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Participatory Design of Classrooms: Infrastructuring Education Reform in K-12 Personalized Learning Programs

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The redesign of the physical spaces of classrooms and schools has become a prominent feature in many K-12, personalized learning schools, though it is often dismissed as a peripheral aspect of change. Through observations and interviews at four public schools, I examine the affordances of these new spaces and the narrative of their design. I situate these spaces-turned-places as pedagogical artifacts in a participatory design process to examine how educators and students create functional and meaningful learning spaces. Reframing the physical spaces in this way suggests how the spaces may be supporting the sustainability of the reform.

In an ongoing inquiry into personalized learning (PL) reforms in urban, suburban, and rural districts, I heard educators and students speak at length, often unprompted, about the ways they had modified their classrooms and buildings, from knocking down walls to adding sofa chairs and lamps (Author, et al., 2015). To them, their physical spaces held meaning toward their efforts of transform what teaching and learning looks like in their schools. Yet some leaders pushed back, saying, "It's not about the furniture!," and suggested that educators change their classroom furniture as a substitute for "real" pedagogical change. This led me to ask: *How do the physical spaces of personalized learning programs become meaningful, learning places, and why does this matter to these educators and students?*

The vast majority of K-12 students in the United States still attend a physical school building - five days per week, 181 days per year - as part of compulsory schooling. School buildings have changed over the course of history, from the one room schoolhouse to the comprehensive high school, yet the basic unit of the classroom and the arrangement within it remains remarkably stable (Jones, 2015). Indeed, the term "classroom" prompts an image of desks in a row with the teacher standing at a chalkboard within the "egg-crate" building, where each room contains a teacher and set of students (Nair & Fielding, 2005). This assumption of the physical classroom as the only place where learning happens or as an inert "container" for teaching and learning also promotes assumptions of fractal-like scalability, where classrooms are the units of change (Leander et al., 2010) or the "black box" of reform efforts (e.g. Bryk et al., 2010).

Yet these PL educators are challenging this arrangement. PL is an increasingly popular, whole-school model of educational reform that redesigns school systems to support student-centered, agency-based models of learning (Rickabaugh, 2016). PL draws on progressive ideas of engaging students as agents in their own learning with the support of digital technologies (Patrick, Kennedy, & Powell, 2013). Educators often use the phrase "voice and choice" as two strategies of engaging students as agents in their learning: listening to student voices for their input on what, when, and where they want to learn; and providing students with choices for how they will learn it and how they will show they have learned it. Notably, "flexible learning environment" is consistently included in descriptions of this reform, but the term "environment" in personalized learning (DiMartino, Clarke, & Wolk, 2003), and more generally in learning theory (Bransford et al., 2000), usually refers to classroom culture, instructional strategies, and digital and online spaces, not the physical spaces. While the relationship between digital technologies and flexible spaces has been explored in the context of higher education (Strange & Banning, 2001; Oblinger & Lippincott, 2006), empirical attention in the context of K-12 personalized learning remains limited (Tanenbaum, Le Floch, & Boyle, 2013, *is an exception*).

To explore this coincidence of the redesign of physical spaces and educational reform, I use participatory design as a theoretical framework to ask theses research questions of four PL programs as exemplars of this phenomenon. This framing attends to the features and activities the spaces afford and the retold narratives of the designers and users (in this case, the leaders, teachers, and learners), while understanding the goal as building agency among participants. This approach considers the physical spaces as pedagogical artifacts and provides insight into how this educational reform is mediated by and constituted in the physical spaces of these programs. I propose that these spaces-turned-places serve two functions for their designers

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and users: the alignment of features and affordances with their vision of personalized learning and the construction of meaningful learning places. Significantly, both of these functions contribute to building the capacity, connections, and sustainability required for the systemic transformation that the PL model proposes.

Literature Review

I situated this study in the context of the physical spaces and educational reform, and thus I focus the following review on how the physical spaces have been conceptualized as a lever for change, then contrast this with a conception of spaces as socially and situationally constructed. Approaching the physical spaces as a lever for school change is fundamentally about correlating the physical space with student outcomes, whether these are test scores or behaviors in hopes of finding "what works." For example, Cleveland and Fisher (2014) focus their review of the literature on these kinds of evaluative approaches. In this framing, there are two areas of focus: how to assess the space and what to consider as outcomes, the latter of which is generally test scores or student perception.

For the former, one approach is to categorize types of spaces, and various typologies have been emerged, such as campfires, watering holes, caves, and life (Thornburg, 2007); together/public, together/private, alone/public, and alone/private (Steelcase, 2015); and knowledge showrooms, knowledge studios, knowledge boutiques, and knowledge salons (Mathews & Soistmann, 2016, p. 32). Others have created assessment tools to map student use (Carpenter, 2016). More broadly, but still within the lever approach, there are frameworks for understanding how spaces fit into other reform elements. For example, Radcliffe's (2008) model of pedagogy, technology, and space as the three key elements of next generation learning spaces, and the school climate model (Owens & Valesky, 2007), an educational leadership framework to inform change efforts.

While the lever approach provides key insights into spaces and outcomes, in the context of an emerging reform, it is more helpful to explore how educators are using and modifying their spaces and how they make sense of this. The influence of the physical spaces on school change is under conceptualized, as Woolner and colleagues (2018) argue in their interpretive investigation of two schools. Their findings suggest that the physical spaces can play a part in supporting, sustaining, and institutionalizing change. Intentional and facilitated participation with the space itself can be a creative, social process of learning as part of the school's pedagogy (Parnell, 2015), and there is emerging interest in exploring the financial, academic, and social value of educator and student participation in the design of their learning spaces (Woolner, 2015).

