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Academic library spaces and student activities during the COVID-19 pandemic

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ABSTRACT

A library in higher education plays a primary role in students' learning on campus. In addition to individually-focused studying, students come to a library for various purposes, such as group learning, collaborating, and socializing. To support students' different types of learning, appropriate physical and functional environments of the spaces must be provided. However, the environmental effects of learning spaces have not been explored extensively. Additionally, the COVID-19 pandemic has forced students to remain and study at home for extended periods, and it is expected that the pandemic experience has affected students' space use patterns. This study aims to examine the effect of the pandemic on students' library usage and to investigate the necessary environments to effectively support students' learning activities. Data was collected via interviews with 12 students. One of the main findings is that, even though students used the library less during the pandemic, they expected to use it as much as pre-pandemic or even more after the pandemic. Furthermore, both physical and functional environments were associated with the study performance and wellbeing of the students. Therefore, understanding students' learning activities and preferred environments in a library is critical to providing appropriate spaces supporting students' learning performance and wellbeing.

Introduction

A library is one of a university's most important physical attributes (Mulrooney & Kelly, 2021). The concept of modern academic libraries is changing to informal learning spaces that encourage active interactions and collaboration among users. The main users of the academic library, students, perform various activities in a library, including individual focus work, group projects, social gatherings, and relaxation (Lee & Schottenfeld, 2014; Waxman et al., 2007). It is required to provide proper spaces and environments for each activity because appropriate environmental support can enhance the perceived performance of users (Y. Kim et al., 2021). However, little has been explored about what environmental factors can explain students' learning performance and wellbeing in library spaces.

The COVID-19 pandemic caused changes in human behaviors, especially indoors. Some rules were required indoors, such as social distancing and wearing face masks, and space usage was very limited in terms of operation hours and capacity. These restrictions were also observed with academic buildings. Due to COVID-19, physical gatherings were temporarily prohibited on campus; lectures were delivered

online, and buildings were closed or had limited use (Crawford et al., 2020). As a result, the form of collaboration among students changed from physical, in-person meetings to online meetings (Byrnes et al., 2021), and space settings and uses are expected to differ from those before the COVID-19 outbreak (Wexler & Oberlander, 2021). This study focuses on academic library settings in higher education and aims to 1) examine how the COVID-19 pandemic changed space use of the library spaces and users' experience and 2) investigate the needs and expectations of an academic library after the pandemic. With these research objectives, three research questions are developed:

RQ1. Do students choose the spaces according to their activities in the academic library during the pandemic?

RQ2. What indoor environmental features do students value in each space of the library?

RQ3. What environmental features explain students' perceived performance and wellbeing in library spaces?

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Theoretical backgrounds

Type of learning in a library

The emphasis on learning has shifted from traditional classroom-based lectures to team-based learning. While traditional learning focuses on the one-way delivery of knowledge from a teacher to students, team-based learning emphasizes knowledge acquisition through active communication between a teacher and students or among students (Beckers et al., 2015). This shift expanded the concept of learning space and changed students' activities associated with learning. This new learning paradigm requires collaboration and discussion outside the classroom (Beckers et al., 2016a). In order to support new learning, colleges and universities provide informal learning spaces for students. Informal learning spaces refer to "non-discipline specific spaces frequented by both staff and students for self-directed learning activities and can be within and outside library spaces" (Harrop & Turpin, 2013, p. 59). An academic library is one of the informal learning spaces on campus with attractive interior design and includes various functional spaces, such as cafés, lounge spaces, learning spaces, and meeting rooms. Libraries are evolving to reflect a new learning paradigm by providing various types of space.

To explain the knowledge creation process in knowledge work, Nonaka (1994) developed a theory using two dimensions of explicit and tacit knowledge. Explicit knowledge means the knowledge that we can explain in formal language. It is considered as a part of the entire knowledge someone has. On the other hand, tacit knowledge is hard to deliver or formalize and can be communicated through a specific context (Nonaka, 1994). Lee and Schottenfeld (2014) emphasized the similarity between the student learning process and the knowledge creation process in the workplace as higher education aims to enhance students' collaboration skills according to industrial needs. Based on Nonaka's knowledge creation model (Nonaka, 1994), Lee and Schottenfeld (2014) proposed students' collaborative work settings and defined related knowledge exchange/creation activities for each work setting: focusing (from explicit to tacit), group learning (from tacit to explicit), collaborating (from explicit to explicit), and socializing (from tacit to tacit). Each process of knowledge creation is achieved by different activities. First, focusing transfers explicit knowledge to tacit knowledge. Focusing includes individual studying, researching, or information processing. The next activity is group work, which changes from tacit knowledge to explicit knowledge, is performed by constructing knowledge through teaching and training. Next, collaboration creates new knowledge through individuals exchanging explicit knowledge. Examples are class assignments/projects or research completed in a group. The main difference between group work and collaboration is that students create content as a group when collaborating, while students study together when doing group learning. The last activity is socializing, which happens when people exchange tacit knowledge with one another. The activities of socializing focus on the casual exchange of ideas by chatting, discussing, and social networking.

Most studies tended to focus on learning spaces in a library, but students also utilize libraries to relax and socialize (Waxman et al., 2007; Xu & Yang, 2018). Socializing is an important part of learning, and students also need to take a break or hang out with their friends in a library. Therefore, it is important to provide relaxing and socializing spaces in addition to learning spaces for enhancing student wellbeing and academic performance.

Type of spaces in a library

Modern academic libraries provide various types of space in order to satisfy users' needs based on the new learning process, which emphasizes the importance of informal learning through collaboration and socialization with other students (Beckers et al., 2015). For this, library spaces have to play a role in connecting people (Simens, 2008) and

encouraging informal face-to-face meetings (Bryant et al., 2009).

Beckers et al. (2015) proposed a conceptual model to explain how learning spaces align with learning processes in higher education. Based on the levels of self-regulation and social interaction, four space concepts were suggested: 1) classroom settings (low self-regulation and low social interaction), 2) collaboration settings (low self-regulation and high social interaction), 3) individual study settings (high self-regulation and low social interaction), and 4) informal learning settings (high self-regulation and high social interaction). Beckers et al. (2016a) suggested that libraries need to provide at least two types of space to support individual study: busy, open space and quiet, closed space. Students use spaces that can better support their learning activities between the spaces for individual study and collaboration (Hong et al., 2021; Lundström et al., 2016). Furthermore, providing appropriate space for different activities increases satisfaction with the spaces in an academic setting (Hong et al., 2021). However, it is still unknown students' space usage depending on their learning activities. Based on Beckers' theory, understanding which space is appropriate for various activities is important to effectively support students' learning in a library.

Physical and functional environments

The learning space can be characterized by its physical features and the perceived quality of social and functional features of the environment (Beckers et al., 2016a). The alignment of physical and functional environments with students' activities consequently supports students' performance and wellbeing (Kim et al., 2021).

Research has shown that learning can be influenced by the physical environment where students perform their tasks (Tanner, 2000), and students prefer spaces that can support their learning activities (Beckers et al., 2016a). Studies have defined the attributes of physical environments as including satisfaction with indoor environmental quality (IEQ), window views, and spatial arrangements [Table 1]. IEQ has been explored in terms of temperature, noise, lighting, and air quality. A study by Lee (2014) found that students were satisfied with the IEQ differently depending on their collaboration activities. However, Lee's study (Lee, 2014) focused on collaborative activities only and did not consider functional environments in a library.

