridor was lined with lockers. The classroom doors have a narrow window that allows one to see into the classroom. The classrooms slightly vary from one another, but for the most part they have the same pattern—a teaching wall at the front of the room with rows of tables and chairs. The teacher desk is placed at the front of the room adjacent to the teaching wall. The rectangular tables and chairs have casters and can be rearranged easily. Two students sit at each table. The perimeter of the room was lined with bookcases and storage cabinets that stored books and resources. Windows on the outside wall brought some daylight into the space.

The 10b SLC features a large commons space in the center that has a variety of seating options (Figure 2). The arrangement of the furniture and changes in flooring and ceiling materials create different zones in the open space. Surrounding the commons were five classroom spaces, a teacher collaboration room, a small group room, and a seminar room. The classroom spaces varied in size and use. One classroom space served as the science lab, two

spaces were called learning studios, one space was called a small learning studio, and one space was called the project area.

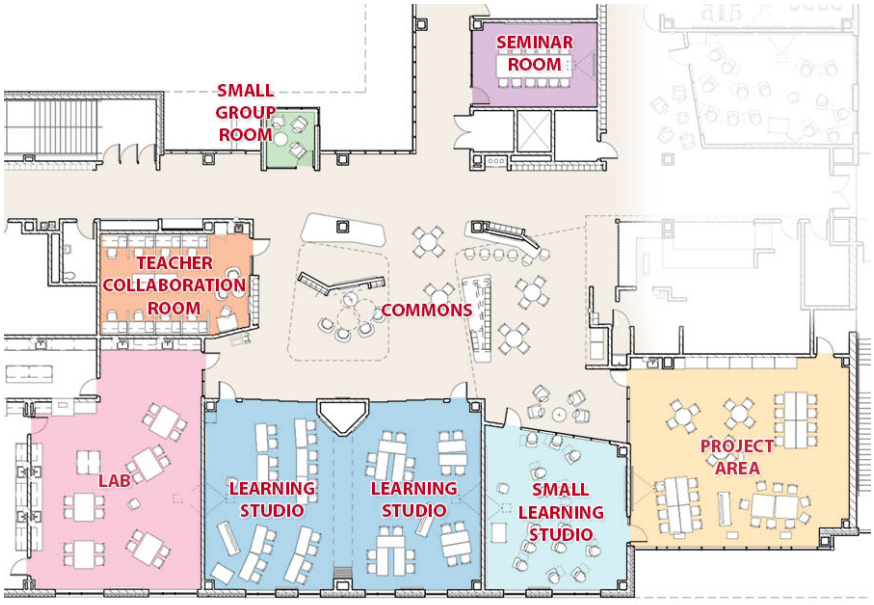

Figure 2. Flexible-plan spaces in a SLC at BHHS.

The science lab was equipped with typical science equipment such as a fume hood, gas and water connections, and a demonstration table. The student worktables had casters on them to allow for reconfiguration. Next to the science lab were two learning studios that had an operable wall between them. The operable wall could be opened to create one larger classroom space. Both learning studios had doors and a sliding glass wall that could fully open to the commons. There was a variety of furniture in the learning studios that included rectangular tables and chairs and high café-style round tables with stools. Most of the furniture had casters to allow for reconfiguration. Flat-panel TV screens were on two opposite walls to allow viewing from multiple angles. There was not a typical teacher desk but rather a mobile pedestal and chair that could be moved around the room.

The small learning studio and the project area both had doors to the commons and a connecting door between each other. The small learning studio had tablet armchairs that were on

casters, which could easily move throughout the space. Similar to the two learning studios, the teacher workstation was a mobile pedestal. A flat-panel TV screen for presentations was located on one wall.

Figure 3. Common area at BHHS.

Connected to the small learning studio was a project area that was used as a messy project workspace. The floor had a hard surface, and the perimeter of the room was lined with storage cabinets. A flat-panel TV screen for presentations was located on one wall. Near the door was a deep sink for project clean-up. The furniture in the space was mobile worktables and stools for students, and a mobile pedestal and chair for the teacher.

Each teacher had a workstation in the teacher collaboration room. This was a dedicated space for each of the teachers who taught in the 10b SLC. The workstations faced the walls around the perimeter of the room. In the center of the room were filing cabinets with a standing height work counter on top. There was also a small kitchenette near the door with a sink, mini fridge, and microwave.

The small group room and seminar room adjacent to the commons space were unassigned rooms. They were not used for classes, only meetings or breakout sessions. Both the small group room and seminar room had a glass wall facing the commons. They also both had a flat-panel TV screen for presentations.

Description of participants. The principal, Robert, assistant principal, Howard, and four teachers—Beth, Sandra, Lisa, and Mark (all pseudonyms)—were interviewed. Following are brief descriptions of each of the participants to establish their background and point of view in order to give context to their interview responses.

Robert. Robert is the principal of BHHS. I have known Robert since 2010 when Fielding International began designing the new high school. Robert was involved with the design of the school. Robert greeted me warmly and after catching up on the latest events in our lives, I interviewed him in his office. Robert has been a principal for 19 years. Before he came to Bloomfield Hills School District, he was an associate principal for two years and then a principal for three years at a large comprehensive high school in northern Illinois. Robert served in the district as the principal of Lahser High School starting Fall of 2005, prior to the merger with Andover High School in 2013. Robert has always been interested in educational reform. He described his interest:

> I was a social studies teacher and I always—educational reform was always something that I was interested in—school improvement work. And I was fortunate in the initial district where I taught in northern Illinois to become school improvement coordinator and work on educational reform. At that time, we were looking at the central schools' model of school reform based out of San Francisco and was fortunate to be part of that organization as we led some of the initiatives through my building that I taught in for 13

years before going into administration full-time. So, education reform, school improvement was kind of my steppingstone into leadership and administration.

Howard. Howard is one of the associate principals at BHHS. He joined BHHS in 2018 and thus was not involved during the design of the new school. Prior to joining BHHS, Howard served as an assistant principal at another high school in the area. He has also served as a 21st century curriculum coordinator and teacher in another school district. Howard has a strong passion for student-centered practices. When I interviewed him, he was talkative and spoke fast and with a lot of excitement. I interviewed him in two sessions. During the first session, we walked the school together and discussed our observations. Later, the same day, I met with Howard again to continue the interview. We sat in an open collaborative area of the administrative suite. Displayed on the wall in this area was the master schedule for the entire school that he referenced serval times during the discussion.

Beth. I met with Beth by video conference. Beth has been teaching for 10 years, all of them at the high school level and within the district. Beth spoke passionately and with excitement about teaching at BHHS. She started teaching at Andover High School prior to the consolidation. During her time teaching, she has primarily taught 9th and 10th grade English. She is the leader of the 10b SLC team and teaches in the newer part of the building that features flexible-plan spaces. She is energetic and eager to serve on many different committees. She also was involved during the design of the new high school. She stated:

> I'm part of the learning community council, which started meeting before the two high schools merged in order to kind of be a transition team and look at the development of the design of the learning communities. So, we went on site visits, things like that. And

yeah, basically I raise my hand a lot, so a lot of different committees that have been working on different aspects of the high school life I'm part of.

Sandra. Sandra teaches math and has been in the district for 11 years. She is part of the 10b SLC team and teaches in the newer part of the building that features flexible-plan spaces. I met with Sandra by video conference during her prep period. She was in the 10b teacher collaboration room. She has an undergrad degree in teaching and a master's degree in curriculum and instruction. She has previously served on the math leadership team for Oakland County. Her current teaching goals are focused on collaborative work, formative assessments, and equity.

Lisa. I met with Lisa by video conference. Lisa teaches science at BHHS and serves as the district's Science Teacher-Leader and is responsible for the science curriculum throughout the district in grades K-12. She currently teaches two forensic science classes and one chemistry class at BHHS. She has been teaching for 20 years but has been in the district for only three years, so she was not around during the merger of Andover and Lahser.

After graduating with a BS at Michigan State University, she went on to work in breast cancer research for four years. She then earned a Master of Arts in Teaching degree and began teaching high school science. She has also earned a doctorate in curriculum and teaching so that she could focus on her passion, which is designing curriculum and learning experiences for students.

Mark. Mark is a business technology teacher at BHHS. The business classes he teaches are elective classes. He has been teaching for 16 years, all of which have been at the high school level and within the district. He has an undergraduate degree in business education and a Master's in school administration. I met with Mark by video conference.

Mark taught at Andover High School prior to the consolidation. He was involved with the planning of merging the two high schools and had provided input to the design team. This was important to him because, as he stated:

> I was pretty involved in the whole merger of the high schools. More so in terms because I'm an elective teacher and I felt not that we were going to get forgotten, but I wanted to make sure that we did not get forgotten in the whole process.

Mark teaches in a traditional space but also teaches one period in a flexible-plan space that is called the Knowledge Market that also has flexible-plan spaces. The classes Mark teaches are considered electives, but he also runs the career capstone internship class, which is an opportunity for students to get real-world experiences outside the classroom. Additionally, Mark coaches several sport teams in the district.

21st century learning goals. The findings related to the 21st century learning goals at BHHS were gathered by reviewing school documents found online or directly requested, by interviewing school administrators and teachers, and by finding physical artifacts within the school. The participants each described different aspects of 21st century learning goals for BHHS from their own understanding. While their descriptions and priorities of the goals differed slightly, the common thread was that the 21st century learning goals were focused on developing skills that transcend subject-based content knowledge. It was clear from the participants' responses that developing 21st century skills is a priority at BHHS. None of the participants described the educational goals as being related to a heavy emphasis on subject content or preparing students to take standardized tests. The educational goals discovered at BHHS were consistent with skills identified in the four main areas of the P21 framework: (a) key

subjects and 21st century themes; (b) learning and innovation skills; (c) information, media and technology skills; and (d) life and career skills (Partnership for 21st Century Learning, 2015).

Robert, the principal, responded to the question about the educational goals of the school by referencing the school's four cornerstones that were created to guide how decisions were made for the design of the school, and in particular, the learning communities. The four cornerstones continue to guide decisions at BHHS related to teaching and learning. Robert stated:

> I've worked on mission statements for a long period of time, but they tend not to be as effective as what we now have which are, we call them, our cornerstones. And really those are the pillars for which our building was designed and for what our building hopes to accomplish and the teaching and learning that we will expect out of our instructional programming staff and that is for one, relationships, two, authentic learning, three, responsibility and ownership and the fourth one being innovation. And those have guided us in our decision-making process and helped make sure that we tend to the vision of the building and in our purpose in terms of what we do daily in the classroom with students.

The four cornerstones are also referenced on the school's website in conjunction with the district's "portrait of a learner" and are stated as being the drivers for how the learning communities were designed. According to the website, the district's portrait of a learner is:

> ***A disposition to inquire about the world.*** A learner who inquires about the world can explore local and global connections, ask questions of significance that call upon critical thinking, frame problems and construct solutions. They seek information beyond

familiar environments. They engage in analysis, synthesis, evaluation, creation, and application.

A disposition to understand multiple perspectives. A learner who understands multiple perspectives interacts with others whose paths differ greatly from their own, honoring the value of our shared human dignity. They recognize and resist stereotypes and understand multiple cultural contexts.

A disposition toward respectful dialogue. A learner who engages in respectful dialogue can communicate across differences and listen with intentionality. They express empathy for others while sharing courageously, openly and appropriately.

A disposition toward grappling with complexities. A learner who can grapple with complexities can persevere in the face of multi-layered processes, ideas, and problems. They can display resilience in the face of challenges and change.

A disposition toward taking responsible action. A learner who takes responsible action collaborates with others with the intent to mobilize ideas into action. They recognize that service to community is a form of action.

Both the high school's four cornerstones and the district's portrait of a learner speak to the skills that students should learn and develop and are not bound to a particular subject-area. Skills that these documents highlight related to the P21 framework are critical thinking and problem solving, understanding multiple perspectives, empathy, communication, dealing with complexity, collaboration, and self-efficacy. Consistent with Wagner (2008), Robert identified collaboration, use of technology, critical thinking, self and collective efficacy, and global awareness as being important because they are highly desired skills in the business world today. Robert stated:

> I think we found it out—business and industry tells us to as well. It confirms it with us but, obviously we felt it important and built those elements into our new building so, collaboration is one. Obviously, technology integration is one. Critical thinking is another. Kind of building a self-efficacy in students and a collective efficacy to as well so there's a sense of mission and purpose for each and every student. We build—we thrive on creativity through hopefully developing those authentic experiences where kids can find their niche, their passion in the in the learning and sometimes we are intentional and that in terms of developing a flat curriculum which gives a lot of opportunities for students to go in different directions but, a lot of those skills—and the other thing I would add to that is being a global learner to as well. We are an IB school so we have the middle years program diploma program so, a lot of the building design and support of our cornerstones also integrates well with international baccalaureate or IB program here to as well.

In describing the educational goals at BHHS, Robert identified them in terms of skills that students should attain. The skills he described are similar to the 21st century skills identified by others (Dede, 2010a; Partnership for 21st Century Learning, 2015; Wagner, 2008). As previously stated, many of the skills he identified are those in the P21 framework. He also described that students may go in different directions after high school, therefore the 21st century skills that are emphasized are skills that transcend disciplines and could be helpful no matter what career pathway a student takes. Additionally, focusing on skills that transcend disciplines can help prepare students for a future where they may have multiple jobs as some predictions show that workers may change jobs seven to eight times (Dede, 2007).

Similar to Robert's response, Beth also talked about preparing students for paths in their lives that relate to the P21's flexibility and adaptability in the life and career skills area. Beth described the educational goals at BHHS shifting from an emphasis on a comprehensive education to being focused more on 21st century skills so that students can be prepared for anything. In particular, Beth highlighted the 21st century skills global awareness, critical thinking, and self-efficacy as learning goals. Beth stated:

> I think it's interesting because we're redefining our mission statement, and as we are living into this 21st century learning that for so long we kind of talked about as a goal. I think the mission has changed. It's always been to provide a comprehensive education for our students. Now I think we're shifting our emphasis on a globally minded comprehensive education to create global citizens who are critical thinkers, who know how to develop those 21st century skills that are going to be really necessary in the next several years and to create or to help students know enough to be able to create and direct their own futures. So instead of preparing them for one future, preparing them to be able to do anything.

Self-efficacy is one's belief in their own competence and ability. Students with higher levels of self-efficacy towards what they are learning tend to be more motivated to educate themselves (Bandura, 1997). Having a motivation to learn and confidence in one's own ability to learn is important when preparing for an unknown future. Sandra, the math teacher, also touched on self-efficacy but described it in terms of responsibility and ownership of one's learning. She added:

> I would say obviously that responsibility and ownership are a big one in terms of relating that to a student's behaviors, academics, policies in classrooms, and just how they, I'd say,

manage their work in terms of what they do for each class. Because I know it looks a little bit different for each course but trying to be consistent in terms of what does responsibility ownership look for each of those classrooms, as well as that authentic learning.

Beth emphasized critical thinking as a highly important skill in a digital age where information can be easily accessed at any time. She described critical thinking in terms of making sense of information and solving complex problems. Memorizing information is less important when it can be easily accessed on the Internet through devices that we carry with us. However, since information is abundant, people must know how to quickly filter and make sense of information. People must know how to distinguish good information from bad information (Dede, 2010a). Related to this, Beth stated:

> I think that critical thinking is the biggest. We are long past a world where students sit and receive information and memorize that information and then regurgitate it back to you. At least I hope we are. And so, the ability to really understand and dig into the material that we're giving them. I always say that if I'm teaching students something that they can look up on their phones, information that they have in their pockets, I'm wasting my time. But what I do need to do is teach them what to do with that information, how to evaluate and assess that information, how to synthesize that information and then again what to do with it. So, I think the critical thinking, the kind of problem solving, complex problem solving, again, not waiting for a right answer to come to you, but really thinking through a problem. Looking at it from multiple angles, getting diverse perspectives to address it.

Mark, who teaches the business classes at BHHS, also emphasized 21st century skills as the educational goals. He stated that teamwork and collaboration are becoming more important in college and the workplace. This is consistent with what other experts and organizations have stated (Dede, 2010a; Partnership for 21st Century Learning, 2015; Sawyer, 2019; Wagner, 2008). Describing the education goals at BHHS, Mark stated:

> It's like your 21st century skills. Collaboration, communication, project-based, working together, real world experiences type of things. That's where it fits us as a business curriculum. Those are the skills that we try to drive through all of our classes. I will say the majority of our classes that we offer are project-based classes, which essentially fits the college experience along with the work experience. Everything's going to teamwork and collaboration. So those are the essential skills I think that are important for high school students to come out of high school. No matter if they're going down the four-year track community college, transferring to a four-year college or going into the workforce. I mean all of those skills are essential no matter what avenue they get into after high school.

Overall, in examining the educational goals at BHHS, it was evident that the emphasis was on developing 21st century skills that transcend subject-based content knowledge. The participants had a sophisticated and cohesive understanding about 21st century skills. Skills identified were use of technology, critical thinking and problem solving, global awareness and understanding multiple perspectives, empathy, communication, dealing with complexity, collaboration, and self and collective efficacy. Additionally, the 21st century skills that were described by the participants and depicted on the school's website were consistent with what

scholars, business leaders, and organizations identify as skills being important for success in life after high school.

