



What Matters for Students' Use of Physical Library Space?

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ABSTRACT

Physical space in an academic library is increasingly important to fully support students' diverse needs for learning spaces. However, inefficient space design and planning give rise to crowded and underutilized spaces in a library, thereby probably lowering students' learning outcomes and wasting costly space. Understanding students' use of space can facilitate effective design and planning, which in turn will result in more efficient use of space. As students' spatial choices (i.e., the act of decision-making of an individual or group among two or more space alternatives for a certain activity) account for much of the space use in a library, this study explored the factors that influence their choice of space in an academic library using a paper-based survey ($n = 252$) at the central academic library, Eindhoven University of Technology, the Netherlands. The five most important space attributes were "Amount of space," "Noise level," "Crowdedness," "Comfort of furnishing" and "Cleanliness." The spatial choice patterns also differed according to different user and activity profiles.

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INTRODUCTION

Although the function of an academic library as an information retrieval space, such as searching databases, checking out books and reading printed materials, has become weaker (Gayton, 2008), use of physical space in a library remains important as student learning space: many students spend long periods in the library to conduct their own studies and research (Applegate, 2009; Bryant, Matthews, & Walton, 2009; Suarez, 2007). Over the past few decades, many research studies have in this sense paid attention to the importance of physical library space with the concept of "library as place" (Applegate, 2009; Bennett et al., 2005; Holder & Lange, 2014). In addition, libraries often serve as an access and linkage between buildings on campus (Cunningham & Tabur, 2012), which also increases students' use of library space. Thus, use of physical library space continues to grow "as place." Therefore, to accommodate the growing demand for learning space, newly constructed and renovated academic libraries are introducing more non-traditional facilities such as classrooms, cafes and group study spaces (Shill & Tonner, 2003; Stewart, 2011).

Such changes in the physical space, however, mean that academic libraries frequently have both crowded and underutilized spaces. Students are sometimes unable to find a space when needed (DeClercq & Cranz, 2014), and even if they find a seat in such a crowded space, they are likely to work less productively than they would in an uncrowded space. Conversely, underutilized space is costly in several respects, e.g., in wasted construction, energy and maintenance costs. Such a mismatch between the demand and supply of library space is

mainly due to a lack of knowledge about how students choose and use library space. Unlike an office building, the use of library space, especially learning space, is usually determined by students' spatial choices as they are not provided with their own work stations in libraries. Thus, understanding students' spatial choices is important in designing and planning efficient library spaces. Increasing the efficiency of library spaces is important because academic libraries are usually situated in the center of campus, and each square meter, particularly on the campuses of urban or older universities, is very costly (Little, 2013, 2014).

The aim of this study was to discover which attributes influence students' spatial choice in academic libraries using a direct-rating survey. The study first defined 18 space attributes that represent space quality and potentially influence spatial choice in an academic library. A paper-based survey was then conducted at the central academic library at Eindhoven University of Technology in the Netherlands. The study compared the importance of space attributes in different contexts in terms of user and activity profiles because users may have different preferences according to their characteristics (e.g., gender, age) and activities (e.g., independent work, group work) (DeClercq & Cranz, 2014; Webb, Schaller, & Hunley, 2008). The findings provide fundamental knowledge about students' spatial choices, and thus can contribute to the design and planning of more efficient academic library spaces.

LITERATURE REVIEW

A library should be designed to reflect the different needs of diverse activities (e.g., independent study, group work), thus creating better student learning spaces (Gayton, 2008; Bennett, 2007; Holder & Lange, 2014). Indeed, design associated with space quality (or a combination of space qualities) affects occupants' satisfaction and

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productivity, as demonstrated by many post-occupancy evaluation (POE) studies (Frontczak et al., 2012; Kim & de Dear, 2012; Lee & Guerin, 2009). The design subsequently affects students' frequency of library use. Indeed, Shill and Tonner (2004) found that improving the quality of space through renovation increased the use of space throughout a library. Studies have adopted a variety of methods to better understand space use in libraries, such as mental mapping, overt observation, unobtrusive observation, visitor tracking, interviews and questionnaires (May, 2011; Webb et al., 2008). Specific spaces in libraries have been selected in some studies, such as study spaces (Applegate, 2009) and computer spaces (Weessies, 2011).

Some interesting relationships have been found between space use and space quality. For example, DeClercq and Cranz (2014) found that students' favorite spaces were located close to windows, similar to the findings of many other studies (Foster & Gibbons, 2007; MIs, 2000; Organ & Jantti, 1997). Weessies (2011) found that proximity, such as the distance from an entrance, was strongly correlated with workstation choice. Holder and Lange (2014) observed that many students preferred to find a quiet space in the library. These studies demonstrate that in an academic library, there are many spaces with different space qualities that are related to space design and planning in terms of their function, aesthetic appearance, furniture, geometry, window view, etc. Although such studies provide useful information on library space use, little is known about which attributes of the physical space determine students' spatial choices in an academic library in a comprehensive manner. As space use in an academic library is mainly related to students' spatial choices for their activities, understanding their spatial choice patterns regarding the quality of this space is essential for effective design and planning. However, rather than directly examining students' preferences and spatial choices, previous studies have concentrated on their level of satisfaction with their chosen spaces (Hassanain & Mudhei, 2006; Montgomery, 2014; Riley, Kokkarinen, & Pitt, 2010).