Functional environments refer to the suitability of environments to occupants' purposes (Kwon et al., 2019). Academic libraries must provide appropriate spaces for learning, socializing, and relaxing activities. An open-plan space setting, which is actively applied to academic libraries to support collaboration among users, raises several issues in functional environments. In addition to spaces that encourage collaboration, students need quiet, individual study areas offering privacy in libraries (Beckers et al., 2016b; Ellison, 2016). Both undergraduate- and graduate-level students reported that space for allowing quiet study is more important than group study and work (Association of Research Libraries, 2019; Ramsden, 2011). Open-plan spaces have been considered inappropriate for work requiring concentration because of distractions and noises (Haapakangas et al., 2018; Yoo-Lee et al., 2013). Crowding is also frequently regarded as a problem in academic libraries that creates noise and distractions (Cha & Kim, 2020; DeClercq & Cranz, 2014). Some studies have argued that an open-plan office could be utilized for individual focus work if enough spaces are provided and managed by controlling distraction (Block et al., 2009), but it is still debatable. Socializing refers to any social situation, including communicating with others and being with others in the same place, and it is regarded as a part of learning. Therefore, the role of a library is emphasized as both a learning and social space (Bryant et al., 2009). In order to satisfy various needs, libraries should be able to provide physical and functional environments that connect people with study sources (Simens, 2008) and encourage informal face-to-face meetings/encounters (Bryant et al., 2009). These functional environments are affected by physical environments and vice versa; students can perceive different types and levels of functional environments in different spaces.

Table 1
Physical and functional environments of a library in literature

Environmental type	Features	Beckers et al., 2016a	Cha & Kim, 2015	Hassanain & Mudhei, 2006	Choy & Goh, 2016	Lee, 2014	Mahyuddin & Law, 2019
Physical environment	Window view	✓	✓				
	Background noise	✓		✓			
	Quietness	✓	✓	✓	✓	✓	✓
	Lighting	✓	✓	✓	✓	✓	✓
	Furniture	✓	✓		✓	✓	✓
	Resources	✓	✓		✓		
	Temperature	✓	✓	✓		✓	
	Air quality	✓	✓		✓	✓	✓
	Concentration	✓			✓		
	Privacy	✓	✓	✓		✓	
Functional environment	Collaboration	✓	✓		✓		
	Crowdedness	✓	✓				
	Socialization	✓	✓		✓	✓	

In order to support students’ learning in a library, it is important to understand how physical and functional environments are related to perceived learning performance and wellbeing in various spaces in a library.

Effects of the COVID-19 pandemic on places

Devine-Wright et al. (2020) argued that the power of the pandemic changes the perception of places. The pandemic has unexpectedly restricted people to their homes while it has displaced people from everyday places (Devine-Wright et al., 2020). One of the notable changes was how people use physical spaces (Jens & Gregg, 2021b). After the lockdown, universities mandated lectures to be provided entirely or partially online (Crawford et al., 2020). As a result, students were isolated from their schools and needed to remain at their homes and experience a wholly virtual learning environment in terms of lectures, in-class activities, group projects, and social interaction. In addition, they needed to be mindful of the physical distance between people regardless of the type of activities (Wexler & Oberlander, 2021). These changes in space use possibly affect students’ learning process and performance because they need to adapt their learning strategy to physical spaces. They also might experience social isolation because of the loss of social interaction opportunities with other students in both direct and indirect ways in physical spaces, negatively influencing their wellbeing. However, there is a lack of studies exploring students’ activities in academic libraries during the pandemic. Some studies have suggested the possibility that their experiences during the pandemic would affect modification to the meaning of places for the post-pandemic (Low & Smart, 2020; Wexler & Oberlander, 2021). Therefore, understanding students’ activities and outcomes in the library is important to support students’ learning performance and wellbeing through built environments.

Methodology

This study uses a mixed-method approach as a follow-up study to Y. Kim et al.’s study (Kim et al., 2021). The previous study collected 66 responses through a survey in October 2019 and aimed to understand students’ space use and environmental effects on their learning performance. The results showed the students’ library space use pattern (i.e., space choice depending on their activity) before the pandemic. The respondents reported the type of their space usage, including 1) solitary work, 2) working as a group, and 3) working alone but staying together. Additionally, they were asked to choose where they stayed between 1) open-plan space for individual study and 2) open-plan space for group work. This follow-up study interviewed 12 students to examine their perceptions of library environments depending on their activities and experiences in the library during the pandemic and what they expected

after the pandemic. A qualitative approach can be helpful to gather rich data on user experience (Navarro-Bringas et al., 2020; Sankari et al., 2018). Fig. 1 shows the data collection process and library operations in a timeline.

Data collection

Semi-structured interviews were conducted between July 2021 and September 2021, and 12 students participated in the interview (Table 2). For recruitment, the researchers invited students at Georgia Institute of Technology in Atlanta, GA to participate in the interview via email and recruited other participants using a snowball sampling method. Interviews were performed either online or in-person in one of the meeting rooms in the library, according to the interviewees’ preference. In order to clarify the spaces that the interviewer and interviewees mentioned, photos of the library spaces were provided as supplementary materials during the interview. Before starting each interview, the interviewer informed the objectives of the study, consent, and anticipated benefits from the interview. Each interview was between 30 and 60 mins and was recorded. A \$10 gift card was given as compensation.

The interviews aimed to understand students’ library space use during the pandemic and their intentions to use the space after the pandemic. The questions focused on students’ learning activities, library space types, physical and functional features of the library, and desired outcomes of the students in the library (Table 3). Interviews are an effective method to know space usage because they enable the researchers to know students’ learning activities beyond the type of space usage (i.e., solitary and group use). The example list of activities included the four different types of collaborative knowledge creation activities of college students suggested by Lee and Schottenfeld (2014): focusing, group learning, collaborating, and socializing. Library spaces were categorized into five types: 1) open-plan spaces for individual study, 2) open-plan spaces for group work, 3) individual study spaces with carrels, 4) meeting rooms, and 5) lounge spaces. Students were asked to identify and describe the spaces they had used previously.

Context

Two targeted buildings of the library are Price Gilbert Library and Crosland Tower Library at Georgia Tech. They were fully renovated in 2019 and 2021, respectively, and the two buildings are connected. The library sought to create spaces for active collaboration, providing open-planned spaces without partitions for most of the spaces. The spaces were categorized into five different types based on the physical learning environment taxonomy suggested by Beckers et al. (2015) [Table 4]. As classrooms in the library can be used for reserved events only, they are excluded from the scope of this study. Photographs of the library spaces are provided in the Appendix.

