

The Effects of Furnishings and Technology on Pedagogical Agility and Student Engagement Across Flexible Learning Spaces

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We explored how furnishings and technology impact pedagogical agility and student engagement across three flexible learning spaces. We collected various kinds of data from faculty and students teaching and learning in multiple classrooms, such as focus group interviews with students, faculty responses to reflection prompts, and pre-and post-occupancy surveys with both. Flexible furniture configuration was found to support various instructional strategies and facilitate interaction between student-student and student-instructor. A writable surface is beneficial to facilitate student engagement during group activities. Digital displays with wireless content sharing capabilities promote collaborative learning. Specific recommendations for learning space designs and faculty development are provided.

Educational researchers and practitioners today have recognized the importance of promoting students' 21st-century learning competencies, such as critical thinking, collaboration, and problem-solving skills. A variety of instructional strategies to improve these learning competencies have been the topic of much investigation in higher education research literature (e.g., Bezanilla et al., 2019; Burbach et al., 2004; Daouk et al., 2016; Fong et al., 2017). At the same time, increased attention has been paid to the role of flexible learning spaces aimed at improving such learning competencies (Hughes & Morrison, 2020; Karippanon et al., 2019). Indeed, an extensive body of work has found the flexibility of learning spaces to support a range of pedagogical approaches (e.g., Lee et al., 2018) and enhance students' cognitive and emotional engagement (e.g., Cotner et al., 2013; Ozkan Bekiroglu et al., 2022), ultimately contributing to better performance as compared to students in traditional learning environments (e.g., Baepler et al., 2014; Chiu & Cheng, 2015). Despite the benefits of flexible learning spaces on teaching and learning in classroom environments, there is a dearth of research about how each feature (i.e., furnishings, technology) of such flexible spaces affects instructors' pedagogical agility and student

engagement. Thus, we seek to minimize this gap by exploring the role of furnishings and technology on pedagogical agility and student engagement across three flexible learning spaces in a university located in the northeastern United States. In this paper, we investigate instructors' and students' perspectives on how furnishings and technology in flexible learning spaces function in specific ways.

Flexible Learning Spaces

Flexible learning spaces, often referred to as active learning classrooms, have been considered to support multiple modes of instruction (e.g., small group discussions, hands-on experiences, and lectures), using furnishings and technology in a number of ways (Learning Space Rating System version 3, or LSRS v3, Brandt et al., 2020). Flexible learning spaces have been characterized by using two perspectives: (a) design principles of architecture such as flexibility to construct a flexible environment and (b) sociocultural theory of learning to focus on students' social interaction during learning (Rook et al., 2015).

Such flexible learning spaces, appointed with a variety of furnishings and technologies, have been found to support pedagogical agility and facilitate student engagement. Pedagogical agility refers to flexible, adaptable pedagogical approaches in response to students' needs, learning content, and learning context aimed at improving student engagement and learning outcomes (Ramsay et al., 2019). Instructors in flexible learning spaces have the freedom to implement a range of instructional activities in a timely

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fashion during class such that the deployment of various instructional activities is beneficial for students' active and continuous engagement, as compared to students in a traditional learning environment (e.g., Chiu & Cheng, 2016; Cotner et al., 2013; Kariippanon et al., 2019; Ozkan Bekiroglu et al., 2022). For instance, in one study, Ozkan Bekiroglu et al. (2022) described how a classroom's flexible layout facilitated student engagement broadly and student-to-student or student-to-instructor interaction more specifically. In their study, analysis from 360-degree video data showed that students could walk around the classroom and see various classmates' opinions by looking at graphic representations on the writable walls in the flexible learning space. Regarding such graphic representations on the walls, students then had an opportunity to discuss with their peers. These findings, however, seemed to describe the overarching impact of flexible space on instructors' pedagogical agility and student engagement, rather than explain the unique impact of each feature that comprised the flexible learning space.

In this study, we examine three critical elements of flexible learning spaces, representing furnishings and technology: (a) flexible furniture configuration, (b) writable surfaces, and (c) digital displays with wireless content sharing capabilities. All were provided in three flexible learning spaces at one university.