An interpretive approach requires a fundamental reconceptualization of the physical spaces as socially and situationally constructed, in which case there are two components to be considered: the physical artifact itself and the process by which it is constructed. First, the physical spaces, like concrete objects more generally, can be considered as *embodied conjectures*, representing the vision, constraints, and context of their design, and are specific and empirically available to be studied directly (Sandoval, 2004). Along these lines, Monahan (2002) considers this in proposing the term *built pedagogy*, or the "architectural embodiments of educational philosophies" (p.5). Second, how physical spaces are socially constructed as *places* has been well conceptualized in geography (Hubbard & Kitchin, 2010) and is beginning to be applied in the learning sciences (Leander et al., 2010). Space can be considered the material dimensions and quality of built objects (Hatch & Cunliffe, 2013), and place as a physical some*where* that holds meaning and is continually redefined and negotiated as material and social aspects change (Casey, 1993). Importantly, this characterization defines place as a process, not a static arrangement of furniture. As such, I propose using a process-based theoretical framework of *design* to explicitly attend to physical places as pedagogical artifacts and how place is constructed.

Theoretical Framework

Design is a process of solving problems that is user-centered, iterative, problem-focused, and implemented in context (Edelson, 2002). Design in education is most popularly associated with design-based research (Design Based Research Collective, 2003); however, design has also be proposed as a meta-representation to understand education as "design for learning," a process by which artifacts are used to shape the natural processes of learning toward particular goals (Halverson & Halverson, 2011). Artifacts are objects that can be physical, like desks and textbooks, or abstract, like schedules and evaluation policies, and they can be externally or locally designed (Halverson, 2003). Artifacts mediate how we think and act, which means they are not merely aids for thinking and acting, but are constitutive of the thinking and acting itself (Wertsch, 1993). For example, schedules affect where and with whom we interact, but they also convey that there are certain times for learning certain things.

All artifacts have *features*, which the designer builds into the artifact and reflects the *intentions* of the designer (Norman, 1994). A feature might be a physical dimension, such as the height of a table, suggesting whether someone should sit or stand, or symbolic, such as the location of a teacher's desk at the front of the classroom. When the object is used, its *affordances* increase the likelihood of particular

outcomes. Because use is socially and situationally constructed, affordances may or may not match the designer's intentions (Pinch & Bijker, 1984). Whereas evaluative approaches seek to correlate intentions and outcomes, the focus here is on the process PL educators are using to align the features and affordances of their physical spaces.

To understand the involvement of educators and students in the design process itself and the focus on the construction of meaning, I also draw on the field of *participatory design* (DiSalvo et al., 2017). With its roots in democratic workplaces but increasingly applied to other fields, participatory design is a process "to uncover self-motivations, identities, and interests and to construct meaningful engagements by working together with participants in co-creating learning environments that meet the needs of the whole community that is engaged in the learning practice" (DiSalvo & DiSalvo, 2014, p.1). In this way, participatory design shifts the valued outcomes beyond just a functional design toward building the capacity, connection, and sustainability for participants to engage in the work (Penuel, 2015), thus I attend to what and how the physical spaces are designed, who participates, and how participants construct meaning. This framework provides an interpretive frame through which to analyze how meaningful learning spaces are constructed and meaningful and sustained education reform.

Research Design

This study is part of an ongoing, four-year phenomenological study of personalized learning of twelve programs (Table 1). All are public programs at district-run schools and initiated their program within the last ten years. Though each has a different origin story and context, whether they were initiated as a teacher-led charter or district-mandated reform, all were connected by an agency-based approach advocated by a regional network (CESA1, 2011). Our research group used network sampling (Patton, 1990) to identify regional leaders, and the saturation principle to establish when we had enough data (Guest et al., 2006).

Data was collected by a team of 10 researchers, and I personally spent multiple days in each of the four programs selected for this case study. Observational protocols focused attention on teacher and student movement throughout the space, including tracking individual students' trajectories as they moved around the space. Photos and sketches of the configurations of the material spaces, such as desks, couches, whiteboards, and screens, were used to document features. Documents were also retrieved from public websites. The research group produced 163 text documents, 176 images, and 58 memos.

For this inquiry, I selected four programs (italicized in Table 1) where the physical spaces had played a prominent role in the organizational narrative of the implementation of personalized learning, while also selecting programs that represented variation in grades, enrollments, and building configurations. Balsam High and Carson Middle provide examples of smaller programs within a larger, traditional school. Delaney Middle and Edison Elementary provide examples of large, whole-school programs. All four programs built their spaces within existing, public school buildings. Carson MS, Delaney MS, and Edison ES were all in 1950/60s era buildings, whereas Balsam HS had its latest renovations in the 1990s/2000s. None of the programs were situated in completely newly designed buildings; all were adapting current spaces. Though not representative of every school in the study, this subsample illuminates a range of what is possible to create within existing buildings at multiple age levels and program sizes. The data set for these four programs included 17 interviews, 101 images, 7 focus groups with students, and 33 field notes from observations.

The research team coded all data deductively using a multi-level framework of 29 codes and yielded 5119 coded segments (Author, et al., 2015). From this larger sample, I selected the documents specifically for the four cases and selected the codes for *learning environment* which revealed 239 coded segments. The original definition of *learning environment* included all learning structures, including schedules or competency-progressions, as well as the material dimensions of where students were learning. I then recoded these 239 segments for physical spaces, yielding 105 coded segments. Of particular note was that of the combined 17 interviews, 7 focus groups, and 33 observation field notes, segments coded for physical spaces showed up in almost half.