Learning/teaching activities. The findings related to learning/teaching activities at BHHS were gathered through interviewing the participants, direct and participant observations, and discovering physical artifacts. The learning/teaching activities in both the traditional and the flexible-plan spaces were described and observed as being predominately student-centered. However, teacher-centered activities such as direct-instruction did occur in both spaces, but it typically lasted only for short periods. The main difference in the learning/teaching activities between the traditional and the flexible-plan spaces was in terms of dimensionality. The learning/teaching activities in the traditional spaces were more unidimensional—a limited number of learning/teaching activities (predominately student-centered) were taking place at a time. The flexible-plan spaces were multidimensional—a range of learning/teaching activities (predominately student-centered) were taking place at a time. Furthermore, during a class period, there was greater range of activities, and the transition between activities was much more fluid in the flexible-plan spaces. Activities in the flexible-plan spaces also were spread out to adjacent spaces, whereas in the traditional spaces the activities were confined primarily to the classroom.

During my visits, I observed learning/teaching activities in both the traditional and the flexible-plan spaces that included direct-instruction, class discussion facilitated by the teacher, small-group discussions, small-group project work, individual study, individual project work, and student presentations. Overall, the activities that took place in the traditional spaces could be considered student-centered. For example, I did not observe a teacher lecturing for the entire period and instead noticed short lectures followed by whole-class or small-group discussions.

However, I typically only noticed one activity—whether it was a short lecture, whole-class discussion, small-group discussion, or others—taking place at a time. I observed quite a bit of discussion in groups about the content that was being covered, whether it was between the teacher and the whole class or small groups of students. Dan, who teaches the business classes, described it this way:

> So, you know that there's been a shift within the last… Prior to having the spaces that we have now. There was a shift where you don't have the teacher, I mean there's classes that have this as well, so I don't want to paint the wrong picture. But more the shift was from the teacher leading and the students learning to now a student-centered learning where at some points students are teaching the lesson. Students are, I feel like always in groups no matter where you walk throughout the building, whether it's a small group, whether it's a whole class circle type of group.

Similar to the learning/teaching activities in the flexible-plan spaces, in traditional spaces there was an emphasis on discussion and students taking the lead in the conversation. This activity was student-centered because the students were formulating and modifying their initial understanding of the topic being discussed (Land & Hannafin, 1996). There was quite a bit of student discussion about what was being learned. Lisa, a science teacher who teaches in a traditional space, described student-centered learning activities:

> So, at least in science we will start with a phenomenon, and we are asking students to make sense of it. So, you won't see, usually, you won't see desks in rows because it doesn't help with collaborating. So, usually we have students facing each other, either in tables, or a lot of times here we do have tables with wheels, so we'll ask them to come together, then break them up depending on what we're doing. But especially in science,

there's a lot of student talking, because the person talking is the person learning, and so that's what we want to see, is more students talking instead of the teacher directing everything.

While the school's website states that the organization of the flexible-plan learning communities is intended for "increased interdisciplinary connections" and several of the participants talked about interdisciplinary learning, I did not observe much interdisciplinary learning activities except for English and social studies that were being co-taught. The students have one class called ID that is for interdisciplinary learning; however, most courses offered to students are still subject based. Thus, the opportunity for interdisciplinary learning is limited. Overall, the learning/teaching activities I observed were primarily focused on a particular subject.

Each of the 9th and 10th grade learning communities that are in the new addition of the school are organized around the four core subjects: math, science, social studies, and English. The teachers share a teacher collaboration room (workroom) where they informally meet daily. Additionally, they meet formally on a weekly basis. During the formal meetings is when most of the conversation around interdisciplinary learning takes places. Beth commented on this:

I think the formal meetings help with that first and foremost. Hey, what are you teaching? How are you approaching it? What kinds of skills and strategies? And also, the interdisciplinary class, because you see what kids are working on, so you can kind of peek over their shoulder and see, oh, this math assignment is kind of similar to the way that we approached this sentence structure assignment. That's interesting. We can think about it that way. So, I think that really builds up the kind of cross collaboration. But yeah, I think, like I said, the kind of off the cuff, casual conversation in the work room

has been the best for that. It's just, hearing or overhearing two other teachers planning and then sticking my nose in to ask questions. That has been a big change from when we were separated by department.

During one visit, I observed the teachers in the 10b SLC during their formal weekly planning meeting. They were discussing field trip opportunities for the students where they could draw interdisciplinary connections, but that was for a special circumstance and did not extend to what was happening in their classes on a daily basis. The goal for interdisciplinary learning is for students to be able to view difference perspectives and to synthesize phenomenon across traditional disciplines (Jones, 2010). In a conversation with Howard about interdisciplinary learning, he stated that while it was a goal, a barrier to fully implement it was their schedule and course offerings. Classes are currently still organized into traditional subjects. Howard stated that next year they are going to start offering career-focused "pathways" that integrate subjects.

In the flexible-plan spaces, I observed, and the participants described, a lot of variation in the amount and type of learning/teaching activities. In this sense, the learning/teaching activities were multidimensional. In multidimensional classrooms, students are working on a range of different activities and may even be working at different paces (Schunk, 2011). Sandra, who teaches math, described the learning/teaching activities in her class on a typical day:

> When they first come in, we usually try to do a warmup, so they can pull out their notes, they can work with their group. It's usually about five minutes of just work on the lesson. Usually it's a review from something we did the class before or it's something that's to get them prepared for something we're about to do that day. Then after we've gone over the warmup, then we start the actual lecture. If it's geometry or algebra II, it's more teacher-

> led instruction. If it's honors classes, we usually try to have more student investigation… They'll get some time throughout the class to do some practice with each other, whether I do some group stuff or just partner work. Usually at the end, we just wrap up the lesson, so we'll talk again like, "Oh, what did we learn about today?" Or, we'll try to review what we already talked about before.

Sandra's description of the learning/teaching activities in her class was consistent with what I observed. During the 90-minute class block, the learning/teaching activities oscillated between whole class activities and small group work. The learning/teaching activities ebbed and flowed throughout the period. At times the class would come together for either group discussion or for direct instruction by Sandra, and then they would disperse into small groups of three to four students while Sandra worked with the group or with an individual. At any given time, students were typically working on the same activity, whether it was individually, in small groups, or as a whole class.

For Beth, who teaches English, the learning/teaching activities vary day-to-day but also follow an ebb and flow of coming together as a whole class and dispersing into small groups or individual activity. She described a typical day:

> So, the first five minutes of class we're doing something. Sometimes it has to do with class, sometimes not. It can be just a little warm up, partner discussion. I like doing side-by-side arguments, so I put up a "would you rather" and they go to either end of the classroom and then argue at each other. That's fun. So, after that we would do, again, either a piece of writing or reading or a literary circle.

Throughout the year, the learning/teaching activities vary depending on the unit or topic being covered, but the range of learning/teaching activities still flows from some direct instruction to working in small groups or working individually. Beth described:

> It's different every day, which I really love. I don't know that any two class periods in a single unit look alike. Usually there is some sort of direct learning that we're doing all together. Small group learning that they might do at a table and then an individual component somewhere in there, if I had to break it down in that way. And then yeah, across the unit or across the year, we kind of pull from all of those ideas. We do a lot of collaborative work. We do a lot of group discussion. Even if it's casual, sometimes I'll ask a question of the whole class and no one has an answer for me. So, I'll step back and say, talk at your tables for five minutes. Get back to me. Instead of 10 years ago I probably just would have given up and given them the answer that I was looking for. So really using that model of talk to each other, figure it out, maybe do a little research, come back and tell me what you know. So really something different all the time.

Beth also co-teaches some of her classes with the social studies teacher in the 10b SLC. They combine their classes so they can have more flexibility with their time. For the classes they co-teach, both Beth and the social studies teacher share the same students. During a 90-minute block, a group of roughly 30 students are assigned to Beth for English and another group of 30 are assigned to the social studies teacher. In the next 90-minute block, their assignment of students is switched. Together, they both have the same 60 students, which gives them flexibility for how they use their time over the entire 180 minutes. Beth described it this way:

> You know, our classes… we have block schedule, so I have a 90-minute class. And actually, because another teacher and I co-teach for two of our classes, or really four of them, we have a three-hour block with 60 kids that we get to break up however we want, which is really fun.

While co-teaching, both Beth and the social studies teacher structure activities for their individual classes but also across both of their classes. Beth described this approach:

> So typically, on a day where we're doing kind of more separate lessons, they're not as integrated, I'll have three or four activities and then she'll have three or four activities. Once in a while we bounce back and forth, so she might do a mini lecture about a topic, and then I would do maybe a reading that is an example of the content she was just teaching, and then we would go into maybe a group discussion about how we can bring all of those things and all of those ideas together. We might then ask them to produce something. If it's for me, it's probably going to be an analytical paragraph or a video explaining their thinking. For her, it might be more of, we're trying to really help them understand the difference between writing for English and writing for History. There is a kind of a big difference in terms of the open-endedness of literary analysis versus the straightforward detail of a history paper. And so, we kind of go back and forth like that.

Some barriers were identified for why the learning/teaching activities did not align with the educational goals. As previously mentioned, Howard identified the course offerings and schedule as barriers to interdisciplinary learning. He stated that because courses are still offered as independent subjects it is difficult to schedule the same students to multiple teachers for a block of time. Next year they are going to start offering what they call “pathways” to address interdisciplinary learning. Students taking a pathway would get credit in multiple subjects.

Sandra identified the curriculum as a barrier for why they cannot embrace project-based and authentic learning in math. She stated:

> With math, I know we have a lot of opportunities to kind of have that authentic learning in there, but unfortunately, we're very curriculum based. We haven't really branched off to those projects yet. That's something that my team has been working on is trying to get more common with each other first, vertically and horizontally, and then we want to start building off into some more authentic projects or service-learning projects.

Sandra noted:

> Now that we can see hey you guys are all really good at noticing this, but you didn't make this connection, then we'll go back and try to find ways that they can connect those a little bit better. I'd say kind of naturally we do a lot more of the inquiry, the investigation, and those higher-level thinking. But yes, we need to work on some of the… We don't do a lot of technology in ours and things like that. I feel like there's a lot of other skills that I feel like we can get to, but we don't ever do because of the curriculum kind of holding us a little bit more.

Overall, in examining the learning/teaching activities at BHHS, it was evident that student-centered learning happened in both the traditional and flexible-plan spaces; however, the main difference was in terms of dimensionality and ease. The learning/teaching activities in the traditional spaces were more unidimensional—a limited number of learning/teaching activities were taking place simultaneously. While the flexible-plan spaces were multidimensional, a range of learning/teaching activities were taking place simultaneously. Furthermore, during a class period, there was a greater range of activities, and the transition between activities was much more fluid in the flexible-plan spaces. Activities in the flexible-plan spaces were also

spread out to adjacent spaces, whereas in the traditional spaces, the activities were confined primarily to the classroom. There were other barriers, such as course offerings, schedule, and the curriculum, that limited the learning/teaching activities to more fully align with the educational goals.

Affordances of the physical environment. The findings related to the affordances of the physical environment at BHHS were gathered by reviewing school documents found online or directly requested, by interviewing school administrators and teachers, and through direct and participant observations. Overall, the affordances of the flexible-plan spaces were much more varied and nuanced than the traditional spaces. Affordances of the traditional spaces were contained within the classroom, whereas the affordances of the flexible-plan spaces extended across the range of spaces within the SLC.

The traditional spaces were typical classrooms aligned along a corridor. The four walls constrained the activities to within the classroom. The adjacent corridor was intended only for circulation, but it did afford some breakout activities. Occasionally, students would go into the corridor and work individually. Since the corridor did not have any furniture students would either sit on the floor or would bring a chair out from the classroom. The only visibility to the corridor from the classrooms was through the doorway. This limited teacher supervision of the corridor.

The majority of furniture within the traditional classrooms had casters and afforded flexible reconfiguration. This allowed for many different arrangements that could support a variety of activities within the classroom. Since the classroom was one open space, it limited having multiple activities take place simultaneously. For instance, multiple activities, such as the

teacher giving a lecture to a portion of the class, students working in groups, and students studying independently, were not able to take place simultaneously.

The traditional classrooms also constrained teacher collaboration and team teaching. In the traditional part of the building teachers were assigned to each of the classrooms and therefore did not regularly interact with other teachers. In addition, they were grouped in areas of the building by subject, so a teacher would have to make an effort to see another teacher in a different subject. This organization limits opportunities for interdisciplinary connections.

The flexible-plan spaces are organized into SLCs. As such, the various spaces within the SLC have a relationship with each other and afford learning/teaching activities to spread out and not be contained to one particular room. Transparency and large openings between some of the classroom spaces and the commons space allowed for classes to flow out into commons space while the teacher could still maintain sightlines to students. Beth commented:

> My glass door is usually open. I usually have kids in the commons, I'm walking around, I'm talking. But the other three classrooms in my learning community don't have that. So we have the chemistry lab that's on an angle on a side with a real door, and if the Chem teacher, well first of all there's no lab stations out in the commons, so they're probably not going to be out here as much any way. But it's difficult to be able to see and monitor from the other rooms into the commons. So the double room gets the most use out of the commons simply because visibility, the ability to monitor your students, and because the other three rooms have those real physical doors

The components and organization of the learning also provided affordances where the sum was greater than the parts. The school's website states:

The creation of learning communities is the result of extensive research, site visits, and collaboration with schools currently in practice. This structure allows for:

- Increased interdisciplinary connections
- Greater personalization for individual student needs and experiences
- Stronger relationships between staff and students
- An elevated community climate

The learning communities are organized with teachers in each of the four core subjects: math, sciences, English, and social studies. The spaces in the SLC are designed to support the different subjects but also for creating opportunities for the teachers in each subject to interact with each other. Beth commented that the SLC affords increased interdisciplinary connections:

> I think that I've been able to see or at least hear about teaching in other disciplines more than ever before. When we were at the old high school, I was in a hallway with English teachers. So, even if I were just walking through the hall, listening in on conversations, it was all about English. Now, because I'm going to work here with a Chemistry teacher, two Math teachers, two History teachers, and I'm hearing a lot more of those conversations at least even if I'm not seeing the teaching itself.

The teacher collaboration rooms also contribute to making interdisciplinary connections. The teachers do not own the classrooms and so when they are not teaching, they are working together in the teacher collaboration room. Beth commented:

> The kind of off the cuff, casual conversation in the work room [teacher collaboration room] has been the best for that [interdisciplinary collaboration]. It's just, hearing or overhearing two other teachers planning and then sticking my nose in to ask questions. That has been a big change from when we were separated by department.

As for providing greater personalization for individual student needs and experiences, the flexible-plan space in the SLC allows students to find the space that is most conducive to the activity they are doing. Sandra described how students in her math class used the range of spaces:

> I've figured out that they all like their own different spots. Some of them like staying in the room, they're like, "No, I want to be close to the teacher. Once I'm away from you, I feel like I just don't get the same work ethic out of them." Whereas other students are like, "No, I need to separate so I'm not so dependent on you that I can kind of think and talk through some of the things that I want to actually talk through if you were right there." And then like I said, some people like the bump out rooms where it's just more independent, quiet space, where they can be left alone, and they can go back and just review their own stuff.

Overall, in examining the affordances of the physical environment at BHHS, it was evident that the affordances in the traditional spaces were limited compared to the flexible-plan spaces. Affordances of the traditional spaces were contained within the classroom, whereas the affordances of the flexible-plan spaces extended across the range of spaces within the SLC. While the flexible furniture in the traditional classroom afforded different learning/teaching activities, it was unidimensional in that only a limited number of learning/teaching activities could take place simultaneously without interference. The flexible-plan spaces afforded learning/teaching activities that were multidimensional—a range of learning/teaching activities can take place simultaneously.

Teacher adaptation to flexible-plan spaces. The findings related to teacher adaptation to flexible-plan spaces at BHHS were gathered primarily through the triangulation of interviews

with the participants. The main finding was that teacher adaptation to flexible-plan spaces was really about adjusting to working collaboratively with other teachers and learning how to share spaces. Because the spaces had transparency and there were common spaces that teachers shared, teachers' practices were exposed to one another, and they had to work together. This is different compared to a traditional classroom where a teacher could simply shut their classroom door and isolate themselves from other teachers.

Robert, the principal, commented that change is hard for teachers when the norms of a comprehensive high school have been the same for a long time, so moving to an SLC model is difficult. He stated:

> But one of the interesting observations that I find is, especially in the comprehensive high school, it's been traditional for a long period of time, teachers sometimes have a hard time living in a community and so we have to spend a lot of time on norms and expectations

Robert further commented that it took time and a lot of hard work to build a new climate and culture that embraced what the new flexible-plan spaces were intended to support—collaborative teaching and learning. He stated:

> One of the things that you find is you step into those spaces there would be that when you first get into the building it's just getting staff settled and then you're really the staff the building leverages it to a new climate and culture which is yet to be developed. So a lot of what we spent was helping staff live into the building and feel situated in there and then building that culture of learning that we want to and then—I felt with a lot of staff it wasn't until year two or three that we then started really saying we're settled we know our roles because a lot of them we had a couple of teams going but we didn't have all of the learning community teams going and we had to tend to some of the adult behaviors just

> getting those norms and expectations [and] teams up and running which spoke to the culture of the building and now we're to the point where I think we're getting everybody to envision themselves as innovators, as lead learners and now I think the progress will be even more rewarding and worthwhile, and in year three, four, five and now six so I don't think we're starting to get our stride even faster and better but I think the next two or three years will be really exciting.