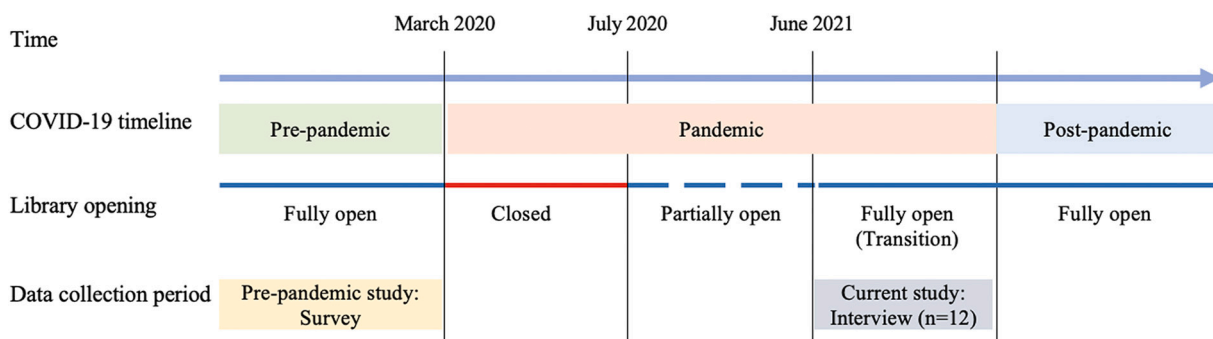


Fig. 1. Data collection process.

Table 2 Interviewee information

Interviewee	Position	College	Year	Gender	Interview location
1	Graduate student	Liberal Arts	6	Female	Online
2	Undergraduate student	Engineering	3	Female	Online
3	Undergraduate student	Engineering	4	Female	Online
4	Undergraduate student	Engineering	4	Male	In-person
5	Graduate student	Engineering	4	Male	In-person
6	Undergraduate student	Engineering	4	Male	In-person
7	Undergraduate student	Engineering	4	Female	In-person
8	Undergraduate student	Engineering	4	Female	Online
9	Undergraduate student	Design	2	Male	Online
10	Undergraduate student	Engineering	4	Female	Online
11	Undergraduate student	Engineering	4	Female	Online
12	Undergraduate student	Science	4	Male	Online

Table 3 Interview questions

Category	Interview questions
Activity-space	For each activity in the list, can you choose where you would like to do each work in the library?
Physical and functional environments	I will give you several keywords related to your experience at the library. Please describe each space using the keywords that are associated. - Physical environments: Furniture, window view, temperature, quiet/noisy, background noise, lighting, resources - Functional environments: Collaboration, crowdedness, concentration, visual privacy, acoustic privacy
Desired outcomes	Is there anything you want to change to better support your performance in the library? How? Why? What makes you feel good in the library? Is there something that you want to change to enhance and better support your well-being? How? Why?
Overall experience	What do you like about the environment of the library? What do you dislike about the environment of the library?
COVID-19-related	During the pandemic, have you ever used the spaces in the library? What spaces did you use in the library? How was it? Do you have any reason that you chose those spaces? Are you going to use the library differently compared to pre-pandemic?

Table 4 Features of library spaces

Type	Description	Learning features	
		Self-regulation	Interaction
Open-plan spaces for individual study	Multiple students share a big table in an open-plan space. Chairs have back support. It is easy to observe each other and to hear others' conversations, but the active conversation is not encouraged in the space.	High	Low
Open-plan spaces for group work	The space provides a big table with various types of chairs such as stools and benches. The size of the tables is conducive to group discussions. The space also offers whiteboards and screens to facilitate discussions, and students can freely talk to each other.	Low	High
Individual study areas with carrels	The space is designed as a quiet space. The finishes use noise-absorbing materials, and group meetings are not allowed. The chairs are ergonomically designed for prolonged periods of use.	High	Low
Meeting rooms	Separate rooms intended for group meetings include a whiteboard and a screen that facilitate discussion.	Low	High
Lounge spaces	The space encourages socializing and relaxing. This type of space is easily accessible and open.	High	High

The library was closed between March 2020 and July 2020 because of the pandemic and has been open since August 2020 with some restrictions regarding social distancing, a requirement for wearing face masks, card-only access, limited space availability, reduced occupant capacity, and contactless services. Since June 2021, the library has been fully open without any restrictions.

Analysis

Interview data were transcribed using Microsoft Word and analyzed using NVivo 12. The transcribed data were analyzed in the first and second cycles, as suggested by Saldaña (2016). In the first cycle, descriptive coding was conducted to label data with summarized words. In this process, a deductive approach was carried out to find space uses depending on their activities as well as physical and functional environmental features. The label was based on a literature review, including the type of spaces, possible activities, and keywords of indoor environmental features. In the second cycle, pattern codes were

generated to identify any positive, negative, or neutral arguments about the environment. For inductive coding, only topics mentioned at least two times were used for analysis and provided in this paper. The interviewees only talked about spaces they had used before. The number of responses for each space was reported in parentheses in Fig. 2.

Results

Academic library uses during and post-pandemic

Even though there were some restrictions to use resources, such as computer stations, whiteboards, and screens, most students (10 out of 12) reported that they used the spaces in the library during the pandemic. However, they commonly stated that they came to the library less frequently than before the pandemic and mostly used the spaces individually. The students also mentioned that it was convenient to find spaces they liked because of fewer users in the library than in the pre-pandemic period. The reasons that students used the library less were because they were not on campus, and there was a fear of COVID-19 infection. On the other hand, the reasons they came to the library during the pandemic were to change scenery, get out of their rooms, or go to a café in the library. For the post-pandemic use, all students except one graduating student responded that they would use the library similar to the pre-pandemic, coming back to the library to use physical spaces with other people like pre-pandemic times or even more often.

For the post-pandemic period, they reported specific spatial preferences for each activity [Fig. 2]. They chose library spaces depending on their intention/activities, and those who identified themselves as active users tended to use multiple spaces in the building. Students mostly preferred the open-plan space for individual study but would use any space for individual study. For group learning and collaboration, students preferred either meeting rooms or open-plan spaces for group learning. They also preferred major-specific academic buildings outside the library. The interviews found that meeting rooms were used for various purposes, such as meetings, group study, individual study, presentation rehearsals, podcast recording, and instrument lessons. On

the other hand, two students stated they would choose online meetings as an alternative to in-person meetings.

It is multi-functional use, so whenever I need a place, the library is always the best place for me to be looking for because they have got everything I need and every functional space that I need. [Interviewee 1]

For socializing, students would go to lounges. However, some students did not consider a library as a space for socializing even though they came and used the library with their friends. They would go somewhere else to hang out with their friends but also needed a space to go when they unexpectedly met someone in the library. Similarly, relaxing was not why students found the library, but space and furniture for relaxing seemed helpful for students to spend a long time studying. In addition, views to the outside provided students time to relax. Some students mentioned that having coffee and food from the café helped them stay in the library longer.

Physical environments of the library

Students described each space using six physical environmental features based on the list provided by the researchers. Physical environments were identified differently depending on the type of spaces [Table 5]. In addition to the features provided, students also mentioned outdoor seating in general for both studying and relaxing.

Window view

The interviewees positively mentioned window views. For open-plan spaces for individual study, the students described that window views helped them feel “productive,” “happy,” “relaxed.” Even though there were big windows in the open-plan space for group work, no one mentioned window views in that space. For individual study spaces with carrels and meeting rooms, the window view was very limited, but the students emphasized that having a view was important because they could feel relaxed. Similarly, one student mentioned that placing natural plants indoors would be helpful for their mental health in the library.