Furnishings and Technology in Flexible Learning Spaces

Flexibility is the core design principle of multi-modal and pedagogically agile learning spaces. Such flexibility, reflected both in furnishings (e.g., flexible furniture configuration, writable surfaces) and technology (e.g., digital displays), has been found to not only support a range of teaching and learning activities but also increase the degree of student engagement (Neill & Etheridge, 2008; Thomas et al., 2019). Indeed, the flexible furniture configuration is effective in stringing instructional activities together (i.e., activity strings, Ramsay et al., 2017), making movement from one activity to another less disruptive to instructional flow or create a bumpy transition between a range of learning activities (e.g., Kariippanon et al., 2018; Neill & Etheridge, 2008). For example, in one study, Kariippanon et al. (2018) found a mix of flexible furniture configurations satisfied students' multiple physical needs in the classroom, to affect students' feelings of comfort during a class session. Simultaneously, students had the freedom to move around the space more frequently, as needed. Results from this study showed that flexible configurations, providing a mix of desk-/chair-style furniture (e.g., height-adjustable desk/chairs) and soft, comfortable seating, are desirable classroom environments, unlike traditional

learning spaces that are typically characterized by rigid seating arrangements (or rows of desks and chairs).

Second, writable surfaces, as a facet of flexible learning spaces, help make students' thinking processes associated with their academic tasks more visible (Rowlands & Kell, 2019; Yeoman, 2018). For example, Rowlands and Kell (2019) found writable surfaces to be effective in facilitating students' critical thinking skills and sharing students' knowledge construction process with their peers, by comparing notes documented on the writable surfaces. Findings from their study demonstrate that writable surfaces have the advantage of encouraging students to collaborate with their peers by sharing their thoughts on physical spaces (i.e., writable surfaces).

Finally, in a flexible learning space, digital displays with wireless content sharing capabilities promote student learning by connecting course content to students' understanding of sense-making activities (Pashak & Hagen, 2014; Ramsay et al., 2019). A range of digital displays, such as interactive digital displays or numerous separate digital displays, are common in flexible learning spaces. In one study, Ramsay et al. (2019) found an interactive digital display, especially when combined with content-sharing capabilities, promote students sharing their small group work very easily with the rest of their classmates. In another study, beyond setting up one interactive digital display in a classroom, Pashak and Hagen (2014) found four separate digital displays to benefit student attention. These four digital displays simultaneously allow students to display various media and write directly on the screen. Building on previous work to examine the overarching impact of flexibility in learning spaces, the purpose of the present study is to answer the following open and overarching question: *how did furnishings and technology in flexible learning spaces support pedagogical agility and student engagement?*

Present Study

The present study aims to investigate the relationships among pedagogical agility, student engagement, and furnishings and technology of three flexible learning spaces at one institution. We specifically explored how flexible furniture configuration, writable surfaces, and digital displays with wireless content sharing capabilities affect instructors' pedagogical agility and student engagement across three flexible learning spaces. In the current investigation, we mainly collected qualitative data to provide insights into the nature of instructors' and students' perspectives about furnishing and technology in flexible learning spaces, which may not be fully captured by instructors' and students' (quantitative) ratings of flexible learning space (Attai et al., 2021). We investigated the following research questions:

1. How was flexible furniture configuration used in flexible learning spaces to support pedagogical agility and student engagement?
2. How were writable surfaces used in flexible learning spaces to support pedagogical agility and student engagement?
3. How were digital displays with wireless content sharing capabilities used in flexible learning spaces to support pedagogical agility and student engagement?

Methods

Study Setting

Flexible Furniture Configuration. Flexible furniture configuration is an indicator of the extent to which particular features support a range of instructional activities within one class session. Part B of the LSRS v3 (Brandt et al. 2020) provides criteria and a rating system to holistically assess the quality of layout and furnishings in flexible learning spaces. The characteristic features include proximities within space, movement through space, and flexible furniture configuration. Rooms with higher scores are considered to provide more flexibility to implement a variety of learning activities (e.g., a transition from a lecture with a circular layout to small group discussions with numerous small group tables). Classrooms in this study, were characterized by flexible furniture including soft seating, height-adjustable and moveable tables and chairs, and ample space for occupants to move themselves and the furniture.