I then organized these 105 segments into two categories: narratives about the origin of the spaces and observations of the features and use of spaces (See Table 2). Origin stories are the recounted design narrative of the space. Design narratives are one way to communicate how artifacts are created and offer insights into intentions, give context, and identify who was involved (Grimaldi, Fokkinga, & Ocnarescu, 2013). For features of the designed space, I attended to layout, openness, visibility, movement, and accessibility (Hatch & Cunliffe, 2013). Finally, from these two categories of data, the origin stories (design narratives) and the learning activities (affordances), I apply the theoretical framework to draw out how a participatory process was enacted to provide insight into why these spaces have meaning to these teachers and students and how they become places.

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Table 1. List of study sites and descriptive information. Italics indicate four programs selected for this case study. All names are pseudonyms.

Name	Level	Type	Location	Students	Free & Reduced Lunch
Anderson	HS	Magnet school	Urban	1000	60%
Balsam	*HS*	*District charter*	*Suburban*	*150*	*20%*
Carson	*MS*	*School program*	*Suburban*	*100*	*40%*
Delaney	*MS*	*District charter*	*Suburban*	*400*	*20%*
Edison	*ES*	*Neighborhood*	*Urban*	*450*	*50%*
Franklin	MS	District charter	Rural	100	20%
Grant	ES	Neighborhood	Urban	450	70%
Hillside	ES	Neighborhood	Urban	350	70%
Irving	ES	Neighborhood	Rural	350	25%
Irving	MS/HS	Neighborhood	Rural	300	30%
Jackson	HS	District charter	Suburban	100	30%
Kingston	MS/HS	District charter	Urban	70	65%

Notably, studying the physical spaces was not part of the original study; it was the repeated emphasis by educators and students that motivated this inquiry. I represent the spaces as they were when observed, but acknowledge that given their dynamic nature, I cannot fully capture the change in these spaces over time. I also acknowledge my position as a former teacher and as someone similar in class, education level, and teaching philosophy to these educators. As a result, I had to dissociate the aesthetic of the space, which appealed to me, from the analysis of utility and meaning ascribed by the educators and students. I use two strategies to minimize, though not eliminate, my role as a researcher. First, my theoretical framework begins with descriptions of artifacts and their use, from which I then draw out interpretations. Second, this is not an evaluative study of whether these spaces are better or more effective. Meaningful learning environments may contribute toward improving student learning, but that is beyond the scope of this analysis. Instead, my inquiry focuses on the processes of the construction of place and the infrastructuring of educational reform.

Findings

For each program, I present an origin story of the physical spaces and description of prominent features, then describe the learning activities observed taking place there (See Table 2).

Balsam High School

Origin Story. Balsam HS is a competency-based, district charter school of about 150 students situated at heart of a large, legacy high school (Figure 1). The program began amidst a regional movement to create different approaches to education as districts were experiencing tightening budgets and higher accountability. Balsam's district chartered a number of schools, including an online academy, but found that students still wanted somewhere to go during the day to get help from teachers and be with their friends. This experience influenced the educators' sense of importance in creating a space that would support students academically and socially. The district and legacy high school have been supportive of Balsam, and several faculty teach or have taught classes in both.

The program is stretched across six classrooms and clustered around an open gathering area. The program began as an arts community, and the space supports studio spaces for visual and material arts, recording space for audio and video production, and performance spaces with risers and stage blocks, as well as small group conference rooms,

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Table 2. Analytic summaries

School	Origin Stories	Affordances	Repurposing Process
Balsam HS	Charter within a large legacy high school	• Visibility • Flexibility	• Intentional use of proximity to legacy to promote institutional change, student participation in creating the space
Carson MS	Program within a legacy middle school, negotiated for unused space	• Designation of spaces by purpose • Responsive	• Negotiation for underutilized space • Feedback from students
Delaney MS	Whole-school charter – situated in an unused, existing school building	• Making learning visible • Responsive	• Ongoing negotiation and iteration of spaces • Feedback from students
Edison ES	Whole-school - required to accommodate increasing enrollment	• Variation for choice and movement	• Teacher control

flexible seating, and informal hangouts. A hallway runs through the middle of the program, with visibility across and into most of the rooms through open doors or glass walls. With a bell to mark the passing period, students from the legacy high school walk through the heart of Balsam, seeing what learning looks like there. At times, this fishbowl location has generated friction between the legacy and charter schools, especially regarding who gets the "cool" furniture and technology, but the principal believes that the proximity and intermingling of students and teachers is critical to changing the broader system, linked to the original mission of charter schools.

Learning Activities. On a typical day, there would be students and teachers in most spaces, engaged in quiet conversations, group or individual work, with doors open. Other than attending seminars, students choose where to work, based on the learning activity, preference, peers and teachers, or tools and resources. Even in the seminars, there might be an extra student working quietly in the back or other students coming in and out. Visibility across the spaces is a key facilitator of the instructional program. At Balsam, students have times when they are working independently or are themselves teaching a seminar. One teacher reflects, "See all these glass walls? You can have one teacher [supervise]. From where I'm sitting, I can see 3, about 4 classrooms - the stage, the amp, this room and that one, so she could be running 4 seminars if she wanted to." By making the different spaces visible yet separate, the spaces facilitate flexibility in supervision, student agency, and shared teaching practices. As one more instance of making learning visible, demonstrations of learning were prominently displayed throughout the space, such as Adirondack chairs that had been painted by students and murals in the hallway.