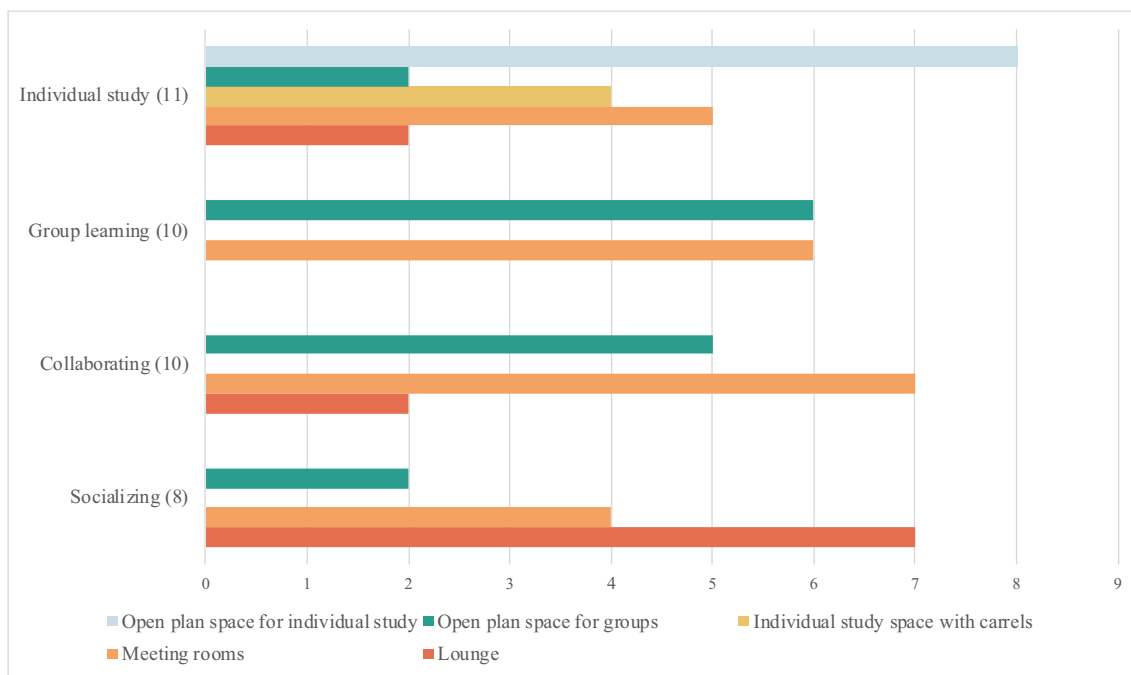


Fig. 2. Preferred spaces in the library depending on activities (n = 12)

* Numbers in each parenthesis mean the number of interviewees who performed a certain activity in the library during the pandemic. Some interviewees reported multiple spaces for each activity.

Table 5
Physical environment features in each space type

Physical environments	Space type	Opinion	Interview example	Related outcomes
Window view	Open-plan space (individual)	▲▲▲	When I was sitting there (individual study space with carrels), I really liked to sit towards the window, just because looking in one small box for a long time is like at night. It is hard for me. [Interviewee 10]	P, W
	Open-plan space (group)	NA		
	Carrel space	▲▲▼		
	Meeting room	▲▲		
Background noise	Lounge	▲▲▲		
	Open-plan space (individual)	▲▲▼	You have to be quiet. I tend to avoid quiet spaces even if I want to work quiet and do hard work. Because, what if I accidentally drop a pencil or something? I don't want to be that guy. [Interviewee 6]	P
	Open-plan space (group)	▲▲		
	Carrel space	NA		
Quietness	Meeting room	▼▼		
	Lounge	▲		
	Open-plan space (individual)	▲▲▲	If I was working in a group where we had to interact a lot, constantly talking out loud and sharing our ideas, I would probably choose a space that's a little bit louder, so we're not distracting to other people. [Interviewee 10]	P
	Open-plan space (group)	▼▼▼▼		
Lighting	Carrel space	▲▲		
	Meeting room	NA		
	Lounge	▲		
	Open-plan space (individual)	▲▲	I just like the bright lights and stuff with lots of big windows and outdoor lighting. It naturally makes you feel more ready to do work and be productive. [Interviewee 2]	P, W
Furniture	Open-plan space (group)	NA		
	Lounge	▲		
	Open-plan space (individual)	▲▼	In terms of furniture, it is great because of all kinds of variety. You have the movable furniture, the fixed furniture, the tall and the short ones. So, there is something for everyone, which I think is a plus for the library. [Interviewee 4]	P, W
	Carrel space	▲▲		
Resources	Meeting room	▲▲▲		
	Lounge	▲▲▼▼		
	Open-plan space (individual)	▲▼▼	I have used these spaces (meeting rooms) quite a bit to work on homework with other people where you can collaborate on the homework or group projects. The whiteboards were super helpful for that, having a large whiteboard space. [Interviewee 10]	P, W
	Open-plan space (group)	▲▲▲		

Note: ▲ Positive; ▼ Negative; ► Neutral; Performance (P); Wellbeing (W).

Background noise

The students reported an appropriate level of background noise in the open-plan spaces for individual study and group work as well as lounge spaces. However, they also mentioned that there was no background noise in the quiet zone for individual study, and sometimes small sounds distracted them.

Quietness

Opinions about quietness differed depending on the type of space. Students were satisfied with the noise level for the individual study space, while they mentioned that the space for group work and lounge was sometimes noisy. Some students said that the space for group work was not quiet but not distracting either. Otherwise, people who did not prefer the library wanted to have a quiet space. Traditional libraries were likely to be quiet, encouraging focus and individual study and providing physical resources such as books, while the concept of the modern academic library encourages active communication in the building.

Lighting

Lighting was mentioned in two aspects: 1) amount of lighting and 2) natural lighting. Students emphasized the importance of proper lighting for their study, while natural lighting is important for both their positive mood and performance.

Furniture

Even though the preferred furniture type was different for each student, they liked the variety of furniture provided in the library. The students mentioned furniture in two different ways: 1) a variety of types and 2) comfort. For open-plan space for group work, students specifically mentioned various furniture types and availability to move them. However, one of the main complaints that students reported was the unavailability of seats they wanted and that sometimes it was hard to know where they could be found. The comfort of the furniture was important for long-term use. On the other hand, for individual study spaces with carrels and meeting rooms, the students highlighted ergonomic chairs in the spaces that were appropriate for prolonged use.

The chairs are very comfortable with that cushioning. So, these are definitely for longer hours of the intense study compared to the high-top stools that do not have backs or are not cushioning. I like these chairs a lot; they are very ergonomic. [Interviewee 2]

Resources

Students pointed out the limited resources in the open-plan space for individual use as the only resource the space provided was electrical outlets. However, they were satisfied with the availability of outlets in every space in the library. They mentioned that whiteboards in the open-plan space for group work and meeting rooms were useful when studying with friends or working on group projects. Some students noted that there were no books in the library. They wanted the books back as they made them feel relaxed. It was also that books were an important signifier for a library.

I do think it is odd that there are so few books. I do not really think of it as a library. It is just weird that it is still called a library. [Interviewee 12]

Functional environments of the library

Students explained the functional features of each space [Table 6]. Like physical environments, functional environments were also differently reported depending on the spaces in the library.