Writable Surfaces. Writable surfaces in flexible learning spaces are intended to provide sufficient writable space such that students can easily interact with the class content and with peers during learning (Yeoman, 2018). There are various types of writable surfaces, such as writable table-tops, fixed and mobile stacking whiteboards, and writable walls. In this study, we aggregated data for different types of writable surfaces across three different flexible learning spaces. Those were (a) writable walls, magnetic whiteboards, and mobile whiteboards in two spaces (i.e., Space A, Space B) and (b) writable table-tops and fixed and mobile stacking whiteboards in the third space (i.e., Space C). By doing so, we aim to comprehensively understand the role of these writable surfaces on pedagogical agility and student engagement across the three flexible learning spaces.

Digital Displays with Wireless Content Sharing Capabilities. Digital displays in flexible learning spaces enable content sharing by making it readily available, visual, and/or readable by all students in the classroom. Digital displays in the three flexible learning spaces were either touch-enabled digital displays or teleconferencing (via software installment). Both instructors and students were




able to manipulate the screen by themselves. Students directly cast content from their devices to room displays visible by all students, while an instructor had the authority to control the shareable screens. Despite the versatile functionality of digital displays in flexible learning spaces, there is little research on how those various functions have impacted pedagogical agility and student engagement.

Data sources

Our research team has engaged in multiple projects to investigate the effects of flexible learning spaces on teaching and learning in higher education. For the current study, we specifically investigated three flexible learning spaces (i.e., Space A, Space B, and Space C). All three are characterized by flexible furniture configurations, writable surfaces, and digital displays with wireless content sharing capabilities. Collectively, these data sources included focus group interviews with students, one-on-one interviews with students, faculty responses to reflection prompts (i.e., Flashback) (Ramsay et al., 2017), and pre- and post-occupancy surveys with open-ended responses from faculty and students. Taken together, these data allowed us to synthesize and explore the standard features of furnishings and technology across the three different flexible learning spaces. Data collected from faculty and students are presented in Table 1.

Data analysis

We adopted both a quantitative and a qualitative approach to analyze multiple sets of data. First, we descriptively summarized quantitative data from student surveys (in Space B). Second, a qualitative approach was used to thoroughly describe instructors' and students' perspectives with respect to flexible furniture configurations, writable surfaces, and digital displays with wireless content sharing capabilities across the three flexible learning spaces. Importantly, the descriptive qualitative approach helped identify common and essential themes related to the role of furnishings and technology in flexible learning spaces on pedagogical agility and student engagement (Vaismoradi et al., 2013). The qualitative data were analyzed using both top-down and bottom-up approaches. Initially, instructors' and students' interview responses from each flexible learning space were classified as reflecting the features of furnishings and technology that aligned with the themes identified from prior literature on flexible learning spaces (e.g., flexible furniture configuration, Kappriippanon et al., 2018, Ozkan Bekiroglu et al., 2022; writable surfaces, Ozkan Bekiroglu et al., 2022; Rowlands & Kell, 2019; digital displays with wireless content sharing capabilities, Pashak & Hagen, 2014).

Table 1. Data Collection Methods			
Learning Space	Space A	Space B	Space C
Figure			
Data collection period	Fall 2019	Fall 2017, Spring 2018	Fall 2019
Sources of instructor data			Pre- and post-occupancy survey Reflection prompts (or Flashback ^a) Press-of-a-button feedback (Happy or Not)
Sources of student data	1-1 interview	Post occupancy survey with open-ended responses	Pre- and post-occupancy survey Focus group interview ^b Press-of-a-button feedback (Happy or Not ^c)
<p>^aFlashback: Weekly reflection prompts were automatically sent to instructors teaching in flexible learning spaces (Ramsay et al., 2017).</p> <p>^bFocus Group Interview: Group of students freely discussed their opinions and perceptions of their experiences in the space.</p> <p>^cHappy or Not: Press-of-a-button feedback to collect overall satisfaction in flexible learning spaces for a particular day.</p>			

Following this initial coding, standard features of responses across three flexible learning spaces emerged. The bottom-up approach was then considered to identify other themes in instructors' and students' perspectives about furnishings and technology, which were not captured in previous literature.