Sandra, the math teacher, talked about the mindset you need as a teacher to adapt to flexible-plan spaces. She stated:

> There's definitely a mindset of you have to be flexible, you have to be willing to try new things, you have to be okay with mistakes, and you have to be okay with being transparent. Just because it's okay if things don't go well, but you have to be able to openly talk about it or let your colleagues come in and view those things so that way they can point out to you what's working and what's not. It's kind of scary, but just, yeah, the being vulnerable, but also being willing is the biggest thing. Just because we have some staff members that I feel like can be flexible when they're on a team, and they can be risk takers, but then when you put them on a whole team scenario where they have to consistently do this for an entire year, I feel like it's different. It's got to be someone that's fully committed to actually wanting to be on a team, I think.

Overall, in examining teacher adaptation to flexible-plan spaces at BHHS, the main finding was that it was not entirely about adapting to the space, but rather to what the space is intended to support—community and collaborative teaching and learning. It took the school time to establish norms and build a climate and culture around the SLC model.

Case #2: Milan High School

The results for this case are organized into seven sections: (a) a background description of MHS to provide an overall context, (b) a description of the physical spaces that were included in the study, (c) a brief description of the participants, (d) an analysis of the 21st century learning goals, (e) an analysis of the learning/teaching activities, (f) an analysis of the affordances of the physical environment, and (g) an analysis of teacher adaptation to flexible-plan spaces.

Background. Milan High School (MHS) is a public school located in Milan, Michigan, which has areas that are suburban and rural. MHS is the only high school in the district. The district, Milan Area Schools, serves over 2,100 students (K-12) who are primarily White (85.18%), followed by Hispanic/Latino (5.25%) and African American (3.77%). The percentage of economically disadvantaged students is moderate (33.2%). The graduation rate is nearly 85%, and just over half of the students continue on to post-secondary education (*MI School Data*, n.d.). According to the school's Annual Education Report found on their website, MHS enrolled approximately 780 students in grades 9-12 during the 2017-2018 school year (*Milan High School*, n.d.). MHS ranks 2,889 out of 17,245 high schools (83.25 percentile) nationally and 108 out of 650 high schools (83.38 percentile) in Michigan in the 2019 *U.S. News* Best High Schools rankings. The rankings are based on six measures: college readiness, college curriculum breadth, reading and math proficiency, reading and math performance, underserved student performance, and graduation rate (*U.S. News* High School Rankings, 2019b). In general terms, MHS is considered to be a good school, but is not as academically high-performing as BHHS. Similar to BHHS, there were no measures found to determine how effective MHS is regarding 21st century learning goals.

Milan High School follows a traditional high school model for grades 9-11. Classes are compartmentalized into the core subjects of English, math, science, and social studies, along with elective choices in physical education & health, visual & performing arts, and foreign languages. These classes are taught in the traditional portion of the school and are grouped together by subjects/departments. Grades 9-11 at MHS follow a traditional daily schedule with seven 50-minute periods. During the 11th grade, students are required to take the Michigan Merit Exam to be eligible for graduation. The Michigan Merit Exam consists of a three-part assessment including the SAT, WorkKeys, and the M-STEP.

In 12th grade, all students—unless they opt out—attend the Milan Center for Innovative Studies (MCIS). Only about 10-15% of the students opt out. Students who opt out do so because of scheduling conflicts with elective classes, such as band and choir, or because they choose to take dual-enrollment classes at the local community college or take online classes. The MCIS is a 23,000 square foot addition that was added onto the school in 2012. It features flexible-plan spaces, and the core subjects are taught interdisciplinary. Students attend the MCIS for a half-day session and receive credit for social studies (government) along with two other core classes – English, math, and science – from which they can choose. The four teachers in the MCIS team teach, and learning is project-based. The MCIS was specifically designed for project-based learning with an emphasis on developing 21st century skills.

Description of spaces. Two areas of the school were observed: a wing that had traditional classroom spaces, and the MCIS that had flexible-plan spaces. The traditional area had four classroom spaces that were aligned along a corridor—two classrooms on each side. The corridor was lined with lockers. The classroom doors had a narrow window that allowed one to see into the classroom. The classrooms were typical. There was a teaching wall at the front of

the classroom that had a whiteboard for dry-erase markers and for projecting an image from a digital projector that was mounted on the ceiling. The teacher had a desk at the front of the room. Students sat at individual chairs that had fixed tablet arms. The perimeter of the room was lined with bookcases and storage cabinets that stored books and resources. Windows on the outside wall brought some daylight into the space.

The MCIS does not look like a traditional school but rather resembles a modern workplace (Figure 3). It has two levels. Classrooms are organized around a large two-story, wedge-shaped space in the center that is called the Innovation Zone. This space is filled with a variety of tables and chairs and comfortable soft seating. Natural light floods the space from high, clear, story windows and large expanses of windows at both ends. A large *gathering stair* at one end of the Innovation Zone connects to the upper level. The gathering stair is made up of tiered seating platforms for about a hundred people and has a staircase on the side. It faces a wall with a large screen that is used for large group presentations.

Figure 4. Flexible-plan spaces in the MCIS at MHS.

On the lower level, six classroom spaces flank the Innovation Zone, three on each side. Large expanses of glass walls allow for direct visibility into the classroom. The classrooms have different features and are designed for different purposes. Two classrooms, called the Collaboratory, have a wall between them that completely opens up to make one large space. There is a makerspace that is called the Production Lab. This space is a shop space that has a variety of tools and lots of storage. There is a computer lab that is called the Design Lab. This classroom is filled with computer workstations in cubicles. There is a science classroom that is called the Exploration Lab. It features typical science tables and equipment. Lastly, there is a typical classroom space that is called Senior Transitions. There is a teaching wall, and students sit in chairs grouped around tables.

Figure 5. Common area at MHS.

On the upper level adjacent to the gathering stair is an open space that overlooks the Innovation Zone below. This space is called the Loft and features a variety of table and chairs and soft seating similar to the Innovation Zone. Adjacent to the Loft is a teacher collaboration area. It is an open office space with workstations around the perimeter for each of the teachers.

In the center is a large table where teachers can come together to work. There is also a conference room near the back of the teacher collaboration area. Next to the teacher collaboration area and connected to the Loft is an area with three restaurant-style booths. These are called POD Bays and can each accommodate up to six students.

Description of participants. The principal: Bill, and five teachers—Seth, Ellen, Jim, Danielle, and Laura (all pseudonyms)—were interviewed at MHS. Following are brief descriptions of each of the participants to establish their background and point of view in order to give context to their interview responses.

Bill. Bill is the principal at MHS. I met with Bill in his office during my first visit to MHS. Bill greeted me warmly and jumped right in talking about his school and especially the MCIS program. I had to ask him to pause for a moment so I could start recording the conversation. Bill was candid and realistic about the challenges to teaching and learning in a public school. After the interview, Bill gave me a tour of the school. When the MCIS first opened, Bill was a teacher at MHS. He left the district but then came back three years ago to become the principal at MHS.

Seth. I interviewed Seth during a snow day by video conference. He was at home with his dogs. He was quite generous and helpful and spoke with energy about the MCIS program. At the end of the interview he mentioned he could talk about teaching in the MCIS for hours. It was clearly evident that he loved teaching.

Seth has taught at MHS for 12 years. He started out as a student-teacher and then was hired on full-time, so all his teaching experience has been at MHS. His background is in physics and math. He currently teaches in the MCIS and is the science lead. The course he teaches is called Applied Physics; however, Seth does not really consider it to be a separate course since he

team teaches in the MCIS alongside the math, science, and English teachers. Prior to teaching in the MCIS, Seth taught science in the traditional area of the school.

Ellen. I met with Ellen at the end of the school day. We sat on one of the soft furniture pieces in the large common space of the MCIS. Ellen was very talkative and spoke with passion—you could tell she loved teaching. Ellen teaches in the MCIS and is the English lead, which she describes as being "more communications-based English, so not like literature, reading, anything like that." She also helps the students with video production and graphics. She is certified to teach math and English and said, "Math is my first love; English was the next thing."

Ellen has been at MHS her entire career. She student-taught in the math department in 2006. In 2007, she was hired to teach a video production class which she had never taught before. She compared teaching the video production class to math as:

> My first real look into alternative type learning, in the sense of math is very rows, columns. Day one you do section 3.1, day two you do section 3.2, like that. Video production was not like that and I loved it, but I also loved the other.

In 2009, Ellen, along with a handful of other teachers, were "volun-told" by the principal at that time to be on a committee to develop a new program for the senior class which ended up becoming the MCIS. This included giving input on the physical design of the MCIS. Early in the design process, the committee toured a school in Philadelphia that had an open layout and soft furnishings. This helped the group get a sense for how innovative learning spaces looked and functioned. Erin commented, however, that the program at the school they toured was failing. As the design of the MCIS progressed, the committee reviewed several iterations of the plans and gave feedback on the overall layout, size of spaces, and storage requirements. When

the new space opened in 2012, she started teaching in the space and has been there ever since. She is the only teacher that has been in the space since it opened.

Jim. I met with Jim in the MCIS computer lab. It was during his prep time, and he was working on a graphics program setting up materials for a student project. Jim has a calm demeanor and speaks with wisdom. Jim has been teaching 16 years at the high school level with 15 of those years being at MHS. He has taught a variety of social studies classes including civics, economics, and government. He has also taught technology classes including computer graphics, Internet, and design. He has teaching certifications in economics, political science, and computer science. He has been teaching in the MCIS for seven years and is the government lead.

Danielle. I met with Danielle during her prep period in the large common space of the MCIS. She was polite and friendly. She has a degree in integrated science and mathematics and started teaching in the MCIS six years ago, right out of college; therefore, she has taught only in a flexible-plan space. Her role in the MCIS is as the math lead. Like the others, she described her role as more than simply teaching math. She stated:

> The course that I technically teach is integrated math two, so anything that we do down here, math related, I take the lead on that, and then, fill other various roles. You'll see today there's a lot of other, not content, things that we do.

Laura. I met with Laura by video conference at the end of the last school day just before the winter holiday break. Laura is a science teacher and has been teaching for 19 years. She is certified in biology and chemistry. She currently teaches in a traditional science classroom in the science wing of the school; however, in the past, she taught for a couple of years in the MCIS. She has taught every subject in the science department except physics. She described her

experience teaching science in a traditional classroom setting ranging from a traditional format to a project-based format. In her words:

> In my time I have done everything from your more traditional format of classroom teaching where if, say in a chemistry setting, working on practice problems ... Maybe I would say it looks more like a math class, if I was teaching that along with lab experiments. I have done project-based learning in my traditional classroom setting where I did things like forensic science units, crime scene investigation that was tied to chemistry standards.

21st century learning goals. The findings related to the 21st century learning goals were gathered through reviewing documents on the school's website and interviewing the participants. The main themes that emerged from the data were: (a) there was a focus on preparing students for success for whatever path they take after high school, b) that 21st century skills were viewed as basic or soft skills, c) that the 21st century skills identified were consistent with recommended frameworks, and d) that there was an emphasis on different goals based on standardized testing pressures.

The educational goals found on the school's website, seen on posters displayed throughout the school and espoused by the participants, were consistent with the Partnership for 21st Century Learning (P21) framework. The school district, Milan Areas Schools (MAS), created their own framework for 21st century skills which is intended to guide learning at all grade levels in the district. It is based on the Partnership for 21st Century Learning (P21) framework and is called Milan 21. On the district's website is what they call their "Theory of Action" for Milan 21 which states:

In order to empower students to achieve excellence in the modern world, MAS will provide every student with a rigorous and authentic educational environment that:

- Develops 21st century skills
- Fosters meaningful and diverse relationships
- Promotes personalized learning
- Embraces teamwork
- Cultivates learning in a highly digital world

Interestingly, many of the participants described the main educational goal at MHS as simply students being prepared for success after high school for whatever that means to each student. Seth stated:

> I'd say that the educational goals are really to prepare our students for success after high school and to give them the best foundation and starting point to keep options open for them, whatever it is that they choose to pursue.

Seth's response acknowledges that students may be doing different things after their high school experience at MHS; therefore, students need to learn skills that prepare them for many different pathways. Jim's response touched on this point further. He stated:

> I think we want to prepare kids for their next phase of life. Traditionally that's been college degree but recently it's been flexing a little bit more towards their career goals and whatever those might be, whether it's four-year or two-year trades, some kids just the workforce and being ready for it. But our goal is to help them be ready for whatever they see is their next phase of life past high school.

Laura also commented that the educational goal is to prepare students for their life after high school. She described them as basic skills. Laura stated:

> Then as they're leaving it is having them have a basic skillset where they can go off into their next step in life, if they want to go to college, military, trade school, community college, whatever that might be, all pertinent to whatever the student's abilities are and so forth.

There were two sets of educational goals at MHS. For grades 9-11, the educational goals included 21st century skill development but still seemed heavily focused on learning subject-matter content due to state testing. All of the state-required testing is completed in 11th grade. In 12th grade, the students no longer have state testing requirements, so instruction is not constrained by those requirements. They can actually emphasize to a greater degree the development of 21st century skills. The participants all made the distinction that the educational goals are different for 12th grade. They stated that developing 21st century skills is important for all grade levels, but they acknowledged that in grades 9-11 there is heavy emphasis on academics and preparing students for standardized testing. Jim stated:

> We do have in the nine, ten, eleven a heavy focus the more traditional college-bound curriculum and preparing kids for the standardized test that they need to take, SAT, was the ACT, now the SAT. So, we want kids to have this opportunity to follow the path that fits them best. We do the traditional college test preparation, traditional curriculum.

Jim continued to describe how the MCIS program is different in that it is focused on skill development. Jim stated:

> This program I think has a different set of overarching goals than the rest of the school. The rest of the school is very much focused on the traditional college preparation in terms of the academic bookwork that's required to be successful in either a two-year or four-year institution. This program is trying to hit skills that they need in those programs, the

two-year and four-year but you don't typically think of that you need. When you get to four-year institution you're going to have to work on team projects, you're going to have to work on real world problems in addition to typical academic work but we're trying to give them the soft skills to be able to work with other people and get along and communicate… talk to their professors. I mean if all you ever do is bookwork and you don't learn to talk to people, you're really at a disadvantage. So, we're trying to get them ready to be adults, in a sense, where they are managing their own time, their focus on things that are interesting to them, they're making choices… some good, some bad… about how to use their time and what to focus on. We're trying to work on other things that aren't typically academic things that they need, other skills they need.

The participants did not explicitly list which 21st century skills are important as their educational goal. Instead, they defined them more broadly as skills that are needed for success in their life after high school. For instance, Ellen eluded to critical thinking skills but stated:

> Our goal is to create well-rounded students that not only know how to reiterate what a teacher says, but they're able to ask their own questions and get their own answers and know whether their answers are logical and within reason of ... are factual. We want them to be able to use us as coaches, not as teachers. Kids have this idea that teachers, whatever they put on the board is factual and golden and that's the only thing that they should remember and then they forget that they have to think for themselves too.

Several of the participants used the term "soft skills" to describe 21st century skills. Jim considered communication, collaboration, problem-solving, critical thinking, and being comfortable with ambiguity as soft skills. Jim stated:

> So, in this program we really are focusing on what people typically call soft skills, so the ability to communicate with other people effectively, the ability to work in teams, the ability to think through a problem that's not a traditional academic problem that's more of a workforce problem and in order to do that they have to have critical thinking skills. So, our focus is to give them projects there aren't clear-cut answers for, there's a thousand different ways to do them, and it's not like there's one right answer to the project, there are many right answers. That ambiguity is hard for the kids because they're very used to there being a right answer and a wrong answer and when you say no, there are better ways to do it and they're not so great ways to do it, that can frustrate kids.

Danielle used the term "social-emotional" to describe the 21st century skills that others were calling soft skills. She touched on a variety of skills that the others mentioned but also included time management and technology literacy. She stated:

> I'm sure you've heard from the other instructors, as well, that this program really focuses on the social-emotional aspects. We call them 21st century skills, so collaboration, and time management, and technology literacy, and a lot of other.

Danielle further stated:

> Our focus is definitely more towards the social-emotional stuff rather than the content. Once a week I do a traditional math class but most of the time it's, I'm working in an open space like this and it's not super math heavy… use some graphs and charts, and things that for most of the projects. But our focus is definitely more on working with teams, and how you solve conflict within the team, and how do you problem solve, or troubleshoot an issue that you're having a computer, or just fixes for different things. And then, for all of our projects, they do a lot of research at the beginning. So, just how do you do quality

> academic research is really important to us, which I know that's important at the other end too, but definitely help getting the students, and how do you manage yourself and your tools? How do you manage your time in a way that will make you successful once you will walk across the stage in June, in a way that you can either go into the workforce, or go to college, or some other sort of post-secondary something and be able to put what you've learned throughout your career at Milan area schools to good use basically, and how you apply it?