Table 6
Functional environment features in each space

Functional environments	Space type	Opinion	Interview example	Related outcomes
Concentration	Open-plan space (individual)	▲▲	Sometimes I like this when there's a lot going in my head, and I want to be cut off for a while. It's like the environment (Carrel space) is telling me, streamlining our focus as well to concentrate on one thing you come in here for. [Interviewee 4]	P
	Open-plan space (group)	▲▼		
	Carrel space	▲▲▲▲		
	Meeting room	▲▲		
	Lounge	▼▼▼		
Privacy	Open-plan space (individual)	▲▼	Part of the reason that goes into public spaces to study is that there is no visual privacy. Too much visual privacy, then I cannot stay on task. [Interviewee 7]	P
	Open-plan space (group)	▲▼▼		
	Carrel space	▲▲▲		
	Meeting room	▲▲▲▲		
	Lounge	▼▼		
Collaboration	Open-plan space (individual)	▲▼	I would say there is a lot of collaboration because it (open-plan space for group work) is very friendly setting to use a big table and use all those stools to move around. [Interviewee 9]	P
	Open-plan space (group)	▲▲▲▲▲		
	Carrel space	▼▼		
	Meeting room	▲▲▲▲▲		
	Lounge	▲▼		
Crowdedness	Open-plan space (individual)	▲▲▼	Honestly, I felt less crowding just because of how spread out the tables are (open-plan space for individual study). [interviewee 8]	P, W
	Open-plan space (group)	▼▼		
	Carrel space	▼		
	Meeting room	▼		
	Lounge	▲▼▼		
Socialization	Open-plan space (individual)	▲▼	I would come here and meet up with friends. We wouldn't be studying together on the same subject, but we would be together. [Interviewee 8]	P, W
	Open-plan space (group)	▲▲▲		
	Carrel space	▼▼		
	Meeting room	▲▲▲		
	Lounge	▲▲▲▼		

Note: ▲ Positive; ▼ Negative; Performance (P); Wellbeing (W).

Concentration

The ability to concentrate was mostly positive in all spaces except the lounge. There were too many people walking and passing by in the lounge space, which easily distracted students. For individual study spaces with carrels especially, students commonly mentioned that the space was appropriate for long-term, intense study as the space provides a formal setting. Students also mentioned ‘quiet,’ ‘privacy,’ and ‘study-friendly atmosphere’ when talking about concentration.

Privacy

Privacy was discussed from two different perspectives: acoustic and visual privacy. For acoustic privacy, meeting rooms provided enough acoustic privacy as they were separate, enclosed rooms, preventing any conversation from traveling outside the rooms. There was no acoustic privacy in the other spaces, but the students reported that they were not concerned with that when studying. Individual study spaces with carrels and meeting rooms provided enough visual privacy. Interestingly, some

students were concerned that having a high level of visual privacy could make them too comfortable and spend time browsing the internet and social media.

Collaboration

Collaboration was required for group learning. Students found the ease of collaboration in the open-plan space for group work and meeting rooms. However, they said having an academic conversation in the lounge was difficult as it was too noisy with high traffic. Students also hesitated to collaborate in the open-plan space for individual study and individual study space with carrels because those spaces were intended to be quiet.

Crowdedness

Students reported crowdedness when many different activities were happening, especially in the open-plan space for group work and lounge spaces. Some students also mentioned crowdedness in meeting rooms when the room was full. As a result, they preferred larger rooms even though the expected number of people in the room was one or two. This consequently led to difficulty in reserving a meeting room, causing another reason for crowdedness.

Socialization

Socialization was mentioned mostly regarding the lounge space, but students added that they could not concentrate or study in that space. Some students thought that individual study spaces with carrels was not for socialization because of the partitions and quiet atmosphere. For the other spaces, they often use those spaces to study alone but be together and be able to interact with others.

Facilities

In addition to the physical and functional environmental features discussed in the previous sections, the students also mentioned some facility-level factors associated with their performance or wellbeing in the library [Table 7].

Available seats

Providing enough seats was related to increased convenience of use. Some students commonly required more seats in quiet spaces and more meeting rooms with seating.

Rules

Students commonly expected some spaces specifically aimed for certain activities to work as intended, and they complained when the spaces did not. For example, they expected quiet in the quiet zones (some open-plan spaces for individual study) and individual study spaces with carrels. As another example, the meeting rooms were supposed to be used according to the number of users, but small groups sometimes reserved big rooms. It consequently led to two problems; 1) small rooms are left unused and 2) big groups could not use any rooms.

A variety of space types supporting different activities

As the library served various functions, students were able to choose where they stayed and studied. They knew what environment they needed, and each environment could support students' expectations.

Purpose of library

The purpose of the library itself affected students' study performance in the building. For example, they said they liked people in the space to study or work concentrating on their own tasks, which they found motivating.

Sense of belonging

Most of the students felt a sense of belonging through a study-friendly atmosphere and rarely mentioned space specifically. The

Table 7
Facility-level features of the library

Factors	Examples	Outcomes
Available seats	One issue that I faced was the availability of rooms here. I like to work in a quiet space, and I had issues with booking (meeting) rooms. [Interviewee 5]	P
Rules	It is supposed to be a quiet floor, but sometimes there could be better enforcement of that. It is not as quiet there as on the 7th floor. [Interviewee 10]	P
A variety of space types supporting different activities	Most of the spaces definitely are very supportive of the vibe that I get from them. So there are places where I know I can focus really well, and it is quiet, and then places where I can collaborate really well. [Interviewee 10]	P
Purpose of library	I like how mostly everyone there is there to study or do work, at least in the spaces that I go to. It seems like everyone is pretty focused. It is not very loud or noisy, though. I think it is a good place to go if you really need somewhere to go outside of your room to do work. [Interviewee 11]	P
Sense of belonging	When I am online, I am usually just sitting in my room; I feel like that is just not great for mental health and stuff. I think that is the only reason I start going back in person and just because I am missing people [Interviewee 3].	W
Outdoor seating	It is really a good place for us to relax a little bit, enjoy drinks, and enjoy the scenery. The seeing there is really relaxing. I guess this is one of the important features for us to enhance well-being and make it more enjoyable to study within the library. [Interviewee 1]	W

students felt a sense of belonging by being around other students in the same space as they were. It was one of the important factors that made students physically come to the library.

Outdoor seating

The outdoor seating was not mentioned on the list given to the students, but five out of twelve students independently mentioned the benefits of using outdoor seating during the interviews. They said they would study, relax, and enjoy views and natural light outside.

Discussion

This study explored the physical and functional environments of the academic library and investigated the effect of the COVID-19 pandemic on students' activities in the library. The finding showed the change in activities during the pandemic, including the reduced frequency and type of usage. The students used the physical spaces in the library fewer times during the pandemic. As they had experienced virtual settings for attending classes, meetings, collaborating with other students, and socializing, a decrease in the use of the physical spaces was expected (Low & Smart, 2020; Wexler & Oberlander, 2021). Interestingly, however, the interviews in this study revealed that the students would use the library spaces after the pandemic as much as in the pre-pandemic period or more often; the most frequently mentioned reason for library use was to defeat social isolation. Even before the COVID-19 pandemic, it was reported that between 20 and 71% of late adolescents and young adults aged 15 to 21 years experienced feeling lonely sometimes or often and overcame the loneliness by reconnecting and socializing with their friends (Qualter et al., 2015). The pandemic disturbed in-person

socialization among students on campus, made them feel isolated and anxious, and accelerated their mental problems in terms of depression (Fruehwirth et al., 2021). A community can be built when people with different interests come to use and share the same space and tools (Schopf et al., 2015), so library spaces on campus can significantly contribute to building a sense of community among students. Engaging with friends and spending time together can increase the perception of enhanced social support and consequently strengthen their mental health (Hefner & Eisenberg, 2009). This study supports that physical spaces on campus play an important role in increasing social support. Therefore, students preferred to come to the library to use the space physically and be around other people. Even though they used the library during the pandemic, this study observed different space use patterns. The students tended to use the space individually, consistent with the observation study by Jens and Gregg (2021a, 2021b). In addition, the students reported that they could easily find the seats they preferred during the pandemic because there were fewer people in the building. The low number of people in the space possibly enabled them to have enough distance from other people, keeping themselves safer with social distancing.