Results

RQ 1. How was flexible furniture configuration used in the space to support pedagogical agility and student engagement?

Pedagogical Agility: *The rooms' flexible furniture configuration was found to support a desirable range of instructional activities (i.e., pedagogical agility).*

Across three flexible learning spaces at our institution, moveable and comfortable furniture is provided to ease and enable reconfigurations within the spaces. The flexible, movable furniture enables instructors and students to create a variety of room layouts easily and quickly (e.g., relocating desks and chairs for small group activities) as well as to reconfigure settings for a range of learning activities within and across classes (e.g., transitioning from lecture to small group activity). By reducing the time required for reconfiguration, instructors and students easily moved back and forth between desired instructional activities. Student A taking a class in Space A explained this in a 1-1 interview:

Student A: And because it's more fluid, it's easier to move things around. And because we're not wasting time, then you can easily move straight from the professor lecturing and explaining what the activity or what the discussion or whatever the class is going to be about, straight into the small group discussions without sort of losing your train of thought maybe or becoming more focused on the configuration of how you're going to be sitting and being able to see people.

Additionally, Instructor A teaching in Space C described this in a Flashback:

Instructor A: Classroom is very flexible for different teaching needs. We particularly enjoyed the ability to move the tables into a rectangle (for all-group discussion) and into smaller groupings (for group work).

In a 1-1 interview with students taking a class in Space A, the interviewer asked Student B how the room aided a particular learning activity (e.g., *how did the room help brainstorming?*). In the responses, Student B explained that flexible tables motivated them to keep discussing when they were brainstorming with peers rather than distracting them.

Student B: So, I remember one of my groups one time, we moved one of the subunits of a table to the side or something. And we all just collaborated there. Another time we would just move the lounge tables and go around like a little one of the smaller circled table things and talk there. Especially at the end where we had to make these presentations about the conference. So, I think that helped in the creative sense.

Student Engagement: *The rooms' flexible furniture configuration was found to facilitate interaction between students and the instructor (i.e., student-instructor engagement) and between students and students (i.e., student-student engagement).*

Our data support that flexible furniture configuration is beneficial for learners to move and group in a variety of ways. While students relocated to engage in small group activities, both students and instructors were provided freedom of movement due to the flexible layout with ample space to move. In particular, instructors were able to quickly visit different small groups to provide feedback to students. During a focus group interview with students taking classes in Space C, Student C explained how the instructor moved around and interacted with students in the learning space:

Student C: I think that when we are in subgroups it was really easy, usually. The professor would walk around and check on each group because of the configuration of the room it was easy to get through....not navigating through a bunch of desks and bumping into other people.

Moreover, in such flexible spaces, students' focal point and attention are not necessarily fixed on a particular spot (e.g., front orientation). For example, by moving furniture and altering the room configuration (e.g., U-shape), students could easily face each other during their whole-class discussion, not facing a front point. This movement is advantageous in promoting student engagement with their peers. Student D taking a class in Space A described this in a 1-1 interview:

Student D: It's much nicer than the normal problem-based learning class that I have, because it's not a classroom where everyone's heads are all facing the exact same way. But we always move the tables so we're in this big U shape; we're all facing each other at the same time. So, our discussions are a lot more productive. We're able to see each other and connect ideas and talk about things.

Additionally, students reported that comfortable chairs served as a mechanism to keep them focused on learning (i.e., active engagement and involvement), even as activities

switched. Students E and F, taking classes in Space C, described this in a focus group interview:

Student E: We are more interactive with our peers in a class like this because we are able to scoot our chairs around and write in a little group around a whiteboard, so I definitely feel like I know my classmates better.

Student F: I look forward to coming to this class for multiple reasons and one of them is the chairs. You can move it forward. It's got a big enough back for a bigger individual. I am not in elementary school anymore. It is very nice. The freedom is wonderful. Honestly, you know what, you can even say that that helps me focus a little bit more because I am always adjusting myself because the chair back is in the middle of my back in almost every other class.