Flexibility is seen in both the physical spaces and the activities of the students. Many of the rooms have flexible furniture, like node chairs. Most spaces have display options, whether a projector or large screen television, for students collaborate or share their work. The largest space had a moveable wall that would allow the room to be divided. One teacher reflects, "I think our spaces are set up to be flexible, to respond to all these different learning needs and modes. I think that also that it encourages having smaller groups and breakout groups which are super important. Like this room is used a lot of the time for smaller breakout groups or for whatever."

Carson Middle School

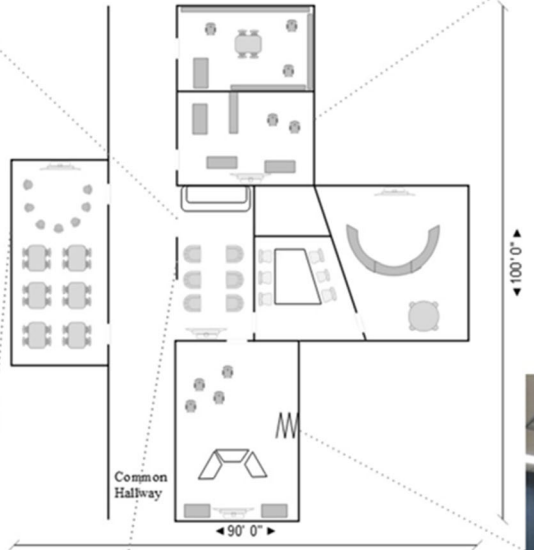
Origin Story. Carson MS, similar to Balsam, is a small program of about 100 students situated within a larger traditional program and stretches across multiple rooms (Figure 2). The two founding teachers wanted to create a personalized learning program that challenged traditional structures of schedules, curricula, and assessment. The guiding principles of the program was to have students determine what they would learn, how they would learn it, and how they would show that they learned it. Although the teachers had previous taught in the legacy middle school, the program was not initially greeted with excitement, and the principal was largely hands off and district administrators played a more supportive role.

As the two founding teachers sketched out their academic plans, they also had to negotiate with the principal and building manager to find a location, and decided to use some

Figure 1. **Balsam High School**

Central gathering area at Balsam HS. The central commons area had plush chairs with attached laptop tables around low "tables" that were actually old bass drums. One end of the common area was elevated to serve as a stage with acting blocks.

Figure 1: Balsam High School.



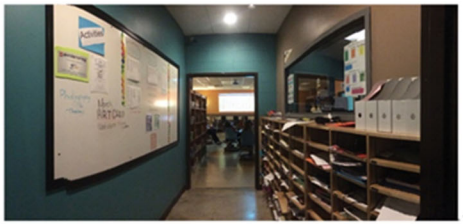
Examples from Balsam HS of flexible furniture: node chairs (above), display options, and moveable wall (below).

Adirondack chairs in a circle for the visual arts seminar.

Student created mural in the Balsam hallway. The student produced this as a final project for a class. It was done in chalk and she periodically changed it to reflect the changing of the year.

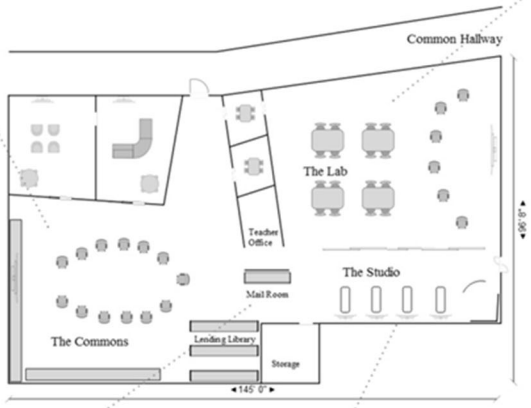
Figure 2. **Carson Middle School**

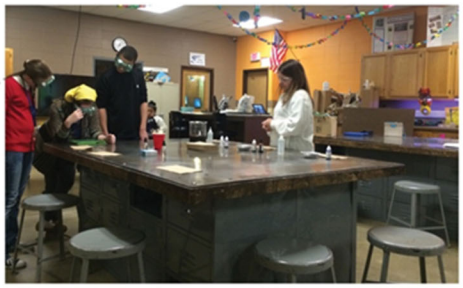
Node chairs for small group work. Here, students are assebmbled for a debate with the teacher mediating in the middle.



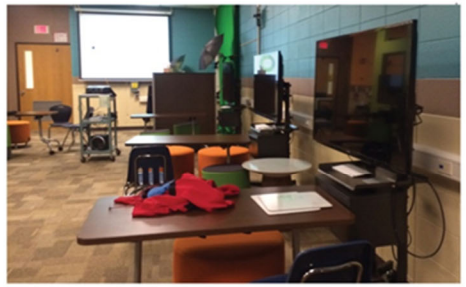
Mail room where each student has a cubby to keep their personalized learning binder. The whiteboard displays announcements, daily schedule, and advisory meetings.

Figure 2: Carson Middle School.





Two versions of the Lab: The first with the preexisting lab tables and metal lab stools (above), the second with flexible tables and chairs (below).



Two versions of the Studio: The first with displays available for student use and multiple types of chairs (left) and the next iteration as a presentation space and set up for standardized tests (right).

underutilized space in the middle school, including a broom closet, storage space, and a dusty exercise room. The space has no windows and is sort of oddly assembled, and the educators budgeted and developed the plans themselves despite a skeptical building manager.