Seth also commented on the difference in the emphasis on goals between grades 9-11 and 12th grade. He made a clear distinction that in grades 9-11 the focus is on academic content, and that 21st century skills are secondary. The MCIS program was created specifically to focus on developing 21st century skills, but what makes it possible to do in 12th grade is that the students are past taking standardized tests. Seth stated:

> In terms of the high school, obviously the MCIS is really focused on 21st century skills. That's our prime, kind of our major goal. And we're really fortunate that we're able to do that, given that all schools, the test scores and academic achievement are important. And for senior year, we're past the high stakes testing, into where we have the options to kind of work and be explicit with that instruction whereas in classes prior to senior year, we're kind of doing both. We're really working, prepare with rigorous academic content and also my colleagues are interweaving 21st century skills with the content instruction.

Bill described the different educational goals as a balance between skill and content. While both are important, the emphasis on each change is based on outside pressures. Because of the standardized testing in 11th grade, the focus is on content in grades 9-11. Additionally, there are some students who opt-out of the MCIS program to take advanced placement (AP)

classes. These students are looking to get into four-year universities. In order to prepare students for taking the AP tests there is a focus on content over skill, whereas in the MCIS program developing a skill is the main focus, and less time is needed for content. Bill stated:

> The balance of skill versus content and parent expectation for your top 25 or 30% on college acceptance, college readiness. Everything's geared towards four-year universities. Yes, but I don't think you could do this model for four... In my opinion, looking at how we do this, if a kid is truly going to be a... want to be a doctor, okay, well, AP chemistry and AP bio are kind of important. They're delivered in a different way because there's an expectation that my goal is really a five on the AP test. I've got to deliver. I need to deliver content to you at a pace that can get you the content needed to be successful, whereas we say down there, "What are the skills we really want to focus on?" I can spend less time on content and more time on that skill. That's not easy to do when it's Algebra, Geometry, Algebra 2, English 9, 10, 11, Biology, Chemistry, Physics. Well, there's still an expectation you have. Something that's not impossible, but that's harder than you think and balancing that is difficult.

Bill explained that the school's belief is that the MCIS program, by focusing on skills, does prepare students for success in four-year universities. However, because universities have entrance requirements that heavily emphasize test scores and taking AP classes, they have to focus more on content to prepare students for taking tests. Bill stated:

> There's a drive that college is it, and we are really trying to say that the value of a program like ours at MCIS will help you do better, but from polls saying area institutions, it's what are your SAT results? How many APs are you? What extracurriculars are you involved in? Until they truly say, until the University of Michigan stops posting that

they're average SATs are 1430, that incoming freshmen have eight APs, that Michigan State's a 1360 with seven APs and two language requirements, well, we can't remove that ability for our students. There's a value judgment there that's real or not real.

Bill continued to explain the reason for why some students opt out of the MCIS program to take AP classes. He also continued to elaborate on why emphasizing skills is important for success at four-year universities. He stated:

> We provide them with a good education, but our students definitely do them [AP classes] and I think that's part of the reason why they don't necessarily value a program like this [MCIS] when we will flat out get an email from a college counselor saying, "That program [MCIS] is not going to help your transcript." You say, "Yeah, but it's going to keep you from failing out because you have so much anxiety in your life right now that you can't handle the simplest… If anything in your life goes wrong, you meltdown. That's why you all drop out of college." That's why kids freak out and that's why Michigan State's… I'm sure their counseling department now is dealing not with academic issues but it's kids who can't handle any adversity in their life. "Well, my payment didn't go through. What do I do?" Well, why is your Mom calling the business department? That shouldn't happen. We've created kids who are really good at doing their job, but when something doesn't go according to plan, "Well, what do you do now? That professor didn't call back during this project?" Or, "You spent eight hours editing this video and its gone." Your project's still due next week. What do you do? If your partner doesn't show, what do you do?

In summary, the key findings from the data related to educational goals at MHS were: (a) there was a focus on preparing students for success for whatever path they take after high school,

b) that 21st century skills were viewed as basic or soft skills, c) that the 21st century skills identified were consistent with recommended frameworks, and d) that there was an emphasis on different goals based on standardized testing pressures. The participants recognized that students take different paths after they leave MHS. Some go on to college or university, some will go into the military, and some will go directly into the workforce. Therefore, an emphasis on developing 21st century skills that apply to all these pathways is important. The participants viewed 21st century skills as basic or soft skills. In this sense, they were not viewed as advanced skills that would only apply to a few individuals who might go on to get advanced degrees or work in highly skilled professions; rather, they were viewed as essential skills that all students needed to be successful in life.

In general, the 21st century skills found on the school's website, displayed on posters throughout the school, and espoused by the participants were consistent with those identified by different organizations. The school district even adopted portions of the P21 framework that acknowledge mastery of key subjects through 21st century themes: learning and innovation skills; information, media, and technology skills; and life and career skills (Partnership for 21st Century Learning, 2015). There clearly was a different emphasis on goals due to pressures from standardized testing in the 11th grade. Students in 11th grade are required to take the Michigan Merit Exam. In preparation for these exams, in grades 9-11 the emphasis is on subject-matter content, and developing 21st century skills is at the periphery. In 12th grade, students no longer take these exams; therefore, MHS created a program, the MCIS, to specifically emphasize developing 21st century skills. There are some 12th grade students who opt out of the MCIS to take AP classes that focus more on content over skill development.

Learning/teaching activities. The findings related to learning/teaching activities at MHS were gathered through interviewing the participants, direct and participant observations, and discovering physical artifacts. Both teacher-centered and student-centered learning/teaching activities were observed in the traditional spaces. The learning/teaching activities in the traditional spaces were unidimensional in that a limited number of learning/teaching activities were taking place simultaneously. In the flexible-plan spaces, the learning/teaching activities were described and observed as being predominately student-centered, and they were multidimensional in that a range of learning/teaching activities were taking place simultaneously.

During my visits, I noticed in the traditional spaces some classrooms looked like predominately teacher-centered learning. I noticed students sitting at desks facing the teacher and the teacher lecturing for the entire 50-minute class period. Occasionally, the teacher would stop to ask the students a question, or there were moments of whole class discussion. In some of the classrooms, I noticed project-based learning where students were working individually or having discussions in groups. Laura, the science teacher described the learning/teaching activities as a set of patterns depending on what was being accomplished. She stated:

> I would say that not one day really looks the same, but I have more of a set of patterns depending on what activity we're doing or what we're trying to … If I'm trying to teach new information, I do what is called … Process Oriented Guided Inquiry Learning. The students are actually sitting in groups of four, so my traditional desks get reconfigured into quads, and it is a time for me to facilitate challenge questions, practice problems, really depends on what the class is. If it's an anatomy class, it's going to be more inquiry of information, inquiry learning for learning information, models, modeling of course, or it can be practice problems if it's chemistry. But the flow of how this activity works is,

they're in their groups, that each student has a job that they perform during the activity, and I am doing everything from leading the class through a mini lecture to facilitating each group working through some targeted questions that address the content that we're working through. It can be anything from a full class discussion to mini group discussions to individual work.

Laura further stated that the flow of learning/teaching activities from full class discussion to mini group discussions to individual work follows a rhythm on a weekly or biweekly basis. She described this as being different from rote instruction 20 or 30 years go. In her words:

> I would say you could almost look at it at more of a weekly or biweekly basis, what that rhythm looks like. As opposed to maybe somebody who was teaching 20, 30 years ago where it would just be the same rote format every day, I would say mine is more of a one and a half to two-week rhythm in terms of how I cycle through things.

Seth, who teaches science in the MCIS, described the learning/teaching activities in the traditional spaces prior to teaching in the flexible-plan spaces. He described the learning/teaching activities in the traditional spaces as being focused on content, which required a lot of instruction and assessment. He stated that just before he moved into the MCIS, that he began "flipping" the classroom so instruction was provided by video as homework and what was traditionally homework—students working individually on problems and projects—was done during class time where he was able to help students individually. He described:

> When I was focusing on content at least, it was what are the things that the content standards kind of prescribe for learning and how do we measure and assess those? So, then I kind of developed my summative assessments. So, would that be a test or a paper, or some kind of project based on standards. And then work backwards from there and

like, "Okay, what do my students already have? What do they need to be instructed on? What sort of things need notes?" And really the focus then was, what are those standards and content-based things? And that would be with the math standards, or the NGSS, or the high school content expectations going back before that for Michigan. So that was the focus then … Towards the last couple of years as the internet became a little bit better, it was easier to flip things, classroom wise, because especially with math and science, a lot of times homework wasn't getting done because students would get stuck on it. And so it helped to provide instruction digitally and then do more of the practice work at school where I could prevent students from getting stuck and then maybe saying, "Well, I'm stuck. So, I'm just going to do English homework, or I'm going to go to work, or I'm going to just never kind of come back to it." It was kind of a barrier to learning, where as a teacher, having the experience and say, "Oh, here's what you need to do." And then they'd get unstuck and then they keep working. It was really about how can you reduce roadblocks, [for] that content focus.

The learning/teaching activities in the flexible-plan spaces—the MCIS—were quite different from the traditional spaces. The focus was on interdisciplinary project-based learning, and teachers collaborated on a regular basis. During my visits, I observed a range of learning/teaching activities that included direct-instruction, team teaching, class discussion facilitated by the teacher, small-group discussions, small-group project work, individual study, individual project work, and student presentations.

Twelfth grade students attend the MCIS for half a day, which spans three 50-minute class periods. Four out of five days a week, students are engaged in interdisciplinary project-based learning. The projects that students work on are based on themes that bring together math,

science, English, and social studies. The projects last anywhere from a few weeks to over a month. During these days, many different learning/teaching activities take place based on where students are at on the project. Wednesday is devoted to traditional subject-based instruction, and on this day, students rotate between the subjects and teachers each period. Jim described the two modes of learning:

> I would say four-fifths of our time are devoted to this project-oriented thing where we will give them sort of a driving question and they will develop a theme to answer that driving question. We do typical lessons that you might see in a more elective-style class to help them achieve the goals of the driving question. So, they won't necessarily know how to do the graphic arts related to creating a marketing campaign. They won't necessarily know how to integrate persuasive techniques that you might see in an English paper—do that in a commercial. It's a different leap when you're looking at pathos, logos and ethos in an English paper versus when you're doing it in a marketing campaign. We will do lessons that help them bridge those gaps and have the skills that they need in order to do the projects in a highly successful way.
>
> The other one-fifth of the time we still do traditional academic—I teach government and I teach that from an issue-oriented standpoint. So, we'll investigate issues, we'll read articles about the issues. I'll give short talks about how government is connected and what role government plays in those but it's not a typical structures, powers, methodical take on the class, it's more of a let's discuss issues and debate them and talk.

Throughout the year students are primarily working on projects that span several weeks to over a month. The learning/teaching activities change over the duration of the project. At the

start of a project, the teachers typically give lessons. Once the initial project material is covered, students then work individually and in teams to complete their projects. Near the end of the project, students finish up projects and prepare to present them to outside guests. Jim stated:

> when we do our lessons we might have two lessons in a day and will split the kids and in our big Collaboratory we might have 40 kids getting one lesson and then in one of the other studios, let's say Studio A, we might have 30-40 kids and they're getting a different lesson and then they go with their teams throughout the space and they work on achieving the goals of the lessons. So, depending where we are in the project, the beginnings of the project are usually more lesson focused and you're more likely to see us in rooms doing what looks like traditional lecturing teaching and then towards the end of the projects they're a little more spread out and they're working on achieving the goals of the project.

Seth also identified the arc that learning/teaching activities follow on a project. He described them over three phases: (a) lesson, (b) open work time, and (c) presentation. He stated:

> Realistically, we found three phases. Phase one is very teacher-centered, so there's a diverse set of projects and there's also a diverse set of skills and I'm really fortunate to have great colleagues who are talented and passionate in sharing those. And that looks pretty traditional, like you would see in any sort of class … We explain some sort of concept in kind of lecture format. We've got a slide show and we have examples and we say, "Hey, here's, what's important. Here's what we're measuring. Here's what quality looks like."

Seth continued to describe a lesson about graphing data related to their current project. He explained that during the lesson, students are introduced to the skills they need and how they apply to their project. He stated:

> For example, in our current advertising campaign project, one of the things that they have to add is kind of a graphical data piece. So, a lot of them haven't used spreadsheets in almost any way. And so, we go over how do you make just a graph and then why would you want to choose a pie graph versus a bar graph? Because that's kind of creation stuff they a lot of times don't have … We talk about, "Here's how you do it, open up sheets." We've got a sample set of data; we go over an explanation of why you would choose each different types of graph and then they have to actually create those graphs.

Seth made an interesting distinction about the lesson phase of a project. He described it as an elective class that is focused on skills rather than content. He stated:

> So, if an outside observer came in during phase one, they would see a lot of traditional classwork. It probably would look oftentimes a little bit more like an elective given that [it is] skills focused rather than content focused. But the things we do, they are no different than you would see in a graphic design course or a film and video course or creative writing or an English course doing research.

Seth continued to describe what phase two of project-based learning looks like. He described it as open work time where students do a variety of things. During this phase students need to manage their time wisely. They must stay focused on their tasks and make sure they meet their deadlines. There is also an emphasis on doing good word and being proud of one's accomplishments. Seth stated:

> Phase two, when it's open work time, if somebody comes in, it looks like a lot of students hanging around and doing varying levels of work. Some of them really, really dive in and maximize the time and some of them get a bunch of reminders of what are our goals and what do we hope to accomplish and what are our deadlines and checking in. And that's nice as a teacher because we get to help. Because we tell them all the time, we want to see good work. There's no goal for us at the end to really say, "Oh, got you. Let's mark a bunch of points off." We want everyone to have a product that they're proud of, which will look different for everyone. But if you've used your time and you've maximized your ability, then you should be proud of what you've done at the end.

The last phase of a project is presentation and reflection. Seth also used the word *authenticity* in describing the activities during this phase. Students are able to see how their work is relevant in the real-world because they present their work to real audiences. Also, during this phase students are reflecting on their work. Reflection is a metacognitive process that is essential for becoming an expert learner (Ertmer & Newby, 1996). By reflecting on their learning, students develop lifelong learning skills. Seth described phase three by giving two projects as examples:

> And then really phase three is presentation and reflection. So, this is where that authenticity piece comes in. That's the presentation. For our personal finance unit, I mean, our phase three, we actually get adults from the community to come in and interview our students about what their plan is. And so, what do you want to do after high school? Why is that a good plan for you? Kind of show all of the learning that you've done so far. For our ad campaign, we run a symposium. We invite students who aren't in our classes to come down. Each of our teams will have a table with a setup and

they'll have their print media. They'll run their digital media, their physical media. If it's T-shirt, they'll be wearing them. If it's 3D modeled item, that'll be out. And they get to interact directly with students to kind of verbally explain what their campaign is about, why that issue is relevant to them and then tie it in with that is some form of reflection of what did you learn? What went well? What skills did you demonstrate? Where we kind of, has some writing prompts for them to say, "Hey here, how did he use teamwork? Or talk about challenges that you've had with your team. What tools did you use to set deadlines and keep yourselves on task?" Because things like organization and teamwork, it's really the direct examples that kind of show what the students have and haven't taken away from it.

Figure 6. Symposium at MCIS.

I visited MHS during the symposium for the public awareness ad campaign project. The MCIS was set up like a trade show. About 20-25 student teams of three to four students were stationed at tables spread throughout the Innovation Zone and in the two adjoined classroom spaces. Each team had their project on display at their table, and I circulated around the space

and listened to the students as they pitched awareness about their social issue. I interacted with them by asking questions about their project and also how they worked together as a team. It was evident that the students took their projects seriously and were proud of their work. The students were articulate and passionate about the issues they chose.

The MCIS teachers collaborated and worked together as a team. Since learning in the MCIS is interdisciplinary and the students work on similar projects, the teachers took ownership of all the students and took turns serving as the project lead. Jim described it as:

> In general, one of us is sort of what we call the project lead. So, that person typically develops the assessments, does at least a rough framework of what the lessons look like and then the other three of us will assist in delivery of those lessons. We also typically break the teams, or individuals if it's an individual project, up into something we call mentor groups so that we can give focus and attention to a smaller segment of kids. We found that if we don't do that, nobody really has a clear thumb or feeling for where different teams are or different individuals are in a project. But if you are focused on your 20-30 kids you can figure out where they're at, where different teams are, and you can provide more individual assistance to a student. As far doing the lessons themselves, we co-teach a lot. So, I might be the one doing the lesson, but Danielle might be in the room with me chiming in and bailing me out on things I forgot to mention. You see that a lot.

Seth further elaborated on teacher collaboration activities. Because the teachers team teach, collaboration takes place all throughout the MCIS and every day. He stated:

> In terms of where [collaboration happens], it's really wherever we are in the moment. Even when we do lessons, if possible, we'll try to split it into two. So, there's kind of two

instructors in place at a time, which then allows us to interact with more students and with each other because there's not necessarily like, "Hey, this is my space," really. Anytime there's passing time or at lunch or on our shared planning, we kind of get together and debrief oftentimes informally. But like I said, if we have a couple of things we need to talk to them. So, "Hey, Wednesday, in conference, we all need to go up to the conference room and we need to plug in, project, and really hash out some kind of like official plans." We meet [a] couple minutes before school every day just to refresh like, "Hey, this is what I think we're all doing. And we all kind of on the same page, who needs to be aware, and we kind of settle it down from there." So really, where do we collaborate? Everywhere. When? It's really almost all the time.