Finally, post-occupancy survey data from students taking classes in Space B revealed students' perceptions of how flexible furniture configuration helped a variety of instructional activities and practices. Specifically, we asked students to report the extent to which they agree with the following statements: Aspects of the physical classroom environment (arrangement of furniture, display, space layout, etc.) helped (a) lecture, (b) whole-class discussion, (c) group discussion, (d) share ideas or thoughts, (e) communication with an instructor, and (f) interaction with peers, on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Overall, students' average scores were between 3.44 and 3.70, indicating that students

perceived flexible furniture configuration supported instructional activities and facilitated communication with the instructor and students at a moderate level. See Figure 1.

RQ 2. How were writable surfaces used in flexible learning spaces to support pedagogical agility and student engagement?

Pedagogical Agility: The rooms' writable surfaces (e.g., writable wall(s) or table surface(s)) supported variations in learning activities (e.g., transitioning from individual work to group work) within one class session.

The use of writable surfaces facilitated student engagement, not only for individual learning and small group activities but also for whole-class activities. During individual learning in Space A, the writable walls were effective in helping students organize their thinking in that students were readily jotting down their ideas on the writable wall. They were then allowed to seamlessly display their ideas or opinions both to team members and to the whole class. As such, students' writing on the writable surfaces was for the purpose of demonstrating their thinking process and learning output for an assigned task, from individual work, through small group activity, to a whole class activity. Students A and G, taking a class in Space A, described this in a 1-1 interview:

Student A: So sometimes depending on what the activity was, sometimes it would be a couple of people with different markers and all of us writing down what we individually thought or all

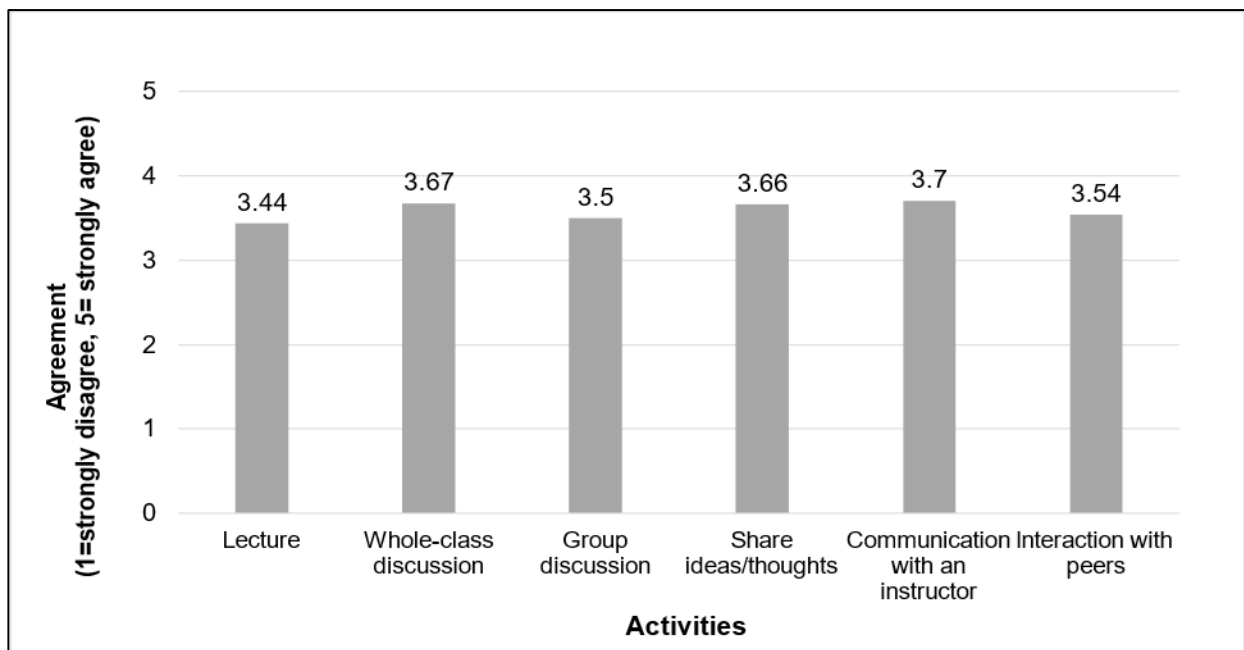


Figure 1. Students' Perceptions of Flexible Furniture Configuration (Space B)

of us discussing and one or two people transcribing it for us. And then we would just sort of show the class in a larger group discussion what we had worked on.