The teachers and students have progressively modified and redesigned different areas. Some spaces were combined by taking down walls whereas others were divided by adding glass walls or panel dividers. Closets were remade as small group or quiet study areas. Furniture and equipment were purchased for the main instructional spaces. In the central joint of the space, the teachers created a small office for three desks so that they could oversee the two main arms and the entrance from the main building.

Learning Activities. Like Balsam, teachers and students scattered across the space, and flexibility and visibility were common themes. Students had open access to all spaces throughout the day, though they had a QR code badge system to scan in and out so that teachers would know where students were. Here, the designation of spaces by name, purpose, and social norms was more explicit than at the high school. For example, the small conference room was called the "Chat Room" to indicate that students should use it if they needed to talk with each other and not disrupt students working in one of the larger spaces. The quiet study room became an important space for students who needed a distraction-free environment, either by choice or by agreement with their advisor. Students and teachers discussed norms for each room, and students described and were observed reminding each other about noise level or off-task behavior.

Both short- and long-term configuration of the spaces emerged in response to instructional and student needs. The Commons had rolling "node chairs" that facilitated different learning configurations within a seminar block. For example, during a social studies seminar, a teacher gathered about 20 students in a circle, each student sitting in a node chair. Students then broke up into groups, wheeling their chairs into small groups facing each other. Then, for the debate, students lined up in two groups facing each other. Movement was done almost in a way that no one noticed how the chairs afforded the changes.

The other large space, the Lab, changed over the time the program was studied. At first, it had traditional science tables and stools, clearly remnants of original construction. These old tables were removed and a mix of small tables on wheels and moveable lab tables were installed to provide the flexibility for engineering type projects as well a traditional science experiments. Adjacent to the Lab is the Studio, which also changed over the time the program was studied. At first, it had six tables, each with a display and soft orange stools to sit on, plus a green screen with photography umbrellas for proper lighting in the corner. This configuration was based on a survey of student opinions, but as student and program needs changed, the Studio became a group presentation space and individual work spaces for standardized tests.

Educators talked to students about their choices about where to work. Conferring at Carson is a regular student- teacher meeting to go over learning progress. Alongside discussions about project deadlines and learning targets, advisors would ask students about where they chose to work and what effects that might have had (positive or negative) on their progress that week. Engaging in reflection about physical spaces belies a belief that the spaces play a role in student learning, and that teaching students to make choices that support their learning is part of developing student agency. A Carson student put it simply, "We like [that] we can pick where we go" and the teachers support them through both spaces that are responsive to student needs and conversations about the role of spaces in their learning.

Delaney Middle School

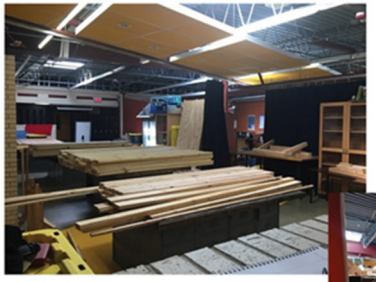
Origin Story. Unlike Balsam and Carson, Delaney MS is a district charter school of about 400 students that occupies its own building (Figure 3). It was an underutilized district building, originally built as an elementary school, that became an opportunity to build a large, competency-based program. The building includes several standard-sized classrooms, science labs, art studio, an engineering lab, several small conference rooms, a gym and cafeteria, and music classroom. At the heart of the building, an open, informal learning space was created by taking down walls and installing café height tables, bean bags, and even ping pong tables.

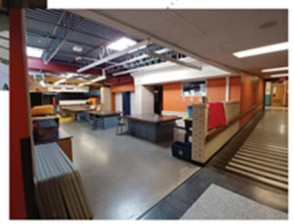
Alongside the evolution of the academic program, the spaces have been progressively modified in an ongoing and explicit strategy to foster innovative teaching and learning. The principal described several scenarios in which the design and use of spaces was grounded in what was best for students. For example, there was an underutilized classroom that was going to be converted to a business lounge. A recent entrepreneurship program had created a lot of buzz amongst students, who could be seen racing each other to get to business class to check their stocks. The principal and business teacher were envisioning turning an underutilized classroom into a business lounge, with glass walls and displays with news and stock tickers running. At the same time, a new arts pathway that had been created to meet student interest in visual arts needed a studio that would allow students to use glue, paint, and clay. After considering the needs of both programs, the decision was made to convert the classroom into the art space. The Delaney principal described his conversation with the business teacher,

Figure 3. **Delaney Middle School**

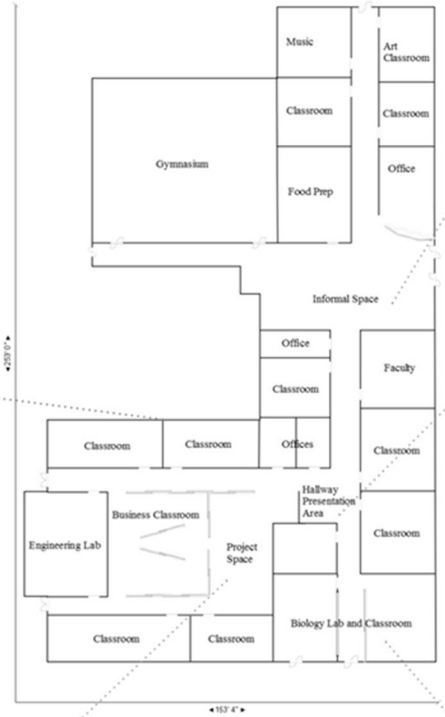
Students spend time rearranging the furniture.