Overall, in examining the learning/teaching activities at MHS, it was evident that more student-centered learning takes place in the flexible-plan spaces than in the traditional spaces. The main difference was in terms of dimensionality. The learning/teaching activities in the traditional spaces were more unidimensional—a limited number of learning/teaching activities were taking place simultaneously. The focus of the learning was on content, and much of the learning/teaching activities were about delivering content. The learning/teaching activities in the flexible-plan spaces were clearly student-centered and multidimensional—a range of learning/teaching activities were taking place simultaneously. There also was an emphasis on interdisciplinary project-based learning, and the teachers were highly collaborative. The MCIS was more than simply flexible-plan spaces; it was an educational program for 12th grade students with a focus on developing 21st century skills over content.

Affordances of the physical environment. The findings related to the affordances of the physical environment at MHS were gathered by reviewing school documents found online or

directly requested, by interviewing school administrators and teachers, and through direct and participant observations. Overall, the affordances of the traditional spaces were primarily contained within the classroom, whereas the affordances of the flexible-plan spaces extended across the range of spaces within the MCIS. There was greater variation and nuance in the affordances of the flexible-plan spaces.

The affordances of the traditional spaces were limited within the classroom designed to accommodate 30 students. The only connection to the classroom was via the door which had a narrow window. The adjacent corridor was intended only for circulation, but it did afford some breakout activities. The furniture in the classroom did not have casters and was difficult to rearrange. Each student sat in an individual chair with a fixed tablet arm. In many of the classrooms, student desks were arranged facing the teaching wall where the teacher had a large desk. The student desks could be rearranged—but not easily—to accommodate small group discussions, whole class discussions, teacher-directed instruction, and student presentations. Students could break out to work individually in the corridor, but they have to either move a desk out or sit on the floor.

Teacher collaboration was constrained in the traditional spaces. Each teacher "owned" a classroom and typically was isolated from other teachers. The space did not make it easy for a teacher to casually observe another teacher's practice. Seth described what it was like when he taught science in the traditional wing of the school. He stated:

> All of our doorways are right next to each other. And so for passing time, it was really easy to have kind of informal conversations. But those are by necessity elicited to limited to three or four minutes and then you close your door and you kind of go to work.

The traditional classrooms were limited to a maximum of 30 students so they could not accommodate any large group gatherings. If a teacher wanted to work with another teacher and bring their classes together, they would have to use the library, cafeteria, gym, or the MCIS, none of which were adjacent to the classrooms. Teachers have to schedule and plan for bringing large groups together, which makes it inconvenient and not likely to happen.

The flexible-plan spaces in the MCIS were specifically designed for 21st century learning. On the school's website under the heading "space meets learning" it states:

> The Milan Center for Innovative Studies (MCIS) is a state-of-the-art facility designed with collaboration, communication, presentation, creativity and research in mind. The space was envisioned with specific zones designed for each of these important learning goals. Yet, each zone is also cross-functional as well, giving students the flexibility use the same space where they are running a science experiment to also give a visual presentation to their group.

As described on the website, each space in the MCIS has a specific purpose but could also be used flexibly. Transparency between the rooms allowed for activities to flow easily throughout all the spaces. The teachers working together as a team could easily group and regroup students into different sizes depending on the activity. The adjacent spaces provided multiple areas for large group (80-90 students) presentations and discussions, class size groupings, small groups, and areas for private discussion or reflection. Because the four teachers in the MCIS share these spaces, they do not schedule different spaces. They can simply talk with each other and use the spaces on the fly. The MICS is conducive to teacher collaboration but requires teachers to understand how it affects each other. As Seth commented:

> If I have an idea 20 minutes in class, I can bounce that off somebody right away. I don't have to wait until a little bit. And then the fact that the space and then the students are shared, it shares the responsibility and makes, at least, me want to reflect, how would this affect my colleagues in a way? Again, if you're just doing it in a contained classroom, you kind of don't have to worry about those things. Just have to worry about how it affects you. And just physically seeing your coworkers all the time and having students working on the same tasks. So we've really got just a much greater shared experience, which makes collaboration and at least for me, happiness day to day, a lot higher, I'd say.

The four teachers in the MCIS all commented that they felt what they were doing programmatically could be done in traditional spaces but that there would be limitations. In response to my question about whether what they were doing educationally could be accomplished in a traditional classroom, Ellen stated:

> I think that if we were required to keep desks in rows and columns and not move things around and create the feel that we're also trying to have, of responsibility and ownership and things like that, then I think it definitely would be restricted. I think we are just very blessed with the space. The space just makes it cool. I think that what makes it powerful and work is the team of teachers that are all willing and able and want to collaborate and are willing to compromise and adjust and be vulnerable to teaching in front of other teachers. I think it can be done in a hallway with four rooms with access to an auditorium or something for large group type of things.

Overall, in examining the affordances of the physical environment at MHS, it was evident that the affordances in the traditional spaces were limited compared to the flexible-plan spaces. Affordances of the traditional spaces were contained within the classroom, whereas the

affordances of the flexible-plan spaces extended across the range of spaces within the MCIS. Traditional spaces afforded unidimensional activities in that only a limited number of learning/teaching activities could take place simultaneously without interference. The flexible-plan spaces afforded learning/teaching activities that were multidimensional—a range of learning/teaching activities can take place simultaneously.

Teacher adaptation to flexible-plan spaces. The findings related to teacher adaptation to flexible-plan spaces at MHS were gathered primarily through the triangulation of interviews with the participants. An important clarification related to the findings was that many of the responses from the participants blurred the distinction between physical space and the educational program. Many of the participants described teacher adaptation in terms of how learning/teaching activities are different in the MCIS. A unique aspect of the MCIS is that it is more than simply flexible-plan spaces. It is a program for 12th grade students that embraces interdisciplinary project-based learning with highly collaborative teaching. Since the physical space was designed to support the educational program there is a relationship with the learning/teaching activities; however, it should be noted that some of the responses about teacher adaptation may apply more to the unique educational program and not the physical space.

Adjusting to the flexible-plan spaces at MCIS also means adjusting to a new educational program. Bill, the principal, stated that teachers in the MCIS must have a different mindset from traditional classroom teaching. They must shift their mindset from being a teacher to a mentor or coach. He stated that the MCIS is not for every teacher and that it takes time to find the right mix of teachers. Bill noted:

> It took time to find the right set of teachers to work together. That was a big thing the first two years, and we had some great teachers that went down there, and it just wasn't their skill set. It took a couple of years to find the right group of people to do it.

Bill elaborated on the traits that teachers needed to be able to teach in the MCIS. He described them as personality traits, but looking deeper into what he said, one could also view them as skills. The skills he described the teachers having are collaboration and flexibility—both are 21st century skills. He also noted that the teachers are highly effective as a team, but as individuals they would not be as effective. He stated:

> I think it's personality. I would say this to their face. They're not necessarily my five best teachers in the building, instructors. They're the five best people for this type of programming. They're the five best people for being willing to be honest with their partners about feedback. They're the five best people for accepting criticism without having their feelings be hurt. The five best people for we come in on a Friday, all these presentations are done, and the internet's down … No big deal. Let's go. We'll order some pizza for lunch for the kids we got out of this budget here. Let's just hang out and talk. They're that, and you can't not have a cancer in a program like this. You cannot have that. I can hide you in other places. You can't, you can't. You have to be willing as an administrator to go, "You're not the right fit for here. You might be the best teacher in the building, that's right, but you are a terrible fit for this." I think they make themselves better. As a unit they're highly effective, but any individual component isn't necessarily.

Seth also described how there was an adjustment to teaching in the MCIS. Similar to Bill, he emphasized the importance of being able to collaborate and work on a team:

In terms of adjustment, I grew up playing team sports. So yeah, I like leading. I like pushing new ideas, but I'm also very happy to not make all those decisions, just be a teammate. And there's a time and place for both of them. And like I said, we've got a really, really good team where hopefully everyone feels heard. So, it's easy to make suggestions, feel good about them, and then also listen to suggestions and occasionally be told, "That's a terrible idea." And you've got to have the right level of ambition and humility to kind of manage that.

Danielle's first experience teaching was in the MCIS, so that is all she knows. She stated:

So, one of the things that scared me the most about starting this position was knowing that three veteran teachers are going to be observing me teach all the time. So, a lot of times when we're lecturing, we're not lecturing, but we'll, a lot of times, have all 80 or 90 students in this room collectively going over something. And so, we're constantly team teaching and bouncing off one another and injecting things here. And so, we always say that you're teaching in a fishbowl because, not only are we all observing each other, but we constantly have people coming down. I think you said you were here on a tour. We're often having groups come through, so that goes away pretty fast, the jitters of teaching in front of someone else, which I know a lot of people, they like to just close their door and do their thing. Can't really do that here, because, like I said, there's a lot of transparency.

I asked her from her perspective, having taught only in the MCIS, what it would be like for teachers to adjust to the environment. Similar to Bill's and Seth's responses, she stated:

I would say the biggest thing would be flexibility and being willing to compromise sometimes because when you're working with a team of three other people, sometimes you think, "Oh, this is the way to do it. This is the best idea." And, if you're used to constantly doing things the way that you usually do them but you're working with others. And, that's something that we teach our students as well. There's a lot of give and take and we all bring our own strengths to the table and we make each other better. And so, being willing to hear someone out and appreciate the things that they are really strong in is really important. And so, I think the biggest thing in working in an open environment, and collaborating with other teachers, and team teaching as close as we do is to just be willing to let go the reins sometimes, and recognize that other people are stronger in areas, and just be flexible with, "Oh, well, Mr. Seth thinks we should do it this way, and he's the lead on the project, and I trust him." And, that can be hard sometimes.

Ellen also addressed the adjustment that teachers have to make to be able to teach in the MCIS. Like the others, she emphasized the point about shifting from a solo teacher to working in a team. She stated that an environment like the MCIS may simply not work for some teachers, while for others it may just take some adjustment. She stated:

Teachers are taught, and go into teaching, knowing that they're going to be the only adult in the classroom minus like paras or TCs, they're going to be the only ... They come in, they're in charge, they close the door, they're the one that's running the show. In this type of environment, you have to give up on being the expert in the room because you're not and you have to know that your team is more valuable than yourself. So us as a team, one of us individually could not pull this off, even with 30 kids, you could not. There's not enough knowledge, not enough resources, not enough anything, but us as a team with

our skills and the fact that we respect each other and are able to give each other feedback and are able to adjust and correct each other when something's wrong and be okay and know that they're doing it for the good of the cause type of thing, it takes definitely a mutual respect and a mutual understanding and not every teacher wants that. They want that control, they want that, "I'm right, I'm in the room, this is my job. I don't want to change."

So, there are teachers that would not function down here. There are teachers that refuse to ever consider something like this and then there's teachers that, probably it would just take a little bit of getting used to, and you do have to give up the reins a little bit and know that it's going to be a team decision, it's not going to be a you decision and that's different than what teachers are generally trained for.

I asked Ellen if teachers could be trained to adjust to the MCIS program, but she did not have a definitive answer. Similar to Bill's response, Ellen pointed to the team and having the right mix of people. Again, she pointed out that some teachers could not be trained to adjust. She stated:

No, I really don't know. I think there's a lot of different things that could be done. I mean, Beth came in, this is her first job and so she doesn't know any different necessarily, but that's not why it works. It works because of her personality, her willingness, her ability to step back and be like, "Okay, the cause is greater than me," type of thing. We didn't necessarily do team building with her, she just fit right in the mold. So, I don't know, I think part of it is literally trying to find that team that meshes almost more than training the teacher to fit it. Because there's five teachers off the top of my head that you could not train to fit down here, it just wouldn't happen.

Jim addressed specifically adjusting to both instruction and the physical environment. He noted that it took time to adjust and to figure things out. At first, the teachers in the MCIS did not know how to use the different affordances of the flexible-plan space. Jim stated that the school did not train them for using the space and further pointed out that no one at the school really knew what to do. This is an important point. The school built the space for the educational goals, but they did not really know how to use it. Jim stated that once the team figured out how to work together and use spaces at the same time, they really were able to figure out its benefits. He said:

> It was a bumpy ride in the beginning. We really had no idea what we were doing. We had some idea that we wanted to do collaborative projects, but we didn't really—I think in the last two years we figured out how to use the space. In the first couple years, for example, we spent way too much time on the stairs doing common—like everybody together—look-like lecture. Kids were uncomfortable, they are cement stairs. We learned really quickly that you know about 5-10 minutes is the max for that space. If you walk in you take a picture and look at it you'll see what I mean. But I think we figured out, especially once we figured out the mentoring aspect and sort the scheduling of we can do two lessons at once and split the kids and then have a common work time afterwards, that really was when it started all click for us that we could use the space and use different spaces at the same time and then use common spaces during work time.
>
> So, we figured out a lot. We know that it's hard for 16, 17, 18-year-olds to be with more than 40 people at a time. So, we have that Collaboratory will seat about 70 comfortably, between 70 and 80, but it's very, very hard for them to pay attention in that space for long periods of time. As a traditional lecture space, it's not great. There are just

too many angles for kids to look at who are a little bit immature to focus and there's lots of places as a teacher where you need to—you focus on this side and then you lose the side behind you. So, it's not the traditional sure like you may see in college where you've got the amphitheater sort of feeling and you can see everyone at once. But then on the other side there's great things about that Collaboratory because you can say "okay now, I've given you this thing to think about, now with people at your table in groups of four, you sit and work." So that's where the co-teachers really have to help each other because we can be eyes on different parts and walking around and making sure people are on task and paying attention.

Many of the teachers commented on how they have grown and become better teachers by working together collaboratively. Danielle, who began teaching in the MCIS right out of college, commented that she has become a better teacher because, in this setting, she has constant guidance from the other teachers and is able to observe their teaching every day. She also felt that by working together with her colleagues, they are modeling collaboration skills to students. Danielle stated:

> There's no way I'd be the teacher that I am today, I'm not saying, "Oh, I'm an amazing teacher." I think I hold my own, but constantly having a mentor with you all the time and being able to see them teach all day. And, they even say even seeing each other, they're a little more level playing field. But, being able to observe your colleagues all day, every day, and get feedback all day, every day just makes you a better teacher. And, I think just seeing other people's styles, and also, we're different content areas so just different perspectives, and we're all personalities. We all have very different personalities and strengths and skills. So, it definitely, I think, it just made me a better person. It's maybe

a better teacher and I just love them. We get along really well even though we're all really different, and I think it's really cool for our students to see us model that, and we tell them all the time, because, some projects, we place them in teams based on surveys and interests, and things like that. And, we tell them at the beginning, we're like, "We're all very different people. We probably wouldn't have selected to work with one another, but we make it work." And, we'll have team meetings and we'll display stuff on the screen while they're working, if we have to get together, so they can see us collaborating and what it takes. So yeah, I really like the team teaching and the open space, and all that.

Danielle's account about beginning teaching in flexible-plan spaces is quite different from that portrayed in the landmark work by Lortie (1975) who stated, "Beginning teachers spend most of their time physically apart from colleagues," and further stated that "anxiety is increased by the limited support teachers receive in the demanding early months" (p. 72). Lortie, however, addressed traditional school settings having self-contained classrooms. What he described as being an "egg crate" (p. 14).

The setting has also improved the practice of veteran teachers. I asked Ellen if she has grown professionally being in the MCIS and working with her colleagues as a team. She responded:

A thousand percent, yep. I would not be the teacher I am today without having worked with these guys. They push me every day to be better. I mean it's so cheesy in so many levels, but literally I am so much better because of them. I could honestly get choked up…

Overall, in examining teacher adaptation to flexible-plan spaces at MHS, the main finding was that teachers had to collaborate, and they had to shift their mindset from being a teacher of content to a mentor. Not all teachers were prepared to do this; therefore, having the right mix of teachers who can work together was essential. A unique aspect of the MCIS is that it is more than simply flexible-plan spaces. It is an educational program for 12th grade students that embraces interdisciplinary project-based learning with highly collaborative teaching. The flexible-plan spaces were designed to support the educational program.

Cross-Case Analysis

In this section the results from a cross-case analysis are presented with consideration of both commonalities and differences across the cases regarding the research questions. The results from the cross-case analysis are organized by the research questions. Research question #1 explored the relationship between the 21st educational goals, learning/teaching activities, and the affordances of the physical environment—the GAP triangle. Research question #2 explored how teachers adapted to flexible-plan physical spaces.

Research question #1: relationships of the GAP triangle. Research question #1 asked: (a) what are the affordances of the physical environment and how do they support (or not support) learning/teaching activities intended to align with 21st century learning goals in traditional and flexible-plan physical spaces?; and (b) how do learning/teaching activities vary between traditional and flexible-plan physical spaces?

The 21st century learning goals at both schools were very similar. This was expected since I strove to hold this variable constant when sampling the cases. I looked for schools that purported their goals to include developing 21st century skills in students. Both BHHS and MHS

identified 21st century learning goals that were consistent with those identified by scholars, organizations, and business leaders.

BHHS expressed their 21st century learning goals in their Four Cornerstones document and the district's Portrait of a Learner document. These documents list the skills and dispositions that students should learn and develop and are not bound to a particular subject-area. Skills that these documents highlighted along with responses from the participants included: use of technology, critical thinking and problem solving, creativity, teamwork and collaboration, understanding multiple perspectives, empathy, communication, dealing with complexity, self and collective efficacy, and global awareness. There clearly was an emphasis on developing 21st century skills that transcend subject-based content knowledge. The participants had a sophisticated and cohesive understanding about 21st century skills.