Student G: Usually it's brainstorming, so we all have to think about our experiences or ideas, or we[re] trying to solve a problem like, "Oh, what would you do in this situation?" So, we all pool together our thoughts. And we write on the walls because you can write on them. Or we write on the whiteboards and we write down our ideas, and then we come back together as a class and discuss what we thought of as groups.

This case was also evidenced during a focus group interview by Student H taking a class in Space C:

Student H: We use them a lot too when we do the breakout sessions and then you can flip them [writable tables] up and show the other groups what you were doing. And also, I had some friends that would take their notes on here and then would take a picture and they could put it in their own PowerPoint slides for notes.

Student Engagement: The ongoing content visibility on writable surfaces supported student engagement by assisting students' group activity.

For small group learning (e.g., brainstorming), a writable surface was also found to help students share their ideas with group members and co-construct knowledge of course content. By writing out information from peers on the whiteboards, students aggregated teammates' ideas and opinions that emerged through the learning tasks. This information may be significant for tracing teammates' thinking processes and having a shared understanding of course content. Student I, taking a class in Space A, described how their small group activity operated with a writable wall surface.

Student I: I think the whiteboards would be another thing that's great, and I think that instructor really uses it often. She makes use of those in a helpful fashion. For one example, we were working on 24-hour recalls. It's a counseling class, so we were talking about, in a session, how you can go through the diet of your client's 24 hours. So, we basically practice writing all of that out on the whiteboards with a partner, and that was kind of fun because then the partner could also see, oh wait, I meant to say this here, or was able to add to it by viewing it on the whiteboard rather than just a paper.

Additionally, data support that students perceived writable surfaces as helpful to their engagement in in-class small group activities. Student J, taking a class in Space A, described this in a 1-1 interview:

Student J: I think the whiteboards really help us to facilitate our [interaction] activity because it was easier for us to write out the information on the board and produce our own self....there was more interaction compared to other classes.. because other classes will be lectures and the professor will just be in front of them talking about his own information. But in this class, we also put in some information.

RQ 3. How were digital displays with wireless content sharing capabilities used to support pedagogical agility and student engagement?

Pedagogical Agility: The digital displays with wireless content sharing capabilities make content easily available, visible, readable, sharable by both instructor and students. Content sharing capabilities supported group collaboration during small group activity.

Digital displays with content sharing capabilities enabled instructors and students to share a variety of learning materials to a screen, including text and visual information. Student D, taking a class in Space A, described this in a 1-1 interview:

Student D: We make a PowerPoint presentation; you just connected the board real quick, and then you can really easily move between people's presentations. And whenever we're presenting a paper, our professor will put the figure on the board that we're talking about and then point out and be like, "All right. You guys went through these questions and look at that." Sometimes we watch videos whenever they put them on that we all watch. We watch it from there. That's about it really. It's just presenting the papers and poster presentations.

Student Engagement: The digital displays with wireless content-sharing capabilities may indirectly affect student engagement by facilitating a smooth transition between instructional activities.

Building on this functionality, Space C is equipped with six digital displays able to cast different content onto each screen. The multiple displays were beneficial for a seamless transition between class activities, such as transitioning from small group activity to whole-class discussion. That is, all six groups were able to simultaneously cast and show their own group's work to the rest of the class. By doing so, students could compare and contrast their group work to other groups' work. Content sharing capabilities allow for more seamless transition to new learning activities compared to a traditional classroom, whereby only one group is able to cast work on a big screen, or not at all. Indeed, Students L and M, who took a class in Space C, described how numerous digital displays with content sharing capabilities helped share small group work to the whole class, which allowed them to

readily get feedback about their work from all their classmates.

Student L: Sometimes we had group projects like three small groups in our thing. We would break up and we could take what was on our laptops and put it up when we were working on a document, so the person working on it we had their screen up, so we could all see it in our group and then we could also come back together as a whole group and show each other what we were doing using the screens from that time, so that helped a lot.