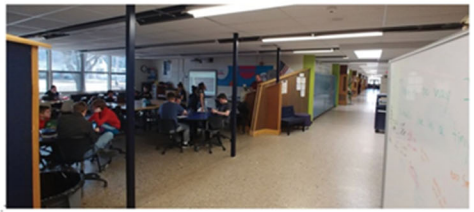
Combined classroom with varied seating and displays.



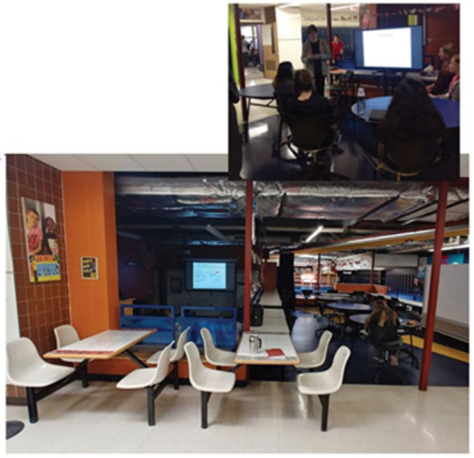


STEAM project area in what was previously an elementary school library.



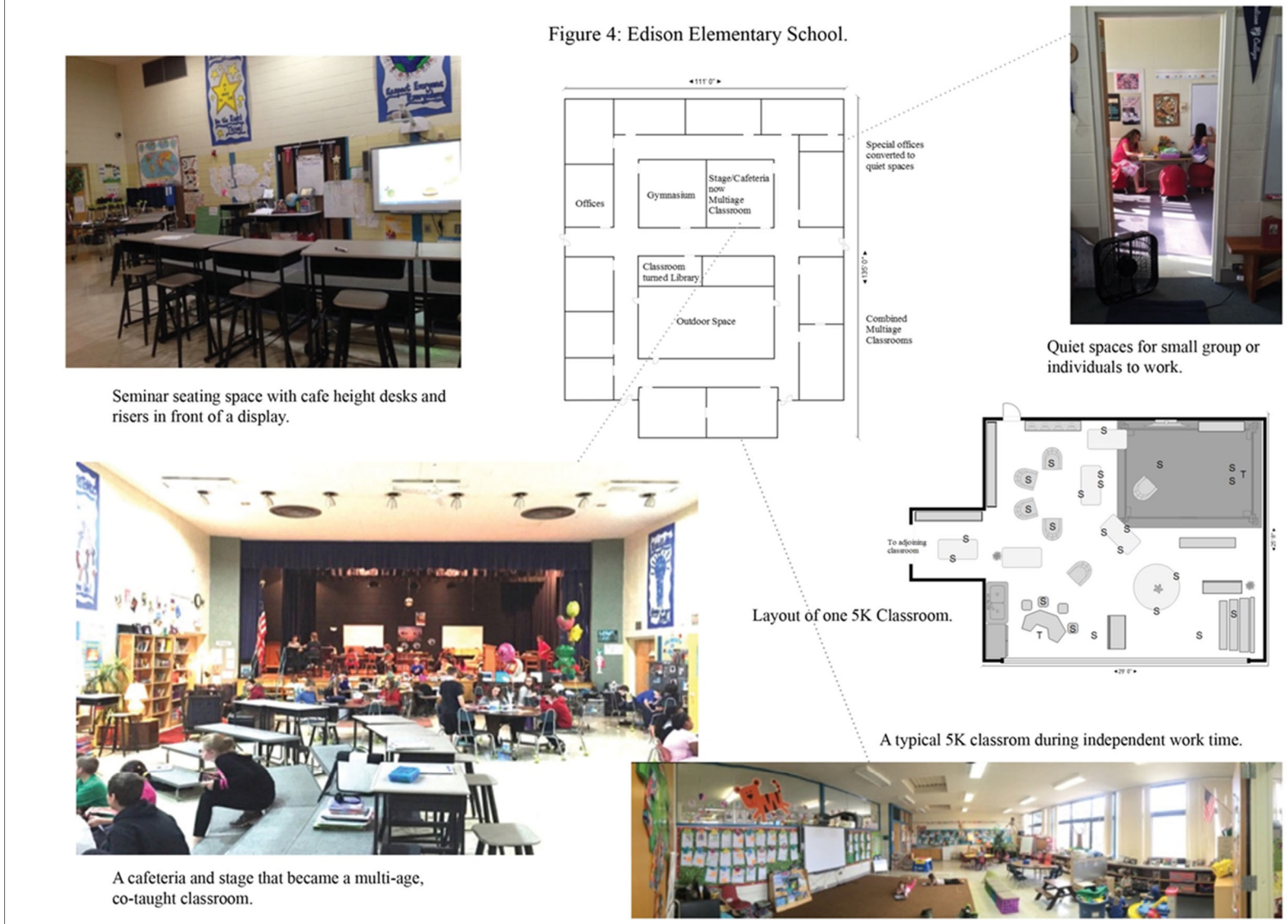


Hallways that have been repurposed.



Biology instructional area with collaborative space and lab.

Figure 4. **Edison Elementary School**



> "I had to say, pretend that you're an art teacher who is going to be working with kids working with glue and paint and clay. Where would you put them in this school? And he looked at me, smiled, and walked away. [He said,] 'I get it.' So then he started designing the space for where he is now. It takes it away from the teacher-centered approach."

Once the decision was made, students came in over spring break to paint and organize the new art room. In this way, the changes in the physical space become intertwined with the values of the program, both of which incorporate student voices into the origin and creation of the space.