Depending on their needs, students' space usage can be explained by the learning space model (Beckers et al., 2015) and the student learning process (Lee & Schottenfeld, 2014). First, students preferred the open-plan space for individual study mostly for focusing, which requires high self-regulation and low social interaction. This preference was observed pre-pandemic as well (Y. Kim et al., 2021). Similarly, the individual study spaces with carrels were also used for focusing. Both types of spaces (i.e., carrel spaces and open-plan spaces for individual study) were appropriate for the same learning activities in terms of self-regulation and interaction so that students might choose spaces based on their preference for the partition, furniture, or view to the outside. Second, group learning requires high social interaction, so the students used the open-plan space for groups or meeting rooms, depending on the needs of resources and privacy. Third, collaborating requires a high level of social interaction. Similar to group learning, most students preferred the open-plan space for groups and meeting rooms. Lastly, the students used lounge spaces, meeting rooms, and open-plan spaces for groups for socializing. Notably, students did not like to use the library primarily as a space to socialize, but they felt a sense of belonging when they were around other people or came to the library with their friends even though they studied alone but together. Similarly, relaxing is also not the main purpose of the library. Lounge spaces were not preferred for study, but those spaces could provide an opportunity to relax and socialize while taking regular and purposeful study breaks, which help maintain energy and the ability to focus (Waxman et al., 2007).

Notably, some students reported interesting opinions on privacy and quietness. Previous studies have found and argued that having privacy and a quiet environment is critical for focus work and study (Beckers et al., 2016b; Ellison, 2016), but, from the interview in this study, too much privacy sometimes distracts students from studying. Students who had a low ability for self-regulated learning tended to avoid the space with carrel and to study in an open-plan space. The reason to use open-plan spaces for individual studying is that there is a little interruption of visual privacy that helps them to keep focusing on studying. Self-regulated learning requires students' active involvement in learning and the ability to control their cognition and surrounding environment (Pintrich, 2004). For monitoring and controlling themselves, students can get a certain level of benefit from open-plan space. Further examination of students' self-regulation ability and academic performance in open-plan space should be required.

In an open-plan study environment, controlling noise is important for students to provide an appropriate environment as it influences cognitive ability and collaboration. In Braat-Eggen et al.'s study (Braat-Eggen et al., 2017), students are also disturbed by background noise frequently when studying for an exam, reading, and writing, while the noise had an insignificant effect on brainstorming, consulting, and

searching. Furthermore, there was little difference in collaboration performance between quiet conditions and background noise scenarios (Braat-Eggen et al., 2019). In this study, the students were satisfied with background noises in all open-plan study spaces regardless of the target activities of the spaces. For example, in the spaces for group work, students expected noise from others' conversations and could make noise themselves without concern about disturbing other people. On the other hand, students did not expect any loud noise in the quiet zone. They sometimes avoided a space that was too quiet because they were worried about making any unexpected noise that might capture others' attention. In other words, based on their expectations, students can perceive the background noise differently. Having explicit rules about space uses (e.g., collaboration space, quiet zone) may support study performance by helping them have appropriate expectations and behave accordingly.

Seats by the window are preferred areas in a library (DeClercq & Crazz, 2014). Most of the students in this study also positively mentioned the presence of windows. Interestingly, their need for windows manifested differently according to the types of spaces. Even though both spaces for individual study and group work had a window wall, the students rarely mentioned the window in the space for group work, whereas students using the space with carrels or meeting rooms tended to appreciate window views much more. One of the possible reasons is that both types of spaces had a relatively small workstation size with closed partitions or walls providing higher privacy. Having windows in an enclosed and small space possibly made the students feel that the rooms were more spacious. In addition, natural light is an important source to maintain circadian rhythms (Aguilar-Carrasco et al., 2021), but it is hard to get exposure to natural light in spaces with carrels and meeting rooms. It may consequently lead people to desire more windows. The effect of window presence should be further explored, considering occupant activities and space arrangements. Windows are also an important source of allowing natural lights indoors. An appropriate amount of lighting enhances performance in the workplace (Brunia et al., 2016), but the effect of natural lighting and window views in academic settings is little known. In this study, the students mentioned that natural lighting with window views helped enhance students' wellbeing and performance. This result also provides possible evidence of restoration effects, which benefit cognitive ability and stress relief from exposure to nature through windows (Hipp et al., 2016; Li & Sullivan, 2016; van Esch et al., 2019). Therefore, providing natural lighting through windows in study spaces can provide a restoration effect and enhance student performance and well-being in a library.

Notably, crowdedness was negatively mentioned in most types of spaces. In open-plan spaces, the students easily noticed people walking around and chatting and reported crowdedness. They reported that too many things were happening around them, and they felt too crowded to collaborate on a group work/project in the open-plan spaces and lounge spaces. Crowdedness is related to privacy and disruption by noise (Kaya & Weber, 2003; D. Kim et al., 2020); so, even for the open-plan space, design strategies such as appropriate furniture arrangement and dividing spaces by partitions would be helpful to give them a supportive environment for learning by decreasing the frequency of social encounters. Some students also mentioned the availability of seats in relation to crowdedness. If they could not find preferred or appropriate seats for their activities, the students felt the space was crowded.

This qualitative approach provides a deeper understanding of the subject library, following the previous study (Kim et al., 2021), which utilized a survey method. The findings of this study also corroborate that open-plan spaces can support various learning activities of students by

adopting different space arrangement strategies in academic libraries. Open-plan spaces are flexible in space arrangement, so they benefit under abnormal situations such as the COVID-19 pandemic (Jens & Gregg, 2021b). It was observed that the space utilization of open-plan spaces is much higher than in enclosed spaces in an academic building, while suitability, spatial integration, user satisfaction were similar to each other (Jens & Gregg, 2021a).

The main limitations to this study are the small sample size and generalizability due to its qualitative, case study approach. Even though the interview method enabled this study to explore diverse opinions about their library use from the students, the nature of the method inherently has limited ability to test statistical significance. Additionally, this study should be repeatedly performed in similar settings to find the generalizability.

