Students’ perspectives on configuration design of universities’ informal learning spaces

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Abstract: Across the Australian tertiary education sector and worldwide, the number of informal learning spaces has increased in newly constructed and retrofitted university campus projects. Research on these informal learning spaces does not pay much attention to the importance of spatial configuration design and how the configuration characteristics of an informal learning space may influence students’ selection of favourite spaces and their learning activities and outcomes. Therefore, there is an urgent need to investigate students’ perceptions of the configuration designs of informal learning spaces on university campuses. Space syntactic theories are applied in this research to formulate the configuration characteristics of informal learning spaces, and students’ perception indexes of designed spaces based on students’ behavioural observations are used to represent students’ perceptions. An empirical study based on the Geelong Waterfront campus of Deakin University explores how the configuration features of informal learning spaces affect students’ approaches and choices. The research findings indicate that the individual learning behaviours of students tend to favour spaces with low integration and high depth values, but they reject completely quiet spaces. Designers and managers of university learning spaces could implement these research findings and approach to improve the configuration characteristics of informal learning spaces for onsite students’ learning activities and the quality of their learning outcomes.

Keywords: informal learning spaces; spatial configuration; students’ perception; university campus

1. INTRODUCTION

Every university campus worldwide is unique in terms of geography and morphology, as well as its physical on-campus spaces. No two physical spaces of a university campus are alike in vision, nor would their users want them to be. The functions of all physical university campus spaces are, however, similar, being designed, constructed and continuously maintained for the uses of teaching or learning, research or development, and social services. There is neither a universally agreed classification of university campus spaces nor robust definitions of each type of campus space. This paper focuses only on a type of particular campus space which is termed informal learning space. In a well-cited paper, informal learning spaces are defined as ‘non-discipline specific spaces frequented by both staff and students for self-directed learning activities’ (Harrop and Turpin, 2013). Various research publications addressing informal learning spaces have recently provided insights into what these spaces are, what goes on in them and what they produce (Matthews and Walton, 2018). The majority of research into informal learning spaces has been focused on improvement of learning environmental infrastructure (Könings et al., 2005; Hunter and Cox, 2014; Frydenberg, 2018) and investigation of students’ learning activities undertaken informally from the viewpoint of pedagogy (Waldock et al., 2017; Wu et al., 2017; Cox, 2018). It is notable that research on informal learning spaces does not pay much attention to the importance of spatial configuration design and how the effects of spatial characteristics on users can be utilised in constructing new and retrofitting existing university learning spaces.
When interpreting students’ approaches to and choices of favourite informal learning spaces, it is important to acknowledge that it is not just the learning space’s characteristics that influence onsite students’ learning, but also the students’ perceptions that direct their interpretation of the space (Walton and Matthews, 2013). Previous research has indicated that students’ perceptions of learning environments are more influential than the environments themselves on students’ learning activities and the quality of their learning outcomes (Könings et al., 2005). Students’ informal learning efforts are mediated by their interpretation of informal learning spaces, and their active perception of a favourite space significantly influences their subsequent learning efforts and the learning outcomes. Across the tertiary education sector in Australia and worldwide, we do not have to look far to find newly constructed or retrofitted informal learning spaces. For instance, the recent redevelopment at all campuses of Deakin University has created many more new informal learning spaces in order to enhance the engagement of students in informal learning. Therefore, there is an urgent need to investigate the students’ perceptions of the configuration design of informal learning spaces on university campuses.

This paper investigates students’ perceptions of the configuration design of universities’ informal learning spaces. The case study building is Building D at the Waterfront campus of Deakin University, Geelong, Australia. The internal renovation of teaching and learning spaces on levels 2 to 4 of this building was completed in 2016 after three stages of redevelopment. The establishment of various informal learning spaces has provided students with an optional, effective learning environment as individuals and in groups, and has also created a case study building for research on informal learning spaces. Space syntactic theories are applied to formulate the configuration characteristics of informal learning spaces, and the occupancy rates of designed spaces based on students’ behavioural observations are used to represent students’ perceptions. The research aim is to enable designers and managers of university learning spaces to increase their configuration characteristics to improve the quality of onsite students’ learning outcomes.