Learning Activities. Making learning visible is a key aspect of the school's mission. By this, they mean both the products and the processes of learning. As such, they have the mind-set that "all spaces are learning spaces." Like Balsam and Carson, students have open access, allowing them to work in the hallway, small conference rooms, and to move in and out of classrooms, and this openness extends to visitors. During one visit, I was having a hard time finding a particular teacher, so I asked a couple kids sitting at their lockers in the hallway. A student jumped up and walked me to a classroom, walked right in, and the teacher welcomed us into the space. There was no sign we were interrupting or questioning what the student was doing. Delaney also has QR scanners to allow students to check in or out of spaces.

Whereas many programs buy and install furniture and technology based on curriculum or teacher needs, Delaney looks to student use. The principal remembers watching students working on their iPads,

> "I would go into a room and I would see 5-6 kids huddle around an iPad and I would think this makes no sense, so we have SmartBoards and all are attached to iPads but it's the teacher on there, so we wanted quick blast stations [for kids]."

They purchased mobile displays that students would have access to plug in their iPads, not just restricted to teacher use. Likewise, when students were seen sitting on the floor in the hallway, tables, chairs, and even a display was installed so that the space supported student learning and sharing. Importantly, I regularly observed students using these spaces, moving between them, and appreciating the flexibility they afforded. One student related that it was easy to coordinate with friends to work together throughout the day.

The principal regularly "crowdsources and vets" ideas with students through informal conversations, google surveys, and "beta testing" programs, everything from wanting more visual arts classes, as described above, or wanting polished concrete floors for a new science lab renovation. Pictures and plans are regularly shared as ideas take shape, and the transparency of process mirrors the desire for making learning visible.

Edison Elementary School

Origin Story. Edison ES is a neighborhood school that serves about 450 students (Figure 4). In contrast with the three other sites, this was an existing neighborhood school that shifted its instructional program toward personalized learning through a district mandate. At the same time, they experienced an almost doubling of their enrollment within just a few years. Space to accommodate this increase was found by rethinking how spaces could be used, including taking down walls, combining classrooms, and converting the cafeteria and library spaces into classrooms. Students now eat their lunch on movable tables in the gym, and the librarian stores books in a classroom, using a rolling cart to bring the library to kids.

The teachers were integrally involved in reimagining their spaces. They were given complete control, as two teachers share in an interview:

> Interviewer: You were here when this was all changed? So, how much say did you have in designing your classroom, or did you design all of it yourself?
> Respondent 1: 100%
> Interviewer: Like all the couches? You picked all of this out yourself?
> Respondent 2: We picked it out, paid for it, brought it in, we picked it from a lot of rummage sales, on the street.

Larger spaces were created as teachers also began co- or team-teaching in different configurations with specialists, and this combining of spaces and teaching configurations was integral to how PL was being implemented.

Learning Activities. Teachers designed a variety of learning arrangements for their classrooms. First, the larger spaces were divided up in into a variety of arrangements: there was a usually a rug in front of a SmartBoard for whole class activities, small reading nooks or comfortable seating for independent work, and tables for small group or collaborative projects. This provided a coherence to the open space, and while a student gave a presentation to a group of students sitting on a small riser, another student sat undisturbed just 3 meters away, tucked into a couch, facing the opposite direction. A few classrooms made seminar style instruction spaces with café table desks and risers. There were also lockers with iPad charging ports, lamps and plants, and chairs with tennis balls stuck to the feet to make them easier to move. In one classroom, there were two sofa

chairs with footstools and big pillows next to a fake fireplace. Notably, teachers did not have their own desk area as they were constantly moving throughout the room leading instruction, working one-on-one, or listening in on group work.

One teacher of a combined 4 year old and 5 year old kindergarten spoke at length about her space, repeating many aspects corroborated by observations of the space,

> We try to keep our classroom, as conducive to play as possible, we do have a large meeting space where we can all gather together for our morning meetings and our closing meetings … we also have individual places for students to go, if they need a quieter spot to go and work … the students know that have to be quieter in that room …[if] they need to collaborate together they know that they have to play that in the tiger room, and if they are working independently, which means that they are working on something by themselves, then they can do that in the elephant room. And they have gotten very used to understanding which room is which and going into the elephant room to be more quieter and into the tiger room to be bit … louder.

Watching students learn in this space challenged what learning bodies should look like. Students were spread out around the room in different body configurations. One boy was lying on his back, sunk down into a small version of a sofa chair, legs straight up in the air, working on his iPad. A few were sitting or lying on the floor.

One leader at Edison credit the flexibility of their spaces and schedules as having dramatically reduced office referrals:

> So last year we had ten fifth grade EBD [emotional or behavioral disorder] boys and girls, and [the new space] works so well for them because it's flexible so one little guy, he decided he was going to spend the year on my couch - he was in one of those big rooms and he didn't like it in a big room, we've since given everyone a little room so kids can go off [when they need]. A special ed teacher said, "You know what? You're brilliant."

This quote shares the sentiment of how these educators connected their change of space and instructional program with meeting the needs of their students. That little boy, who had fifteen office referrals the year before, had none this year. These little rooms were often repurposed specialist offices, who now worked directly in classrooms or floated between.

Discussion

Up to this point, I have written exclusively about spaces, not places. I now look across programs to draw out insights from the origin stories and learning activities, connecting both to participatory design processes.