Conclusion

As a follow-up study, this study explored student perception of academic libraries during and after the COVID-19 pandemic. This study showed that students would be willing to come to academic libraries to use the physical spaces and to meet other people after the pandemic. Traditionally, academic libraries provide a learning opportunity through physical resources, such as books, journal articles, and other materials, for their users. However, libraries, especially academic libraries, are recently evolving by removing physical books and focusing on providing commons spaces. Even though some people still find the value of the library in physical materials, it is time to realize the meaning and purpose of libraries in their communities, as discussed in this study. Modern library spaces on campus, which often afford various activities, such as focused work, group learning, collaborating on class projects, socializing, and relaxing, can significantly contribute to building a sense of community among college students and help them reconnect with their peers. These modern academic libraries are likely to play a major role in providing a comfortable venue to study, collaborate, and interact with each other throughout their college lives. Future studies should examine the link between physical and functional environments in different spaces and find the appropriate environment for each activity in academic libraries.

Furthermore, students would use the library spaces for their different learning activities. The results of this study support the great possibility of enhancing the perceived study performance and wellbeing of students through the environments in the library. For this, understanding students' activities and preferred spaces is critical for new construction and major renovation of libraries and continuous improvement with smaller changes, such as furniture reconfiguration, space assignment and planning, and user policy (i.e., collaboration vs. quiet zones). As the size of the building is limited, investigating the needs of space types is required to strategically provide spaces in various sizes and types based on appropriate space programming.

CRedit authorship contribution statement





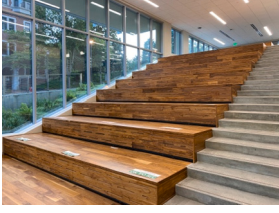
Yujin Kim: Conceptualization; Data curation; Formal analysis; Investigation; Writing - original draft; Methodology.

Eunhwa Yang: Supervision, Validation, Writing - review & editing.

Declaration of competing interest

None.

Appendix A. Example photographs of each space type

Space	Example
Open-plan space for individual study	
Open-plan space for group work	
Individual study space with carrels	
Meeting room	
Lounge	

References

- Aguilar-Carrasco, M. T., Domínguez-Amarillo, S., Acosta, I., & Sendra, J. J. (2021). Indoor lighting design for healthier workplaces: Natural and electric light assessment for suitable circadian stimulus. *Optics Express*, 29(19), 29899–29917. <https://doi.org/10.1364/oe.430747>
- Association of Research Libraries. (2019). LibQUAL2019 survey. https://www.libqual.org/documents/LibQual/notebooks/272_6.pdf
- Beckers, R., van der Voordt, T., & Dewulf, G. (2015). A conceptual framework to identify spatial implications of new ways of learning in higher education. *Facilities*, 33(1/2), 2–19. <https://doi.org/10.1108/F-02-2013-0013>
- Beckers, R., van der Voordt, T., & Dewulf, G. (2016a). Learning space preferences of higher education students. *Building and Environment*, 104, 243–252. <https://doi.org/10.1016/j.buildenv.2016.05.013>
- Beckers, R., van der Voordt, T., & Dewulf, G. (2016b). Why do they study there? Diary research into students' learning space choices in higher education. *Higher Education Research and Development*, 35(1), 142–157. <https://doi.org/10.1080/07294360.2015.1123230>
- Block, M., de Korte, E., Groenesteijn, L., Formanoy, M., & Vink, P. (2009). The effects of a task facilitating working environment on office space use, communication, collaboration, privacy and distraction. In *The 17th World Congress on Ergonomics (IEA 2009)* (pp. 9–14).
- Braat-Eggen, P. E., Poll, M. K.v.d., Hornikx, M., & Kohlrausch, A. (2019). Auditory distraction in open-plan study environments: Effects of background speech and reverberation time on a collaboration task. *Applied Acoustics*, 154, 148–160. <https://doi.org/10.1016/j.apacoust.2019.04.038>
- Braat-Eggen, P. E., van Heijst, A., Hornikx, M., & Kohlrausch, A. (2017). Noise disturbance in open-plan study environments: A field study on noise sources, student tasks and room acoustic parameters. *Ergonomics*, 60(9), 1297–1314. <https://doi.org/10.1080/00140139.2017.1306631>
- Brunia, S., De Been, I., & van der Voordt, T. J. M. (2016). Accommodating new ways of working: Lessons from best practices and worst cases. *Journal of Corporate Real Estate*, 18(1), 30–47. <https://doi.org/10.1108/JCRE-10-2015-0028>