MHS expressed their 21st century learning goals in their district-wide Milan 21 framework along with their Theory of Action for every student that "fosters meaningful and diverse relationships, promotes personalized learning, embraces teamwork, and cultivates learning in a highly digital world." At a high level, the participants described the main educational goal at MHS as simply preparing students for success for whatever path they take after high school. To accomplish this, they felt that students needed to develop 21st century skills which they considered to be soft skills. While they considered 21st century skills as a learning goal for all students, they also acknowledged that there are two sets of goals at MHS. Because students take the state required standardized testing in 11th grade, grades nine through 11 have a heavy emphasis on covering subject-based content and developing 21st century skills is secondary. In 12th grade, since students no longer need to take standardized tests the focus is first on developing 21st century skills, and the subject-based content is weaved in.

The flexible-plan spaces at both schools were intentionally designed to support learning/teaching activities intended to align with their 21st century learning goals. As stated on BHHS's website, the SLCs were designed with flexible-plan spaces for "increased interdisciplinary connections, greater personalization for individual student needs and experiences, stronger relationships between staff and students, and an elevated community climate." At MHS, the flexible-plan spaces in the MCIS were designed with cross-functional zones to flexibly support collaboration, communication, presentation, creativity, and research.

The affordances of the flexible-plan spaces at both schools were similar and can be described by their characteristics. The characteristics the flexible-plan spaces had in common were: (a) variety, (b) flexibility, (c) agility, (d) transparency, (e) comfort, and (f) technology integration.

Variety. Unlike the traditional spaces, the flexible-plan spaces had variety. Not every classroom space in the SLC was the same size and shape. Some of the classrooms were intended for flexible use, and some were intended for specialized use such as science or messy project building. There were also spaces for small groups to meet and other spaces for large groups to meet. The common areas had different zones that were defined by changes in material on the floor and changes in ceiling height. There was also a variety of furniture throughout the spaces.

Flexibility. The flexible-plan spaces were designed for flexible use. While there was a variety of spaces that could accommodate different functions, the spaces were not designed to be task-dependent and could be used flexibly for different activities. Doors, sliding glass walls, and operable walls allowed rooms to be flexibly reconfigured. For instance, both schools had an operable wall between two classroom-sized spaces that allowed for creating one large group gathering space.

Agility. The flexible-plan spaces afforded quick transitions between activities or reorganizing students. The casters on the furniture allowed for quick reconfiguration based on the activity. Tables could be quickly pushed together for group activities or pulled apart for more individual work. The adjacency of spaces also supported agile transitions. For instance, the teacher could give a mini-lecture to students in the classroom space and then have them break off into the adjacent common space to work in small groups or individually while the teacher could circulate throughout the space giving assistance as needed. Beth, the English teacher at BHHS, described how agility is facilitated by the open space and movable furniture:

> So, I think the biggest piece for me has been the open spaces, the movable furniture. I can tell them to get in a group of four and they can be in that group of four, and then we can get into a group of 10 and they can be in a group of 10 in 30 seconds. And then we want to talk as a class of 60 and we can make that happen immediately, as opposed to once I would set up my desks for the day in the traditional setting, that's it. They're not moving. So, it's just facilitated the easy movement of a lot of different compartments or components, and I feel like I can make more moves throughout a 90-minute period than I could in the past.

Transparency. Some of the classroom spaces in the SLC had glass walls to the commons that allowed visual connections between these spaces but acoustic separation. This allowed for activities to take place simultaneously while also providing supervision. For example, a teacher could be in a classroom space with some students working on an activity while also being able to supervise what was happening in the adjacent common space. Transparency also afforded stimulating curiosity. For example, students could see what was happening in another space, such as other students working on a project, which might lead to cross-fertilization of ideas.

Comfort. The furniture, lighting, views to the exterior, and overall aesthetics in the flexible-plan spaces contributed to student and teacher comfort. By providing comfort, the space invited people to stay and work. At MHS, the principal and some of the teachers commented that the MCIS feels like a modern workplace, which inspired them to work and want to be there. In the space the students feel more respected, more like adults. Bill, the principal at MHS, stated:

> That space definitely drives it. You can do it without it, but it's the same reasons McDonalds redo McDonalds and Burger Kings redo… They feel special. They feel like you're treating them like an adult when they can sit in a chair with cloth on it as opposed to hard plastic.

Technology integration. Technology was integrated throughout the spaces. This allowed students and teachers to easily present materials and collaborate. For instance, the commons had flat-panel TVs in different zones that a group of students could easily plug their laptops into and share what they were working on with members in their group. Seth, the science teacher at MHS, stated:

> We're also really fortunate with quite a set of monitors. So, there's a lot of projection ability for our students, which when they're working on collaboration, really helps to be able to say, "Hey, I'm working on this particular design. Let's all look at it on a hundred-inch projection rather than a 13-inch Chromebook." And it's really kind of cool to watch when you plug them in and you let them project and kind of everyone can kind of see what they're working on. The change that comes over them with that.

The affordances of the traditional spaces at both schools were primarily contained to individual classrooms. The corridor did afford some breakout activities, but since it was not

designed for those activities it did not really function well. The furniture at BHHS had casters and provided some flexibility within the four walls of the classroom. In that sense it provided some agility since it could easily be rearranged. At MHS the furniture did not have casters and was more difficult to rearrange. The traditional spaces at both schools did integrate technology, but it was primarily for use by the teacher.

It was evident that the affordances of the flexible-plan spaces at both BHHS and MHS better supported the learning/teaching activities intended to align with 21st century learning goals. The learning/teaching activities in the flexible-plan spaces were multidimensional and much more dynamic and fluid than in the traditional spaces. Students were moving fluidly between a range of activities and were not all engaged in the same activity at the same time. The learning/teaching activities in the traditional spaces were unidimensional, and most of the learning/teaching activities were driven by the teacher. Though student-centered learning strategies, such as personalized learning, problem- and project-based learning, and collaborative and cooperative learning, were still able to happen in the traditional spaces, the learning/teaching activities were not as robust as they were in the flexible-plan spaces. There was little evidence of interdisciplinary learning and teacher collaboration happening in the traditional spaces.

Robert, the principal at BHHS, described the difference between the flexible-plan and traditional spaces. He stated that beyond the space, there were no restrictions imposed on the teachers for doing learning/teaching that were aligned with the 21st century learning goals. However, there still are differences. He stated:

> I think first of all I would say just as kind of a disclaimer whether you're in a more traditional space or you're in a learning community space or one of our newer developed spaces, there's no restrictions on not being innovative and not living our cornerstones and

> providing authentic experiences. But that being said, in the learning community spaces we see a lot more active learning going on. We see a lot more collaboration between students and teachers, students to students, teacher to teacher. We see a lot more connection to the outdoor spaces, easier utilization. I think you start to see—that the creativity I see going on because our LCs are divided into interdisciplinary teams so I think the conversation even between an LC team and somebody in traditional, an LC team is going to talk about the student a lot more holistically. I think they're going to talk about skills more. The conversation going back to traditional model I'm going to hear a lot more about content, going to hear a lot more about curriculum, going to hear a lot more of the typical talk that you would expect from a traditional high school. All being that a number of our teachers even in a traditional setting have wanted to, and we've tried to accommodate where we can, have those experiences the learning community teachers have and so I think our next project is to help get them there to, in whatever we can do to adjust their spaces to help support them.

At MHS, the MCIS is a unique program that is especially focused on developing in students' 21st century skills. It was clear that they leverage the affordances of their flexible-plan spaces to a higher degree compared with the flexible-plan spaces at BHHS. An interesting comment from several of the participants at MHS was that they felt their program could still be done in traditional spaces, but they did identify some restrictions. They commented that even though it might be easier to run their program in the space they have, it still could be done in traditional spaces. Seth stated, "We say that our program is not really dependent on the environment. We're just really fortunate to have it." He then added:

> You can do it [interdisciplinary project-based learning] in desks and traditional classrooms. The nice thing I think about it is I think it really lends itself to collaboration and to a level of comfort. Students are really able to go to each other, kind of in an organic way. And because it's such a big space, and we have upwards of 80 students at a time, they have a lot of different students that they can go and kind of interact with and help each other. And really in terms of the pure volume of the space, that really, really helps.

Jim, in responding to whether or not the interdisciplinary project-based learning they are doing in the MCIS could be done in the traditional spaces of the school, stated:

> I think as long as you had the schedule, the common schedule with the teachers is probably more important than the physical space. So, if for example, if we had a wing on the other side, on the traditional side where we had four classrooms and a computer lab, we can pretty much do everything that we do here and it wouldn't be hard at all.

I asked Jim if a requirement then would be that the teachers would need to be co-located. Jim answered:

> Yeah, you would need co-location. So, the other side of our school is built sort of on a plus format where you have wings that come off and they form sort of a plus if you will. So, you would need four sets of classrooms in one of those sections of the building that were fairly close to each other in order to do the overlap and the cross teamwork that we do, cross classwork that we do. But I don't think you need this big open space, all these bells and whistles that we have to do what we do.

Danielle also identified that co-location was important for collaboration. This is consistent with research by others. For instance, Spillane, Shirrell, and Sweet (2017) used social

network analysis to determine that proximity is a significant factor in collaboration. The researchers found that teachers who are located closer to each and happen to cross paths are more likely to talk about their work. If the design intent is to foster collaboration, then co-location is important.

In summary, the flexible-plan spaces at both BHHS and MHS were intentionally designed to support student-centered learning/teaching activities. These activities aligned with their educational learning goals that included developing 21st century skills in students. The characteristics the flexible-plan spaces had in common were: (a) variety, (b) flexibility, (c) agility, (d) transparency, (e) comfort, and (f) technology integration. The learning/teaching activities in the flexible-plan spaces were multidimensional and much more dynamic and fluid than in the traditional spaces. The learning/teaching activities in the traditional spaces were unidimensional, and many of the learning/teaching activities were driven by the teacher.

Research question #2: teacher adaptation to flexible-plan spaces. Research question #2 was: (a) how do teachers adjust from traditional physical spaces to flexible-plan physical spaces?; and (b) to what extent and in what ways has their practice changed in flexible-plan physical spaces compared to when they were in traditional physical spaces?

There were many similarities for how teachers adjusted from traditional spaces to flexible-plan spaces across the cases. The main finding was that teacher adjustment was less about the space itself and more about adjusting to new practices. The biggest adjustment was with moving from a relatively isolated practice to a collaborative practice. Because the flexible-plan spaces are shared, teachers have to work together. Transparency also exposed teachers' practice to one another. The flexible-plan spaces made it difficult for teachers to isolate themselves from one another; therefore, teachers have to be willing to adjust their practice.

In many ways, in flexible-plan spaces teachers need to already have or need to develop the same 21st century skills that they are trying to instill in their students. At MHS, Bill, the principal, talked about how it took time to find the right individuals to teach in the MCIS. In finding the right team of teachers to teach in the MCIS, Bill stated:

> They're the five best people for this type of programming. They're the five best people for being willing to be honest with their partners about feedback. They're the five best people for accepting criticism without having their feelings be hurt. The five best people for we come in on a Friday, all these presentations are done, and the internet's down … No big deal. Let's go.

Bill described these individuals as having strong communication and collaboration skills. He also described them as having problem-solving, flexibility, and adaptability skills. If something goes wrong, such as the Internet going down, they are able to figure out a solution and still move forward. Seth, the science teacher in the MCIS, described adjusting to the space in terms of being a teammate. He stated:

> In terms of adjustment, I grew up playing team sports. So yeah, I like leading. I like pushing new ideas, but I'm also very happy to not make all those decisions, just be a teammate. And there's a time and place for both of them. And like I said, we've got a really, really good team where hopefully everyone feels heard. So, it's easy to make suggestions, feel good about them, and then also listen to suggestions and occasionally be told, "That's a terrible idea." And you've got to have the right level of ambition and humility to kind of manage that.

The participants at BHHS also talked about adjusting to working together and being a member of a team. Sandra, the math teacher, stated:

> There's definitely a mindset of you have to be flexible, you have to be willing to try new things, you have to be okay with mistakes, and you have to be okay with being transparent. Just because it's okay if things don't go well, but you have to be able to openly talk about it or let your colleagues come in and view those things so that way they can point out to you what's working and what's not. It's kind of scary, but just, yeah, the being vulnerable, but also being willing is the biggest thing. Just because we have some staff members that I feel like can be flexible when they're on a team, and they can be risk takers, but then when you put them on a whole team scenario where they have to consistently do this for an entire year, I feel like it's different. It's got to be someone that's fully committed to actually wanting to be on a team, I think.

Danielle, the math teacher at MHS, also stated that you need to be flexible and open to other perspectives. She also commented that this type of mentality is what they are trying to teach their students as well. In her words:

> I would say the biggest thing would be flexibility and being willing to compromise sometimes because when you're working with a team of three other people, sometimes you think, "Oh, this is the way to do it. This is the best idea." And, if you're used to constantly doing things the way that you usually do them but you're working with others. And, that's something that we teach our students as well. There's a lot of give and take and we all bring our own strengths to the table and we make each other better. And so, being willing to hear someone out and appreciate the things that they are really strong in is really important. And so, I think the biggest thing in working in an open environment, and collaborating with other teachers, and team teaching as close as we do is to just be willing to let go the reins sometimes, and recognize that other people are stronger in

areas, and just be flexible with, "Oh, well, Seth thinks we should do it this way, and he's the lead on the project, and I trust him." And, that can be hard sometimes.

The findings showed that teachers in flexible-plan physical spaces had to be more collaborative compared to when they were in traditional physical spaces. While it was hard adjusting, many of the participants felt the challenge was worth it. They felt that they have become better teachers because they collaborate in the flexible-plan spaces. The teachers also spoke very fondly of their fellow teachers. Beth at MHS stated:

> So, it definitely, I think, it just made me a better person. It's maybe a better teacher and I just love them. We get along really well even though we're all really different, and I think it's really cool for our students to see us model that, and we tell them all the time, because, some projects, we place them in teams based on surveys and interests, and things like that. And, we tell them at the beginning, we're like, "We're all very different people. We probably wouldn't have selected to work with one another, but we make it work." And, we'll have team meetings and we'll display stuff on the screen while they're working, if we have to get together, so they can see us collaborating and what it takes. So yeah, I really like the team teaching and the open space, and all that.

Seth at MHS also spoke fondly of his team. He described how working with the team makes the work fun. He stated:

> I love my team right now. They make working generally pretty fun together. I enjoy just bouncing ideas off them and being able to share thoughts and inspirations and suggestions in real time. Especially for me, I have a lot of ideas that I just want to kind of get down and maybe sometimes verbalize that can, I might just forget, otherwise.

Beth at BHHS said that after being in the flexible-plan spaces, she could not go back to teaching in traditional spaces. She also emphasized how important collaboration is for 21st century skills. She stated:

> I think that the opportunities for collaboration, I think the kind of mentality that students come in with, that it's not, "I will sit at my desk and learn for 90 minutes and then I will leave and forget everything." I think that is instrumental. And so, I don't think I could ever go back to teaching in a traditional classroom where I couldn't say, "All right, get in a group of four, let's go." So, I do, I think the collaboration piece is one of the driving forces behind all of those other skills. Critical thinking can't happen in a vacuum. You need other ideas and other voices and other opinions and other texts and content to drive that critical thinking.

In summary, adapting to flexible-plan spaces is really about learning to work collaboratively with other teachers since spaces are shared. It is important to have the right team, and it takes time to build the team. Teachers need to have or need to develop the same 21st century skills that they are trying to instill in students. This adjustment can be hard and requires a flexible mindset. Transparency exposes teachers' practice to one another, which can be uncomfortable but is also an opportunity to learn. Many of the teachers believed that working in a team has made them better teachers and has even made teaching fun.

Challenges and Constraints

In this section, findings related to the GAP triangle that were considered to be challenges and constraints of flexible-plan spaces at each of the schools are identified. While this study was not focused directly on the challenges and constraints of flexible-plan spaces, they are worth noting so that a reader may compare and contrast them to other flexible-plan spaces that they are

familiar with. The challenges and constraints could be explored further in practice and future research to understand better how they may be overcome or may continue to serve as problems.

Distractions. Some of the teachers commented that students can be distracted in flexible-plan spaces. They stated that the affordance of transparency and openness can be problematic at times because students see their friends and begin to socialize, thus being distracted from the learning activity at the moment. At face value, what some of the teachers were telling me made sense; however, during a visit to MHS, I casually asked several groups of students in the MCIS flexible-plan spaces how they liked the space and if they ever felt distracted from learning. Every student I spoke with said that they really liked the space and that they did not feel distracted in the open spaces. Some students even commented that they felt more distracted being in the traditional spaces of their school because they felt cooped up and bored. In the flexible-plan spaces they could move around which helped them focus on their learning. I followed up on this observation with the teachers via email. Danielle, the math teacher, responded with:

> In regards to the comments from students, I think their responses to your questions genuinely reflect how they feel about the space. The comment, "I'm more distracted in a traditional classroom because I'm cooped up in a seat and can't move around" is interesting. As a teaching staff I think we would say that the open space can sometimes have the opposite effect. Having the ability to move about freely often creates more distractions than they realize.