Origin Stories. Common across all the origin stories is that they took a space that was already built and repurposed it into their vision for student learning. For Balsam and Carson, this meant carving out a space in the middle of larger program. For Delaney, this meant occupying an empty school with a new vision. For Edison, this meant opening doors, taking down walls, and moving libraries to create larger spaces with small pockets. Whereas renovation or restoration of a space means returning it back to intended use, these programs were repurposing their spaces, or altering how the spaces were used relative to the intentions of the original designer. Repurposing has the advantage of being faster and cheaper than building a new space (Bloszies, 2013), but it is also constrained by existing structures. This presents a design challenge for educators and students to create a learning space that affords desired learning activities. Creating these learning spaces required educators and students to negotiate between their vision of personalized learning and physical constraints. As such, the actions of educators, with the input from students, to repurpose their physical spaces is an act of design and it communicates their intentions about the types of learning activities that should happen there.

Learning Activities. Once they had designed a new space, however, they did not stop. Through attention to how learning actually happened, all programs were in a continual process of redesigning and repurposing. The actions of students, in this way, acted as a feedback mechanism toward redesign. This took place on different scales. At Carson and Delaney in particular, educators solicited direct feedback from students, and at Balsam, Carson, and Delaney, students were directly involved in creating spaces. At Edison, the process was in response to student behavioral needs. Importantly, these iterations do not exist apart from the instructional system and relationships between teachers and students. For example, once students had the flexibility to choose where they wanted to work, this meant teachers needed to support students instructionally, including using a learning management software that allowed students to work at their own pace and integrate conversations about these choices into conversations about learning.

Participatory Design. The process of repurposing spaces became one of participatory design in two ways: who was involved and the shift in desired outcomes. First, the educators and students were both the users and designers, thus intimately engaged in the design process and attention to their own practice informed each iteration. Consequently,

the spaces they designed were functional toward their instructional and learning goals because, rather than being designed by someone far away, they are able to customize each bit of the design. Second, their own intentions become embedded in the physical space itself. As the program and learning activities change, the physical spaces become a site that has multiple meanings to multiple people. This continual construction of meaning through repurposing is how physical spaces become meaningful learning places. It is worth noting that this is more than educators and students being asked their opinion. What makes this a case of participatory design is the engagement of users in design *and* the program goal of building agency in educators and students. These programs have explicit goals of empowering teachers to construct the conditions for students to be agents in their own learning. This reform, in this way, aligns with the democratic roots of participatory design of developing agency, meaning, and community. In these programs, the physical spaces become the site for participatory design.

Physical Spaces in Educational Reform. Taken as an instantiation of participatory design, repurposing the physical spaces becomes an *infrastructuring* activity, or activity that builds the capacity, connections, and sustainability for continued work (Ehn, 2008; Penuel, 2015). Infrastructuring is often seen through agonistic interactions, such as the conflict with the legacy high school at Balsam or negotiation over space at Delaney, because they build relationships, history, identity, and meaning. Seeing the design processes as infrastructuring reveals, again, why these spaces matter to these educators, but also points to their role in educational reform.

The shift to personalized learning in this region has largely been "inside-out," with changes beginning with educators and growing out to the system (Calhoun & Joyce, 2005). Thus understanding this as an educational reform movement means attending to how educators narrate the changes they have made, and this includes the prominent attention they put on their physical spaces. The framing presented here thus considers these spaces-turned-places as artifacts of the reform. In this way, these places create and reflect the social infrastructure of change: the work of educators and students as they literally and socially construct places for authentic, genuine, and meaningful learning.

This analysis supports the argument that the physical spaces can be treated as an integral aspect of how this reform is being enacted and sustained and develops a theoretical framework to do so. To be sure, the reform is not solely enacted this way; the physical spaces are part of the larger educational system. Further inquiry is needed into how the physical spaces interact with the instructional system, staffing decisions, budgets, etc. What I observed in these four programs is that meaningful learning places are one aspect of how educational reform is happening and why they are a prominent aspect of the change narrative.

One question that emerges here is the perennial critique of which came first: does the participatory design of these places rely on or create meaningful places? Did these educators and students already find their school spaces meaningful and so they engaged in participatory design, or did the engagement in participatory design create the meaningful places? Given the national discussion of the lack of student engagement in schools (Washor & Mojkowski, 2014) and Fisher's (2004) argument that the physical spaces of schools are largely ignored aspects of educators' and students' schooling experiences, it is reasonable to conclude that this is, at the minimum, a synergistic process. Given this, it is worth keeping in perspective that *the artifacts themselves are not the answer* (Halverson, 2003); the artifacts mediate and constitute the work, and this is what evaluative studies of spaces miss. It is not the particular height of the table or wheels on the tables: it is the participatory design process and the engagement in design that builds the infrastructure for change.

Conclusion

The questions I set out to answer are: *How do the physical spaces of personalized learning programs become meaningful, learning places, and why does this matter to these educators and students?* Studying the origin stories and activities in these programs provided insight into how the changes in space are happening, through the participatory design process of repurposing. The first part of why this matters is functional: it allows educators and students to match the features of their spaces to desired activities. The second part is that the process embeds meaning in the physical space, becoming the mechanism for constructing meaningful places. Finally, understanding repurposing as a form of participatory design lends the perspective of infrastructuring as one mechanism that creates the capacity, connections, and sustainability for educational reform.

It is worth noting, that in these cases, there were no architects or professional designers present. In most cases of participatory design, there is a university- or industry-based designer who acts as a facilitator. This may mean that the designated leaders, such as principals and instructional coaches, take on the role of facilitating design, but without the explicit knowledge of spatial literacy (New London Group, 1996) or environmental competence (Lackney, 2008). This may result in spaces do not properly support learning, are inefficient, or may be out of compliance with building codes. However as architects and designers seek to improve educator awareness of the importance of space, a first step may be recognizing the design processes already in place, as this paper does.

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