Student M: It is so much easier when we have different readings and things like that that we discuss in class or different assignments, so it is easier to break off into our little sections and then in each pod you can cast something different onto each screen and see different things, so we are able to have different sections with all the different readings or everybody is able to throw up the assignment that they have been working on and discuss how they can improve it and things like that. So, I think the projectors and each pod definitely makes it a lot easier to do things like that in this class.

Implications and scholarly significance

The ability to move and adjust quickly, deftly, seamlessly, gracefully – this is agility. Pedagogical agility, then, is the quality of being able to nimbly adjust the instructional approach depending on the needs of learners, the nature of the content, and other contextual variables. Importantly, these variables may change within a singular class session and may not be predictable. Pedagogical agility in physical learning spaces is an aspiration that requires furnishings and technology to support optimal student engagement. Indeed, consistent with prior work (Thomas et al., 2019), students in flexible learning spaces perceived their flexible learning spaces as a more engaging atmosphere, even when switching from one activity to another. One possible interpretation is that students are able to exhibit more steady and ongoing interactions and connectedness to others in an uninterrupted transition between class activities than in traditional lecture-style classrooms.

The research undertaken here forces us to confront two specific challenges. First, faculty in higher education are increasingly using a wide range of instructional modalities. They need to be agile as they move between and among different instructional approaches. Additionally, each new group of space occupants may have different needs. We must address the challenge of determining what is required of learning spaces to support pedagogical agility. Second, students come to learning environments with a diversity of physical, cognitive, and emotional predispositions. Yet at any time, they may be invited, in fact expected, to engage physically, cognitively, or emotionally in learning.

Leveraging and supporting student engagement in learning spaces is, therefore, complex. We must address the challenge of determining what is required of learning spaces to support such wide-ranging student engagement scenarios. The current research addresses both challenges and supports that furnishings and technology—flexible furniture configurations, writable surfaces, and digital displays with wireless content sharing capabilities—can support pedagogical agility and facilitate student engagement. From this work we offer recommendations for both learning space designs and faculty development.

Three recommendations for learning space design

Across the three spaces of focus in the current research, one similarity is the characterization of all three spaces as discipline-agnostic. Anyone from any discipline may teach in these spaces. What should general purpose spaces look like if supporting pedagogical agility is the goal? Our research suggests we do the following:

1. *Create flexible configurations.* People and furnishings need to be moveable, and they need room in the space to move. The combination supports both pedagogical agility and student engagement.
2. *Provide ample writable surfaces for faculty and students.* Writable surfaces allow thinking to be vertical, and thus, more visible to faculty and student peers. Such surfaces introduce countless instructional possibilities for encouraging student engagement.
3. *Furnish digital displays with wireless content sharing capabilities.* The ability for both faculty and students to create and share content creates instructional flexibility and promotes collaborative learning.

Three recommendations for faculty development

1. *Provide faculty multiple, ongoing, and diverse opportunities to think about and practice using the affordances above to support their instructional goals.* Being nimble and agile takes intentionality and practice.
2. *Consider the range of personnel who can support faculty in learning spaces: educational technologists, learning designers, and faculty peers.* As pedagogical agility is multifaceted, so must be support for it.
3. *Engage faculty and students in discussions of classroom design.* As we endeavor to align spaces with a wide range of teaching and learning needs, let's not forget that faculty and students are invaluable stakeholders. What do they need to be agile and engaged?
4. *Help faculty consider the importance of design principles for flexible spaces that support teaching and learning.*

With a recognition that design matters for teaching and learning, provide professional development for faculty to learn how to actively use design features in flexible spaces.

Limitations

Several limitations must be acknowledged. First, there may be limitations associated with the data sources we collected. While we have accumulated data from various sources with regard to students' perceptions of flexible furniture and technology and its effect on learning, it noted that the source of the instructor and student data from three flexible learning spaces were not consistent. One avenue for future work may be to collect consistent data sources across different learning spaces. Second, another limitation is associated with student engagement from the student perspective. Given students are likely to overestimate their learning (Panadero et al., 2016), promising future work is to explore student engagement from both faculty and student perspectives.

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