I felt this was noteworthy and would be interesting to understand in a further study about the students' opinions and perceptions about flexible-plan spaces, especially in regard to distractions. Gislason (2009) also identified distractions as a potential drawback in open spaces,

however, as long as the teachers worked together as a team in coordinating the learning/teaching activities, then the distractions were very minor. The benefit of the student-centered learning outweighed the minor inconvenience. Gislason (2009) further stated:

> If the curriculum were not interdisciplinary, or if teachers did not work in teams, there would be little reason to work within an open setting. The inherent disadvantages of the open plan design, particularly the noise and traffic distractions, would outweigh its advantages. (p. 31)

The point Gislason makes is that if the learning/teaching activities are not in alignment with the educational goals and the physical space, then problems with distractions may occur.

Time for adjustment. At both BHHS and MHS, there was a learning curve of a few years for adapting to the flexible-plan spaces and it was believed that they would still adjust the learning/teaching activities and learn how to best use the space to realize their educational goals. Robert, the principal at BHHS, stated:

> I felt with a lot of staff it wasn't until year two or three that we then started really saying we're settled we know our roles because a lot of them we had a couple of teams going but we didn't have all of the learning community teams going and we had to tend to some of the adult behaviors just getting those norms and expectations [and] teams up and running which spoke to the culture of the building and now we're to the point where I think we're getting everybody to envision themselves as innovators, as lead learners and now I think the progress will be even more rewarding and worthwhile, and in year three, four, five and now six so I don't think we're starting to get our stride even faster and better but I think the next two or three years will be really exciting.

Researchers studying new flexible-plan schools in Australia also found that there was an adjustment period (Prain et al., 2014). The researchers found that the physical space became a catalyst for change because of its constraints to traditional practices. Teachers had to learn how to change their practice, along with how they facilitated learning/teaching activities to align with the affordances of the space.

Understanding the time for adjustment in order to know what to expect could help other schools that are transitioning to flexible-plan spaces. Perhaps there are aspects to adjustment that, if better understood, could be sped up or made easier. If this were better understood, school leaders could reassure staff members that adapting to flexible-plan spaces will improve over time and they could offer professional development to help during the transition. Future longitudinal research should focus on better understanding the time needed for adjustment and measures that could be implemented to make the process quicker and easier.

Curriculum and programming. The curriculum and programming that is in flexible-plan spaces seemed to be very influential to its use. At MHS, the MCIS is a program for 12th grade that focuses on interdisciplinary project-based learning. Further research is needed about how the curriculum and programming has an impact on the learning/teaching activities. The principal, Bill, stated:

> The space doesn't change the instruction. That's the bottom line because they could go down there. There's six classrooms. They could all be in the classroom. The space itself doesn't... The teachers, with the support of administration, have chosen to adapt their curriculum and instruction and have used the space to its fullest intent.

At BHHS, the SLCs, even though they were organized around interdisciplinary teams, did not have a high level of interdisciplinary learning. A barrier to this seemed to be that

students were still assigned to traditional classes in the flexible-plan spaces. Related to this, Mark, the business teacher, emphasized that programming was important. He stated:

> Yeah, I think we've adjusted to the space. So, if we were in a different space and I don't know what space that would be. But if we were in a different space, could we do the same stuff? Yes. Would we have to change a little bit? Yes. But we've adapted to that space because that space has provided us with an opportunity... Without the willingness of the administration for us to take this risk. Like it doesn't matter what space we're in. So you can talk about space all you want. But you also have to talk about programming too. So if they said, no, you can't do this, then obviously the space would be obsolete to us and we would find something else to do. So, the programming is there, the space is there, the flexibility of the spaces there. So, then we develop our ideas off of that.

If curriculum and programming does not change along with the physical space to align with the educational goals, then the learning/teaching are not likely to change either.

Co-location. I touched on this in my findings related to research question #1 but felt it is noteworthy for further study, so I am mentioning it here. The co-location of teachers did not appear to be a challenge or constraint to the flexible-plan spaces at BHHS and MHS, however, it was identified as a constraint to collaboration if teachers were not co-located. Some participants even stated that they did not even need flexible-plan spaces in order to collaborate. Particularly at MHS, many of the teachers in the flexible-plan spaces stated that they could run the MCIS program in traditional spaces with some limitations. A requirement they stated was that they would need classrooms that were co-located. Spillane et al. (2017) used social network analysis to determine that proximity is a significant factor for collaboration in schools. There are many schools that cannot afford to build new facilities or do significant renovations to their existing

facilities. Could a program like MCIS, which is interdisciplinary project-based learning, be implemented simply by moving teaches closer to one another?

Summary

This chapter included a review of the findings based on analysis of the data. Each case was analyzed separately to better understand their unique context and full complexity. Findings for each case were organized based on the GAP triangle along with teacher adaptation to flexible-plan spaces. A cross-case analysis was then presented that considered both commonalities and differences across the cases regarding the GAP triangle relationships, and the research questions were directly addressed. Lastly, miscellaneous findings beyond the GAP triangle that were considered noteworthy are listed as ideas and recommendations for further study.

A major finding was that the flexible-plan spaces at both BHHS and MHS were intentionally designed to support student-centered learning/teaching activities. These activities aligned with their educational learning goals that included developing 21st century skills in students. The characteristics the flexible-plan spaces had in common were: (a) variety, (b) flexibility, (c) agility, (d) transparency, (e) comfort, and (f) technology integration. The learning/teaching activities in the flexible-plan spaces were multidimensional and much more dynamic and fluid than in the traditional spaces. The learning/teaching activities in the traditional spaces were unidimensional, and many of the learning/teaching activities were driven by the teacher. Additionally, adapting to flexible-plan spaces is really about learning to work collaboratively with other teachers since spaces are shared. In the next chapter is a discussion of the findings along with conclusions.

CHAPTER 6

Discussion

In this chapter, the findings are discussed through the lens of the theoretical framework. In chapter three, I established the theoretical framework by first defining physical space as a technology. As a technology, physical space can be designed with certain goals in mind. I used the concept of affordances to describe the action possibilities of physical space. In other words, the design of physical space can make certain learning/teaching activities possible—whether intended or not. I presented a framework for exploring the relationships between the educational *goals*, the teaching and learning *activities*, and the affordances of the *physical* environment that I call the GAP triangle. These theories apply to research question #1:

(a) What are the affordances of the physical environment, and how do they support (or not support) learning/teaching activities intended to align with 21st century learning goals in traditional and flexible-plan spaces?

(b) How do learning/teaching activities vary between traditional and flexible-plan spaces?

Previous research showed there to be difficulty for teachers to change practice or adapt to new physical spaces (Alterator & Deed, 2013; Costa, 2004; Deed & Lesko, 2015; Gislason, 2009). Thus, I included institutional theory and the concept of institutional isomorphism to better understand why this change can be challenging. This concept applies to research question #2:

(a) How do teachers adjust from traditional physical spaces to flexible-plan physical spaces?

(b) To what extent and in what ways has their practice changed in flexible-plan physical spaces compared to when they were in traditional physical spaces?

Educational Technology, Affordances, and the GAP Triangle

My theoretical proposition as it pertains to research question #1 was that physical space can be framed as an educational technology. As such, it can be purposefully designed with a goal in mind—that is, to facilitate and support desired learning/teaching activities. This can be achieved through affordances. Affordances, as defined by Norman (2002), are the perceived possibilities for action between a person and an object or a person and the environment. A person's background, beliefs, and previous knowledge shape how affordances are perceived. Physical space is typically not thought of as an educational technology, and much of the literature is written in a way that takes physical space for granted. The assumption is that physical space is immutable, so you just make do and adapt the learning/teaching activities to it.

I examined two cases in which the physical environment was purposefully designed to support the educational goal—that being an emphasis on developing 21st century skills. These cases also had traditional spaces that teachers were making do with and adapting learning/teaching activities to. The data suggests that both the learning/teaching activities and the affordances in the flexible-plan spaces were—in a holistic sense—better aligned with the 21st century educational goals than in the traditional spaces. The learning/teaching activities in the flexible-plan spaces both described by the participants and observed were predominantly student-centered and multi-dimensional—students were working on a range of different activities at different paces. While there were student-centered learning/teaching activities in the traditional-plan spaces, they were limited and more unidimensional—only one activity took

place at a time, whether it was teacher-centered or student-centered. I also observed teachers lecturing for the majority of the class period in some of the traditional spaces.

The learning/teaching activities in the flexible-plan spaces included some direct-instruction, but there was a lot more time devoted to student-centered learning. Students were working individually or in small groups on projects or assignments that did not have prescriptive steps and a defined outcome. There were also whole-class discussions where the teacher guided the conversation with open-ended questions that required students to think critically and to provide creative responses rather than simply recite facts requested by the teacher. There were also student presentations ranging from being in front of the class to a symposium at MHS where the entire study body, teachers, parents, and outside guests were invited to see the students present their finished projects. Lastly, there was a high level of teacher collaboration and teachers team teaching in the flexible-plan spaces.

These findings are consistent with the concept of affordances. The flexible-plan spaces were purposefully designed having affordances to support 21st century educational goals; therefore, it makes sense that the learning/teaching activities were more student-centered compared to the traditional spaces. To recap, the characteristics of the affordances identified in the flexible-plan spaces were: (a) variety, (b) flexibility, (c) agility, (d) transparency, (e) comfort, and (f) technology integration. Having a variety of spaces allows for different types of activities and a range of activities to take place simultaneously. Flexibility of a space refers to how it can be used for different learning/teaching activities and how it can be reconfigured. Agility of a space refers to how easily the space allows for quick transitions between activities. Transparency refers to the visual connections between spaces. Having transparency allows for activities to take place simultaneously across a range of spaces, while also allowing for teacher

supervision. Transparency also exposes activities and stimulates curiosity. Comfort refers to creating a comfortable setting for people for whatever activity they are doing and that stimulates their desire to be in a space. Technology integration refers to how other technologies such as flat-panel TVs and computers are distributed and integrated within the space.

While the traditional spaces had some of the same affordance characteristics as the flexible-plan spaces, they were primarily limited to within the classroom, and the learning/teaching activities were constrained. For example, the furniture in some of the traditional classrooms had casters which allowed for easy reconfiguration—giving the space flexibility. The teacher could start with a short lecture and then have the students reconfigure the furniture so they could work on a project in small groups. The constraint, however, was that the teacher and all students were confined to the single classroom. This limited the amount of movement because the classroom was filled with furniture and people. Occasionally, students would move out to the corridor to work, but it was not convenient to do so because there was not any furniture. Also, the teacher did not have direct visual supervision of the students and therefore was unlikely to have students use the corridor.

While the evidence suggested that the learning/teaching activities and the affordances in the flexible-plan spaces were better aligned with the 21st century educational goals than in the traditional spaces, there was no evidence to show this relationship was causal. Simply having the flexible-plan spaces did not *cause* student-centered learning/teaching activities to happen. The curriculum and programming seemed to be very influential on the learning/teaching activities. At BHHS, one of their educational goals was interdisciplinary learning. While the physical space was organized by having the core subjects—math, science, English, and social studies—all within the SLC, classes were still segregated by subjects. The teachers had

difficulty informally creating interdisciplinary learning opportunities for students since they were still responsible for teaching a particular subject. On the other hand, MHS created a program were the core subjects were integrated. Students would attend the MCIS program for a half-day and would work on projects that emphasized the development of 21st century skills.

Oliver (2013) pointed out that the failure to explain technology theoretically is a significant gap in the field of educational technology. Oliver argued that this failure leads to a naive acceptance that technology somehow causes learning. Examples of this can easily be observed in schools. For instance, supplying teachers with interactive whiteboards does not mean they will use them in ways that are innovative for learning. A teacher could use an interactive whiteboard simply as a whiteboard or a projection screen and not leverage the interactive function of it that is designed to engage learners. In this sense, they are not using the full capabilities of the technology; however, an interactive whiteboard functioning simply as a whiteboard or a projection screen could still be viewed as a technology.

The physical environment can be viewed as a technology that helps to shape a multitude of learning processes that are taking place inside. In a sense, it could be viewed as hardware that supports the software—the learning/teaching activities. Nair stated (2014):

> Think about school buildings as the hardware within which the software of education runs. Like any piece of hardware, every school building also has limitations on what kinds of software it can run. The question we must ask ourselves is this: Do we design new software—the future of education—around the limitations posed by existing hardware—school buildings? Or do we design a twenty-first century education model according to what we think is best for students and then figure out how the buildings can be designed or renovated to accommodate this model? (p. 2)

The hardware/software analogy suggests that student-centered learning/teaching activities are still possible to do in traditional spaces; however, since it was not intentionally designed for those activities, they are more difficult to do—the space places constraints on those activities. In contrast, in flexible-plan spaces that are intentionally designed for 21st century learning goals, student-centered learning/teaching activities are easier to do—the space affords those activities to happen.

The findings showed that teachers at both schools had difficulty adapting to the flexible-plan spaces. It took several years for them to figure out how to use the spaces effectively. Institutional isomorphism can be used to understand this phenomenon better. While organizational theory describes why there is diversity in structure and behavior in organizations, institutional isomorphism describes the tendency of organizations to resemble institutional norms (DiMaggio & Powell, 1983). The traditional plan and organizational structure of schools has been in existence for over a century and as such, it has become an institutional norm in K-12 education settings (Nair, 2014). In organizational fields that are well-established—such as the construct of school as an organizational structure—there is a tendency towards homogeneity, not diversity (DiMaggio & Powell, 1983).

Institutional Isomorphism

The findings related to research question #2 can be looked at through the three mechanisms of institutional isomorphism: coercive, memetic, and normative. Institutional isomorphism is a concept that explains why there tends to be homogeneity of organizations having a similar function such as schools. Coercive isomorphism refers to outside pressures on an organization for it to resemble the cultural expectations from society broadly. Mimetic isomorphism is the tendency for organizations to resemble institutional norms. Instead of

embracing a new organizational structure, organizations may simply *mimic* more traditional and well-established organizational structures. Mimetic isomorphism happens when there is uncertainty. Lastly, normative isomorphism relates to pressures rooted in professionalization. Teaching is a well-established profession with expected practices and norms.

In terms of coercive isomorphism, the traditional plan and "cellular" (Lortie, 1975, p. 14) organizational structure in K-12 education are what is expected by society. Identically sized classrooms are aligned along a corridor. A teacher "owns" a classroom and is assigned students. In this setting, a teacher primarily works independently from other teachers (Lortie, 1975). A key finding from this study was that adjusting to flexible-plan spaces is really about learning to work collaboratively with other teachers. Since this is not the institutional norm, this could explain why there is difficulty for teachers to adjust to flexible-plan spaces. Danielle at MHS stated that teachers go into teaching expecting to have their own classroom. She said:

> Teachers are taught, and go into teaching, knowing that they're going to be the only adult in the classroom minus like paras or TCs, they're going to be the only… They come in, they're in charge, they close the door, they're the one that's running the show. In this type of environment, you have to give up on being the expert in the room because you're not and you have to know that your team is more valuable than yourself.

Similarly, Beth at MHS stated that teachers like to simply shut their doors to teach in isolation. She pointed out that the affordance characteristic of transparency in flexible-plan spaces makes it difficult to do that:

> We're often having groups come through, so that goes away pretty fast, the jitters of teaching in front of someone else, which I know a lot of people, they like to just close their door and do their thing. Can't really do that here, because, like I said, there's a lot of

transparency. But, that helps you to be comfortable with the people that you're working with, and that collaboration piece, like you said, it definitely lends itself more, because if we were all just in our own classrooms but in a shared hallway on the other end, you, for sure, wouldn't have as much of the opportunity to work with one another, or even feel to do it.

In terms of mimetic isomorphism, flexible-plan spaces are new and not understood well by teachers. Teachers are typically not used to working in teams so there is uncertainty about what to do. If there is not any effort to define what learning and teaching should look like in these new spaces, and to provide professional development and support for teachers, then teachers may still practice in traditional ways. There was evidence of this at both BHHS and MHS. BHHS simulated what the new environment would be like during the two years that the new high school was under construction which did help some teachers get ready for change, but it still was not enough. Beth talked about her experience during the transition:

I think Robert [the principal] used to tell us like, "Grieve and detach." So, when I started, I had my own classroom with a giant bookshelf of every book that I would ever reference in my class or want my students to pick up on a whim and look at, very idealistic. And I had filing cabinets with all of the papers I needed and a desk and this and that and my posters on the wall. Right? And I could go and refer to a chart and we could work things out. And then when we moved to Lahser for the two temporary years, I had to get rid of all of it. I was able to take one filing cabinet and packed all my stuff in one filing cabinet and a big red box and that was it.

So, all my books, there was nowhere to put them. All of my posters, I was in three different classrooms, nowhere to hang them up. So, it changed the way that I

> organize. It changed the way… I mean I went 95% digital, which yeah, I should be doing anyway, but the loss of an ownership of space was tough. Right, but this is my room and I want kids to feel comfortable here and I want kids to be… to know where to find me at any given moment. If they have a question or they need to talk about something. It kind of lost a little bit of that relationship piece. Almost like this is Max's room and I know when I'm in Max's room, this is what I do. Well now I had four rooms or five rooms or however many I was moving between. So, I think it just kind of changed the way I had to form those relationships. How did I make sure that my kids always knew where to find me? How did I make sure that walking into whatever room I was going to be teaching in could feel like our space for those 90 minutes? And I think I'm still trying to figure that out.