- Bryant, J., Matthews, G., & Walton, G. (2009). Academic libraries and social and learning space: A case study of Loughborough university library, UK. *Journal of Librarianship and Information Science*, 41(1), 7–18. <https://doi.org/10.1177/0961000608099895>
- Byrnes, K. G., Kiely, P. A., Dunne, C. P., McDermott, K. W., & Coffey, J. C. (2021). Communication, collaboration and contagion: “Virtualisation” of anatomy during COVID-19. *Clinical Anatomy*, 34, 82–89. <https://doi.org/10.1002/ca.23649>
- Cha, S. H., & Kim, T. W. (2015). What matters for students’ use of physical library space? *Journal of Academic Librarianship*, 41(3), 274–279. <https://doi.org/10.1016/j.acalib.2015.03.014>
- Cha, S. H., & Kim, T. W. (2020). The role of space attributes in space-choice behaviour and satisfaction in an academic library. *Journal of Librarianship and Information Science*, 52(2), 399–409. <https://doi.org/10.1177/0961000618794257>
- Choy, F. C., & Goh, S. N. (2014). A framework for planning academic library spaces. *Library Management*, 37(1–2), 13–28. <https://doi.org/10.1108/LM-01-2016-0001>
- Crawford, J., Henderson, K. B., Rudolph, J., Malkawi, B., Glowatz, M., Burton, R., Magni, P. A., & Lam, S. (2020). COVID-19: 20 countries’ higher education intra-period digital pedagogy responses. *Journal of Applied Learning & Teaching*, 3(1), 9–28. <http://journals.sfu.ca/jalt/index.php/jalt/index>.
- DeClercq, C. P., & Cranz, G. (2014). Moving beyond seating-centered learning environments: Opportunities and challenges identified in a POE of a campus library. *Journal of Academic Librarianship*, 40(6), 574–584. <https://doi.org/10.1016/j.acalib.2014.08.005>
- Devine-Wright, P., Pinto de Carvalho, L., Di Masso, A., Lewicka, M., Manzo, L., & Williams, D. R. (2020). “Re-placed” - reconsidering relationships with place and lessons from a pandemic. *Journal of Environmental Psychology*, 72, Article 101514. <https://doi.org/10.1016/j.jenvp.2020.101514>
- Ellison, W. (2016). Designing the learning spaces of a university library. *New Library World*, 117(5–6), 294–307. <https://doi.org/10.1108/NLW-01-2016-0006>
- Fruehwirth, J. C., Biswas, S., & Perreira, K. M. (2021). The Covid-19 pandemic and mental health of first-year college students: Examining the effect of Covid-19 stressors using longitudinal data. *PLoS ONE*, 16(3), Article e0247999. <https://doi.org/10.1371/journal.pone.0247999>
- Haapakangas, A., Hongisto, V., Varjo, J., & Lahtinen, M. (2018). Benefits of quiet workspaces in open-plan offices – Evidence from two office relocations. *Journal of Environmental Psychology*, 56, 63–75. <https://doi.org/10.1016/j.jenvp.2018.03.003>
- Harrop, D., & Turpin, B. (2013). A study exploring learners’ informal learning space behaviors, attitudes, and preferences. *New Review of Academic Librarianship*, 19(1), 58–77. <https://doi.org/10.1080/13614533.2013.740961>
- Hassanain, M. A., & Mudhei, A. A. (2006). Post-occupancy evaluation of academic and research library facilities. *Structural Survey*, 24(3), 230–239. <https://doi.org/10.1108/02630800610678878>
- Hefner, J., & Eisenberg, D. (2009). Social support and mental health among college students. *American Journal of Orthopsychiatry*, 79(4), 491–499. <https://doi.org/10.1037/a0016918>
- Hipp, J. A., Gulwadi, G. B., Alves, S., & Sequeira, S. (2016). The relationship between perceived greenness and perceived restorativeness of university campuses and student-reported quality of life. *Environment and Behavior*, 48(10), 1292–1308. <https://doi.org/10.1177/0013916515598200>
- Hong, S., Kim, Y., & Yang, E. (2021). Indoor environment and student productivity for individual and collaborative work in learning commons: A case study. *Library Management*. <https://doi.org/10.1108/LM-06-2021-0055>
- Jens, K., & Gregg, J. S. (2021a). Building performances in open and enclosed spaces: A method for balancing operational costs and space utilization with a focus on user needs and satisfaction. *Architectural Engineering and Design Management*. <https://doi.org/10.1080/17452007.2021.1941742>
- Jens, K., & Gregg, J. S. (2021b). The impact on human behaviour in shared building spaces as a result of COVID-19 restrictions. *Building Research and Information*. <https://doi.org/10.1080/09613218.2021.1926217>
- Kaya, N., & Weber, M. J. (2003). Cross-cultural differences in the perception of crowding and privacy regulation: American and Turkish students. *Journal of Environmental Psychology*, 23(3), 301–309. [https://doi.org/10.1016/S0272-4944\(02\)00087-7](https://doi.org/10.1016/S0272-4944(02)00087-7)
- Kim, D., Bosch, S., & Lee, J. H. (2020). Alone with others: Understanding physical environmental needs of students within an academic library setting. *Journal of Academic Librarianship*, 46(2), Article 102098. <https://doi.org/10.1016/j.acalib.2019.102098>
- Kim, Y., Hong, S., & Yang, E. (2021). Perceived productivity in open-plan design library: Exploring occupant behavior and perception. *Journal of Learning Spaces*, 10(3), 28–42.
- Kwon, M., Remøy, H., & van den Dobbelen, A. (2019). User-focused office renovation: A review into user satisfaction and the potential for improvement. *Property Management*, 37(4), 470–489. <https://doi.org/10.1108/PM-04-2018-0026>
- Lee, Y. S. (2014). Collaborative activities and library indoor environmental quality affecting performance, health, and well-being of different library user groups in higher education. *Facilities*, 32(3/4), 88–103. <https://doi.org/10.1108/F-02-2013-0012>
- Lee, Y. S., & Schottenfeld, M. (2014). Collaborative knowledge creation in the higher education academic library. *Journal of Learning Spaces*, 3(1).
- Li, D., & Sullivan, W. C. (2016). Impact of views to school landscapes on recovery from stress and mental fatigue. *Landscape and Urban Planning*, 148, 149–158. <https://doi.org/10.1016/j.landurbplan.2015.12.015>
- Low, S., & Smart, A. (2020). Thoughts about public space during Covid-19 pandemic. *City and Society*, 32(1), 1–5. <https://doi.org/10.1111/ciso.12260>
- Lundström, A., Savolainen, J., & Kostiaainen, E. (2016). Case study: Developing campus spaces through co-creation. *Architectural Engineering and Design Management*, 12(6), 409–426. <https://doi.org/10.1080/17452007.2016.1208077>
- Mahyuddin, N., & Law, J. B. (2019). Indoor environmental quality assessment in a learning space: University of Malaya’s main library. *Journal of Surveying, Construction & Property*, 10(1), 1–15. <https://doi.org/10.22452/jscp.vol10no1.1>
- Mulrooney, H. M., & Kelly, A. F. (2021). Belonging, the physical space of the university campus and how it is perceived by students: A quantitative analysis among a diverse student group. *Journal of Learning Spaces*, 10(2), 1–13.
- Navarro-Bringas, E., Bowles, G., & Walker, G. H. (2020). Embracing complexity: A sociotechnical systems approach for the design and evaluation of higher education learning environments. *Theoretical Issues in Ergonomics Science*, 21(5), 595–613. <https://doi.org/10.1080/1463922X.2020.1723037>
- Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science*, 5(1), 14–37.
- Pintrich, P. R. (2004). A conceptual framework for assessing motivation and self-regulated learning in college students. *Educational Psychology Review*, 16(4), 385–407. <https://doi.org/10.1007/s10648-004-0006-x>
- Qualter, P., Vanhalst, J., Harris, R., Van Roekel, E., Lodder, G., Bangee, M., Maes, M., & Verhagen, M. (2015). Loneliness across the life span. *Perspectives on Psychological Science*, 10(2), 250–264. <https://doi.org/10.1177/1745691615568999>
- Ramsden, B. (2011). Evaluating the impact of learning space. *Reference Services Review*, 39(3), 451–464. <https://doi.org/10.1108/00907321111161430>
- Saldaña, J. (2016). *The coding manual for qualitative researchers* (3rd ed.). SAGE Publications Ltd.
- Sankari, I., Peltokorpi, A., & Nenonen, S. (2018). A call for co-working – users’ expectations regarding learning spaces in higher education. *Journal of Corporate Real Estate*, 20(2), 117–137. <https://doi.org/10.1108/JCRE-03-2017-0007>
- Schopf, J., Roche, J., & Hubert, G. (2015). Co-working and innovation: New concepts for academic libraries and learning centres. *New Library World*, 116(1), 67–78. <https://doi.org/10.1108/NLW-06-2014-0072>
- Simens, G. (2008). *Learning and knowing in networks: Changing roles for educators and designers*. IIFORUM. <https://eclass.uoa.gr/modules/document/file.php/PPP233/αρθραβιβλιογραφια/Siemens2008.pdf>.
- Tanner, C. K. (2000). The influence of school architecture on academic achievement. *Journal of Educational Administration*, 38(4), 309–330. <https://doi.org/10.1108/09578230010373598>
- van Esch, E., Minjock, R., Colarelli, S. M., & Hirsch, S. (2019). Office window views: View features trump nature in predicting employee well-being. *Journal of Environmental Psychology*, 64, 56–64. <https://doi.org/10.1016/j.jenvp.2019.05.006>
- Waxman, L., Clemons, S., Banning, J., & McKelfresh, D. (2007). The library as place providing students with opportunities for socialization, relaxation, and restoration. *New Library World*, 108(9/10), 424–434. <https://doi.org/10.1108/03074800710823953>
- Wexler, M. N., & Oberlander, J. (2021). COVID-19 as a super crisis: Implications for place management. *Journal of Place Management and Development*. <https://doi.org/10.1108/JPM-09-2020-0093>
- Xu, D., & Yang, E. (2018). *Library transformation in higher education. 2018. World Workplace*.
- Yoo-Lee, E. Y., Lee, T. H., & Velez, L. T. (2013). Planning library spaces and services for Millennials: An evidence-based approach. *Library Management*, 34(6/7), 498–511. <https://doi.org/10.1108/LM-08-2012-0049>