2. UNIVERSITIES’ INFORMAL LEARNING SPACES

In a number of research publications, university students’ learning activities have been clustered from different viewpoints. It is widely recognised that students mainly prefer learning spaces related to their learning activities (Beckers et al., 2016). In terms of learners’ intentionality and consciousness, Schugurensky (2000) developed a taxonomy with three types of informal learning: self-directed learning, incidental learning and socialisation. From the intentional learning perspective, Bennett (2011) took a detailed look at different learning behaviours to characterise twelve learning forms, which include collaborative learning, studying alone, discussion with others and so on. Based on the behaviour patterns of learners on campus and combined with the multiple classification dimensions, this paper divides informal learning spaces into three types: individual learning, collaborative learning and interactive learning spaces. These classification criteria also depend on the users’ behaviour patterns, the space structure and the spatial interface morphology.

Cunningham and Walton (2016) argued that informal learning must occur in informal learning spaces and that different learning behaviours tend to favour spaces with different characteristics. This paper assumes that single corresponding relationships exist between informal learning behaviours and informal learning spaces; these relationships are presented in Figure 1. A space where it is convenient for an individual learning behaviour to occur is defined as an individual learning space. Similarly, collaborative learning tends to take place in a collaborative learning space, while interactive learning is likely to occur in an interactive learning space. It should be noted that one type of informal learning space may be occupied for a different learning behaviour. Through defining informal learning spaces according to specific categories, each type of learning space may be effectively observed, maintained, updated temporarily using removable furniture and other facilities, or even renovated permanently to maximise its usage for students’ learning.

The spatial environment cannot be neglected in evaluating the learning activities and outcomes of students, but is a key factor in meeting diversified learning needs and even shaping the outcomes of learning. It can be argued that learning activities become a behavioural and social process that has a strong correlation with informal learning space. Learning activities occur not only inside the classroom but also in informal learning spaces, where a behavioural experience or social interaction may take place. Therefore, the campus design of spatial configuration plays a particularly important role. Little
research has been conducted on the influence of spatial configurations on different learning behaviours in informal learning spaces and this study fills the gap using quantitative methods to verify the connection between spatial configurations and learning behaviours in order to facilitate the design of more effective informal learning spaces.

3. CASE STUDY BUILDING

An empirical study based on the Geelong Waterfront campus of Deakin University explores how the configuration features of informal learning spaces affect students’ approaches and choices around them. The campus, which was originally built as wool stores in the 19th century, has been extensively renovated to create a modern and impressive property. Building D on the campus, after three stages of redevelopment by 2016, was selected as the research object for this study because it provides primary study and active spaces for students, who can participate in a variety of activities individually or in groups to meet their diverse needs. The case study building is a complex facility with a library, computer labs, classrooms, an atrium space, cafeteria, indoor parking and in-between spaces. Only the informal learning spaces on floors 2, 3 and 4 (abbreviated as F2, F3 and F4) are selected, such as in-between spaces, rest areas and interactive areas, as shown in Figure 2. The first floor, which mainly contains a staff parking area, a computer lab, a few staff offices and a public cafeteria, is excluded from the research of this paper as these spaces are not popular for learning activities. The concept of informal learning space in this research includes all kinds of spaces where informal learning behaviours took place through observation, such as the library, atrium space, cafeteria, lounge and in-between spaces.

The method of non-participant observational sweeps of informal learning spaces is adopted in this study. The investigation was conducted from 9:00 to 10:00 am and 3:00 to 4:00 pm on weekdays and weekends from January to April 2018. These time periods were selected because then the spaces are not fully occupied and so students can choose seats according to their own needs rather than making passive decisions. Observations were undertaken including observing usage and behaviours, counting the number of users present and recording the users’ location distribution. During the investigation, many details were noted when observing the usage and behaviours of the users, such as whether students worked individually or in groups, whether they studied quietly or communicated with others and the number of spaces that were in use or idle. Different learning activities are distinguished and recorded in different colours on each floor plan drawing, as displayed in Figure 2.