At MHS, it took a couple of years for the teachers to really figure out what to do in the flexible-plan spaces in the MCIS. There was a lot of adjustment in the beginning, and the administration even had to replace some of the initial teachers in the MCIS in order to get the right team in place. Jim stated:

> But as far as teaching in the space, and learning, that aspect of it, I don't think anybody really knew how to do that, so there really wasn't much in the way of professional development for that.

Lastly, since normative isomorphism is rooted in professionalization, high school teachers are typically expected to be subject content experts and are not really trained for teaching collaboratively and in an interdisciplinary manner. The flexible-plan spaces at both BHHS and MHS were designed to be interdisciplinary SLCs in response to their educational goals. At MHS, the MCIS is a program for project-based and interdisciplinary learning. While

the teachers have their subject content expertise, they teach collaboratively. BHHS has not fully embraced an interdisciplinary model. During my visits to BHHS, it was evident that the teachers still focused on their subject expertise and were still figuring out how to draw interdisciplinary connections between the classes they taught. During one visit in particular, I observed the teachers during their planning period brainstorm ideas for taking field trips that could connect what each other was doing independently in their classrooms. While they were trying to find interdisciplinary connections, it was clear they viewed their classes as being separate.

Overall Differences Between BHHS and MHS

Both BHHS and MHS had very similar educational goals which emphasized developing 21st century skills. At BHHS the 21st century skills identified were use of technology, critical thinking and problem solving, global awareness and understanding multiple perspectives, empathy, communication, dealing with complexity, collaboration, and self and collective efficacy. The 21st century skills identified at BHHS were consistent with the P21 framework. The school district for MHS adopted portions of the P21 framework that acknowledge mastery of key subjects through 21st century themes: learning and innovation skills; information, media, and technology skills; and life and career skills (Partnership for 21st Century Learning, 2015).

One difference in the educational goals between the two schools was that there clearly was a different emphasis on goals at MHS due to pressures from standardized testing in the 11th grade. In grades 9-11 the emphasis was on subject-matter content, and developing 21st century skills was at the periphery. In 12th grade, MHS created a program called the MCIS to specifically emphasize developing 21st century skills. At BHHS, the goals seemed to be consistent throughout all grades, however in grades 9-10 there was an emphasis on

interdisciplinary learning because the learning communities were organized with a cohort of students and offered the core subjects: science, math, social studies, and English.

In terms of the learning/teaching activities at BHHS and MHS, it was evident that student-centered learning happened in both the traditional and flexible-plan spaces. This finding was sobering as an architect who designs flexible-plan spaces in schools. There are many architects—including myself—who design flexible-plan schools with the assumption that they support 21st century educational goals. Student-centered learning/teaching activities that were in alignment with the educational goals did take place in the traditional classroom spaces which suggests that flexible-plan spaces are not required. However, the learning/teaching activities in the traditional spaces at BHHS and MHS were more unidimensional—a limited number of learning/teaching activities were taking place simultaneously. While the flexible-plan spaces were multidimensional, a range of learning/teaching activities were taking place simultaneously. This nuanced difference in how student-centered learning/teaching activities varied between traditional and flexible-plan spaces suggests that the affordances of flexible-plan spaces are better suited for the 21st educational goals. There was a greater range of activities, and the transition between activities was much more fluid in the flexible-plan spaces.

The flexible-plan spaces at both BHHS and MHS had similar affordances. The affordance characteristics they had in common were: (a) variety, (b) flexibility, (c) agility, (d) transparency, (e) comfort, and (f) technology integration. The main difference between the two schools was not related to physical space, but to other barriers related to the educational program. MHS created a program called the MCIS that was designed for interdisciplinary learning. The emphasis was on developing 21st century skills by working on integrated projects where they covered topics in the core subjects. At BHHS, the focus was still on the core subjects

and developing 21st century skills was periphery. Because of the difference of the educational program, the teachers and students in the MCIS at MHS seemed to take more advantage of the affordances in the flexible-plan spaces.

Conclusion

In conclusion, physical space can be viewed as an educational technology having affordances that support and constrain learning/teaching activities. The flexible-plan spaces at both BHHS and MHS were intentionally designed to support student-centered learning/teaching activities. These activities aligned with their educational learning goals that included developing 21st century skills in students. The affordance characteristics the flexible-plan spaces had in common were: (a) variety, (b) flexibility, (c) agility, (d) transparency, (e) comfort, and (f) technology integration. The learning/teaching activities in the flexible-plan spaces were multidimensional and much more dynamic and fluid than in the traditional spaces. The learning/teaching activities in the traditional spaces were unidimensional, and many of the learning/teaching activities were driven by the teacher. Simply having flexible-plan spaces did not cause student-centered learning/teaching activities to happen.

Teacher adaptation to flexible-plan spaces is really about learning to work collaboratively with other teachers since spaces are shared. The difficulty for teachers at BHHS and MHS to adapt to flexible-plan spaces can be looked at through the three mechanisms of isomorphic change: coercive, memetic, and normative. The traditional plan and cellular organizational structure in K-12 education are expected by society and therefore are coercive isomorphisms. Since teachers are typically not used to working in teams and there was uncertainty about what to do, mimetic isomorphic change would suggest that traditional and well-established practices in organizations are mimicked. Lastly, normative isomorphic pressures are driven by the

profession of teaching. High school teachers are typically trained and expected to be subject content experts and are not prepared for teaching collaboratively and in an interdisciplinary manner.

Limitations

The limitations of this study that may have influenced the findings are primarily due to the nature of qualitative research in general. The findings from qualitative research are highly interpretive and are influenced by the researcher who serves as the research instrument (Creswell, 2013; Merriam, 2001; Stake, 1995). Since my biases may have influenced my observations and interpretations of the data, I made an effort to use member checks. I shared interpretations of the findings that needed more clarity with the participants during follow-up conversations and via e-mail. I received some clarifications but mainly received short confirming responses, which may also have been a limitation since the participants may not have wanted to take the time to give detailed and accurate feedback. Stake (1995) said that member checking is useful to "triangulate the researcher's observations and interpretations" (p. 115). However, Stake also noted—similar to my experience—that participants may not always take the time to thoroughly review the findings and typically provide very little feedback.

Since the researcher is the research instrument in a qualitative study, I practiced reflexivity by positioning myself (Creswell, 2013; Merriam, 2001). I reflected on and described my point-of-view and tried to identify my biases. In particular, my background as a practicing architect and involvement with one of the cases, BHHS, has shaped my observations and interpretations. Yin (2014) looked at this positively and stated that personal experience with a case can even serve as another source of evidence. While my bias may be a limitation, it could also be viewed by the reader as providing a unique perspective to the interpretations of the

findings. Thus, I used extensive direct quoting alongside my interpretations so the reader can judge for themselves and make their own interpretations.

Another limitation was bias that may have come from the participants' interview responses. Interviews were a large part of data collection. I recorded over eight hours of audio with 12 participants. I asked the participants open-ended questions related to the GAP triangle and about teacher adaptation to flexible-plan spaces. While some of the questions addressed current experiences, there were some questions that required them to reflect on past experiences. They may not have remembered exact details, or their recollections may have changed over time. Some questions also required them to make their own interpretations about the GAP triangle and teacher adaptation. Their responses may be biased, which could be a limitation. To account for this possible bias, I used triangulation and a constant comparison analysis method across the data. As I collected data, I compared and triangulated the findings from the interviews between participants and also compared them with other sources of evidence, such as documents found on the schools' websites, archival records, my observations, and finding physical artifacts during my visits.

Lastly, a major limitation of this study is in terms of generalizability. The findings from these two high schools do not provide a strong base for generalization to other high schools. The cases were purposefully selected as instrumental cases for the phenomenon under investigation—the relationship between the educational goals, the teaching and learning activities, and the affordances of the physical environment in traditional and flexible-plan spaces. In case study research, having a small number of cases is not ideal for making generalizations to populations (Stake, 1995). Findings from the cases under investigation may not directly apply to other cases—even those having similarities. Case study research, however, can support

generalization to theory, or what Firestone (1993) called "analytic generalization" (p. 22); therefore, I have stated my findings in these terms. This is important because the relationship between physical space and learning is a premature field of inquiry.

Implications

The findings from this study have implications for the design of physical spaces for 21st century learning, professional development, program development, and future research. By understanding how the affordances of the physical environment support learning/teaching activities that are intended to accomplish 21st century learning goals, architects and educators can better design the physical environment to support their educational goals. The findings from the case studies also showed that the educational program and how teachers used the spaces influenced the learning/teaching activities. These we found to be additional variables that impacted how the space was used to accomplish 21st century learning goals.

A key finding was that in the flexible-plan spaces the learning/teaching activities were multi-dimensional—many activities were taking place simultaneously. The spaces also better supported student-centered learning/teaching activities through the affordance characteristics of: (a) variety, (b) flexibility, (c) agility, (d) transparency, (e) comfort, and (f) technology integration. The traditional spaces in the study lacked these affordances; therefore, it was more difficult for student-centered learning/teaching activities to happen. By articulating the 21st century educational goals and imagining the learning/teaching activities that are aligned with those goals, educators and architects can design physical spaces with affordances that support the learning/teaching activities.

It was found that teachers adapting to flexible-plan spaces required them to work collaboratively. This is not typical in traditional settings where teachers work separated from

other teachers by their classrooms. Professional development for teachers in school that are transitioning to flexible-plan space can focus on developing collaboration skills. For instance, at BHHS they created SLCs at the existing Lahser High School to prepare their teachers during the construction of the new high school. Even with this early preparation, the teachers did not fully understand what the new spaces required in terms of changed practice. Ongoing professional development that is focused on collaboration could be helpful during the first several years in new flexible-plan spaces. It took several years for the teachers at both BHHS and MHS to adapt to the new spaces. Additionally, it was found that the educational program also influenced the learning/teaching activities. There needs to be emphasis on aligning the educational program with the educational goals.

The findings from this study add to the relatively small body of knowledge around this phenomenon. There are relatively few case studies of high schools that have flexible-plan spaces. By conducting case studies at other high schools that have flexible-plan spaces and comparing the findings to this study, further generalizations to theory can be made, adding to this growing body of research.

Equity and special needs. As previously mentioned, the two cases in this study do not represent underprivileged schools or specifically go into detail about students with special needs. While these areas are not covered in depth, a reader should not dismiss this study as only pertaining to affluent schools. The affordances of the flexible-plan spaces at BHHS and MHS may work well for underprivileged schools and for students with special needs. These students typically need more learning supports than other students which may be easier to provide in flexible spaces (Benade, 2019).

While future research in these areas is warranted, the findings from this study hint at some possibilities that flexible-plan spaces could be beneficial to these populations. In particular, flexible-plan spaces allow students to easily be regrouped depending on the learning/teaching activity that is taking place. Teachers working in collaboration could regroup their students based on the level of support that is needed. For example, the majority of students in a learning community could be working on a project where they are spread throughout the commons space. If some students need additional support, a teacher could pull them into an adjacent classroom or small group room for additional instruction. This would be very difficult to do in a traditional classroom that is limited by a single space.

Recommendations for Future Research

Case study methodology was used for gathering the results to understand the relationship between the educational goals, the teaching and learning activities, and the affordances of the physical environment—the GAP triangle. There were findings beyond the GAP triangle that warrant further study. Additionally, this study focused on the adult perspective—that is, of teachers and administrators. I did observe the activities of students, but it would be interesting to interview students to better understand their perspectives as they relate to learning in flexible-plan spaces.

The findings beyond the GAP triangle that I noted for future research were distractions in flexible-plan spaces, co-location, time for adjustment, and curriculum and planning. While flexible-plan spaces supported student-centered learning/teaching activities, several of the teachers identified that distractions in these spaces could be problematic. This was also identified as a problem in a study by Gislason (2009). Additionally, as an architect who designs flexible-plan spaces, I am frequently asked by various stakeholders whether or not students are

distracted in these spaces. Future research should define what distractions are and investigate whether flexible-plans spaces cause distractions any more than traditional spaces. For instance, what some may consider to be distractions to learning may actually be a part of the learning process.

Several of the teachers and the principal at MHS emphasized that their project-based interdisciplinary program, the MCIS, could be supported in traditional spaces. However, they did comment that co-location of teachers would be needed. This is because the teachers team teach in the MCIS. In a study by Spillane et al. (2017), the researchers used social network analysis to determine that proximity is a significant factor for collaboration in schools. Since there are many schools that cannot afford building a new school or making significant renovations, it would be important to know how co-location influences teacher collaboration and indirectly supports student-centered learning/teaching activities. In the flexible-plan spaces, teachers are co-located, but would co-locating teachers in traditional spaces help? Research in this area could be design-based or experimental.

Findings from this study showed that it took time for teachers to adapt to flexible-plan spaces and for the school to build a culture around practice. Understanding the time needed for adjustment would help schools that are intending to create flexible-plan spaces prepare for these changes. Curriculum and programming also related to teacher adaptation. This study found that at MHS an educational program for 12th grade students was created that emphasized project-based and interdisciplinary learning. The program guided curriculum and assessment, and the teachers showed high levels of collaboration. At BHHS, the educational program did not change much from when it was delivered in traditional settings. Even though the flexible-plan spaces were organized around interdisciplinary SLCs, students were still taking subject-based classes.

The teachers made an effort to find connections across subjects, but they were still taught primarily as separate subjects with an emphasis on content. Future research in this area needs to also consider the curriculum and educational programming.

While detail of each teacher who participated in this study was provided to give context, this study did not focus on how their background influenced the learning/teaching activities or how they perceived the affordances of the physical space. Several of the participants commented on how flexible-plan spaces are not suitable for all teachers. When the MCIS at MHS first opened, some of the teachers who were first assigned to the space had difficulty teaching and later were moved back into traditional classroom spaces. Research on the background of teachers could shed light on whether flexible-plan spaces, and the associated learning/teaching activities, may or may not work for all teachers. For instance, in a previous study by Betoret and Artiga (2004), the authors examined the conceptions of pre-service teachers about learning/teaching and the classroom layout. The results of their study verified their assumption that teachers whose beliefs and conceptions were teacher/product-centered preferred the traditional classroom layout while teachers with student/process-centered beliefs preferred the innovative classroom layout with multiple areas for different learning activities. Future research in this area could help inform decisions about transitioning teachers into flexible-plan spaces and with professional development.

Summary

To better understand the GAP triangle relationships and how teachers adapt to non-traditional spaces, this research focused on: (a) identifying the affordances of the physical environment and how they did or did not support learning/teaching activities intended to align with 21st century learning goals in traditional and flexible-plan physical spaces, (b) how

learning/teaching activities varied between traditional and flexible-plan physical spaces, (c) how teachers adjusted from traditional physical spaces to flexible-plan physical spaces, and (d) to what extent and in what ways teachers' practice changed in flexible-plan spaces compared to when they were in traditional spaces.

In discussing the findings in terms of the theoretical framework, physical space can be viewed as an educational technology having affordances. The flexible-plan spaces at BHHS and MHS were purposefully designed having affordances to support 21st century educational goals; therefore, it makes sense that the learning/teaching activities were more student-centered compared to the traditional spaces. The characteristics of the affordances identified in the flexible-plan spaces were: (a) variety, (b) flexibility, (c) agility, (d) transparency, (e) comfort, and (f) technology integration. Having a variety of spaces allows for different types of activities and a range of activities to take place simultaneously. The learning/teaching activities in the flexible-plan spaces were multidimensional and much more dynamic and fluid than in the traditional spaces. The learning/teaching activities in the traditional spaces were unidimensional, and many of the learning/teaching activities were driven by the teacher. Simply having flexible-plan spaces did not cause student-centered learning/teaching activities to happen.

Adapting to flexible-plan spaces meant having to work collaboratively with other teachers since spaces are shared. The difficulty for teachers at BHHS and MHS to adapt to flexible-plan spaces can be looked at through the three mechanisms of isomorphic change: coercive, memetic, and normative. With this research, I sought to better understand the relationship between the educational goals, the teaching and learning activities, and the affordances of the physical environment—the GAP triangle. Implications of this research are for

the design of physical spaces for 21st century learning, professional development, program development, and future research.

APPENDIX

Semi-Structured Interview Protocol

Background Questions

1. What is your role at this school?
2. How long have you been at this school?
3. How long have you been teaching altogether?
4. What inspired you to become a teacher?

Educational Goals

5. What is the purpose of education?
6. What skills do students need to learn to thrive in the world today?
7. What would you say are the overall educational goals at this school?

Learning/teaching Activities

8. Describe the type of activities that you do with your students?
    a. How does it change throughout the day?
    b. How does it change throughout the year?
9. Describe the type of learning activities that students do informally?
10. What learning activities do you feel are most important for accomplishing the educational goals at this school?
11. How often do you collaborate with your peers?
    a. Describe how you collaborate?

Affordances of the Physical Environment

12. How does the physical environment support the activities that you do with your students?
    a. Does the physical space provide enough flexibility for different learning activities?

13. How does the physical environment constrain or limit the activities that you want to do with your students?
14. What spaces do you use when you collaborate with your peers?

Teacher Adaptation

15. What was it like adapting to this new physical environment?
16. Did it take time to adjust to the new spaces?
17. How did your practice change in the new physical environment?

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