METHOD

The study collected the data on students' preferences for spatial attributes using a paper-based survey (Supplementary S1) ($n = 252$) of students using the central academic library, Eindhoven University of Technology (TU/e), the Netherlands. This is a research university focusing on science and engineering with about 9000 students (i.e., undergraduate and graduate) and 3000 staff members. After a pilot study ($n = 30$) to check the clarity of the questionnaire, the study conducted the main survey between 13:00 and 16:00 over a two-week period during Spring 2013. The library at TU/e was chosen for the survey because it is a central place with diverse spaces to support students' different needs and activities and it was renovated in 2012. The library is located in the Metaforum building, which serves as a campus hub with diverse facilities (e.g., dining hall, classrooms, and student service center) and is connected to other main buildings by footbridges. The library comprises three floors with around 950 seats (e.g., soft chairs, lounges, seats for over 50 computers, individual study rooms and group study rooms). On the first and ground floors, conversation is allowed for group work, but many students also use these floors for independent study. Only the underground floor is reserved as a quiet study space. WiFi Internet is accessible and strong throughout the library, and power outlets are available close to all seats except for some soft chairs and lounges. The use of the library greatly differs between weekdays and weekends: the library is rarely used at weekends, perhaps because TU/e does not provide student housing on campus, but many of the library spaces are crowded on weekdays.

The survey comprised two sections. The first section asked students about their personal characteristics (e.g., gender, age, and frequency of visit to library) and for what purpose they were currently using the library (e.g., activities, whether with friends or not, expected length of stay). Example questions used to ask about students' activities include "Studying or working on one's own assignments or project," "Meeting

a group to study or work on a project," "Use of public computer," and "Reading a book or article." These reflect the most frequent activities in libraries, except for "Walking through" (i.e., transition to other building) (Crumpton & Crowe, 2009; DeClercq & Cranz, 2014).

The second section asked about the perceived importance of each space attribute when choosing a space. The attributes representing space quality were determined based on post-occupancy evaluations (POEs). Among others, the Center for the Built Environment (CBE) at the University of California Berkeley has conducted over 600 POEs and found relationships between occupant satisfaction and 15 space attributes related to indoor environmental quality and building characteristics (Frontczak et al., 2012; Kim & de Dear, 2012). Therefore, the study used basically the same space attributes as those used by the CBE. However, as the POEs at the CBE mainly concentrated on occupant satisfaction, the study modified the space attributes so that they were more related to spatial choice. The study added the following five space attributes: "Crowdedness," "Air movement," "Distance from an entrance," "Accessibility to facilities (e.g., printer, restroom, and cafeteria)" and "Window view" (i.e., access to an outside view through a window from where you sit) based on space use studies in libraries (Applegate, 2009; Crumpton & Crowe, 2009; Webb et al., 2008; Weessies, 2011). The item "General maintenance of the building" was deleted because it is irrelevant to decision making based on space. Accordingly, 18 candidate space attributes were generated for the survey, as shown Table 1. The study asked participants how important they considered each space attribute to be when making their current spatial choice, measured on a 7-point Likert scale (i.e., perceived importance: 1 = not considered at all, 7 = strongly considered).

The study analyzed the collected data by recording the scores for each space attribute, and these scores were then compared according to the different characteristics of the users and their activity profiles using t-tests.

RESULTS

Table 2 shows the respondents' profiles with regard to their personal and activity information. Most of the respondents were less than 25 years old and about 80% were male and European. Most of them carried a personal laptop and visited the library frequently for studying or working on their assignments and projects. More than half of the respondents came to the library with a friend(s), to work together or just to meet them. In addition, 83.3% of the respondents considered their activity in the library important, with a mean score above five. Only 2% of respondents stayed in the library for less than an hour and 55.5% stayed for over 3 h, which indicates that space use in the library is important for student activities on the university campus.

Table 1
A list of space attributes representing the quality of physical space.

Category	Space attribute
Space layout	Accessibility to facilities
	Amount of space
	Crowdedness
	Distance from an entrance
	Ease of interaction with friends
	Visual privacy
	Window view
Space furnishing	Adjustability of furniture
	Comfort of furnishing
Space ambience and cleanliness	Aesthetic appearance
	Cleanliness
Thermal comfort	Temperature
	Air movement
Air quality	Air quality
Lighting	Amount of light
	Visual comfort (glare, reflection, contrast)
Acoustic quality	Noise level
	Sound privacy

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