Figure 2: Examples of distribution of students’ learning activities in each floor and distribution of different types of learning spaces based on the learning activities
Figure 2 shows examples that record the distribution of students’ learning activities and the distribution of different types of learning spaces based on the learning activities. Red marks represent the individual learning behaviours of students, blue represents collaborative learning behaviours and green represents interactive learning behaviours. At the same time, the accurate position of each student and the total number of students were also recorded during every survey activity. People walking around and randomly distributed pedestrians in the building were ignored because these are not considered learning behaviours. The distribution of students verifies that different learning behaviours tend to favour different kinds of study spaces.

4. METHODOLOGY

4.1 Measuring students’ perception of spatial configurations

In order to present the distribution of learning activities as quantitative data, the concept of seat occupation rate is defined as a method to measure students’ perception of spatial configurations. The seat occupation rate is calculated according to the proportion of users to the total number of seats in each learning space. Average values were obtained by recording the occupancy rate of each learning space over the three-month survey. In other words, the rate indicates students’ decisions in selecting seats. Therefore, the rates are influenced by many factors, for example, spatial configuration and indoor environment quality such as facilities, thermal comfort, air quality, light environment and acoustic environment. The average rates obtained in relation to different learning behaviours can be considered the initial indexes.

The students’ perception index, which directly indicates the relationship between the fixed seat occupation rate and the spatial configuration, can be measured by eliminating the effects of the other indoor environment factors on seat occupation rates. According to (Al Horr et al., 2016; Kang et al. (2017), the key indoor environment factors of facilities, lighting environment, thermal comfort and air quality should be taken into account. Here the fixed coefficients are defined as the influence of indoor environment quality, which is conducive to analysis of the relationship between spatial configuration and learning behaviours. First, the values of the key weighting factors were separately graded and averaged according to their importance, based on the published references (Al Horr et al., 2016; Kang et al. (2017). Second, the results for the informal learning spaces were respectively marked based on the key indoor environment factors. Third, the fixed coefficients were respectively calculated for each space through multiplying the weight value by the marking results. Finally, by considering the lowest fixed coefficient as 1, the other coefficients were relatively measured. In other words, if there was one student in the space with the lowest fixed coefficient, the other spaces should have the number of students of their coefficients.

4.2 Measuring space syntactic indicators of spatial configurations

Two indicators developed in space syntax – mean depth and integration – are employed in this research to represent the convenience and centrality features of an informal learning space, respectively (Hillier and Hanson, 1989). As a theory and analytical method, space syntax describes spatial relevance and accessibility based on topological relations, and quantifies abstract space into spatial analysis diagrams. Because this theory is concerned with the correlations between different spatial units but not a single space, the core concept of spatial configuration has been proposed. Spatial configurations are described as interdependent relations between different elements in a spatial system, or how spaces within the system relate to each other (Hillier and Hanson, 1989). Space syntax theory has been found to be appropriate for spatial organisation and adaptability in educational spaces (Coelho and Krüger, 2015). Based on the degree of spatial linearity, there are three types of models of space in space syntax: axial map, convex space and isovist (Hillier and Hanson, 1989). The convex space model was selected in this study because the informal learning space presents a non-linear form and this research focuses on the syntactic characteristics of every learning space. Each convex space was divided according to the division principle of convex space, and the layout and spatial characteristics of the building also needed to be considered. Pillars, walls, bookshelves and furniture all have an influence on the spatial division.

After the convex space model was selected, the quantised parameters of spatial attributes related to this study were confirmed. A convex space provides several parameters of spatial attributes which include variables such as mean depth, integration, connectivity, choice and others (Hillier and Hanson, 1989). A mean depth value reflects the difficulty of transforming one space into another, namely, spatial convenience (Turner et al., 2001). Integration emphasises the centrality of a space, which means the degree of scatter or aggregation of one space to all other spaces. The convenience and accessibility of a spatial layout are closely related to students’ choice of learning space, and accordingly the mean depth and integration values were selected as the indicators of space syntax in order to access space layout in this study.

The mean depth value represents the average value of the shortest path from a certain space to others. The shortest path means not the actual distance, but the topological distance. If the topological distance between two adjacent spatial units is abstracted as 1, then the depth value of any two spatial units indicates the shortest topological step from one spatial unit to another, which can be calculated from the relational diagram. When the value is smaller, it means that people can reach all of the other spaces more easily. Mean depth is calculated as follows (Hillier and Hanson, 1989):
\[ MD_i = \frac{\sum_j^n d_{ij}}{n-1} \]  

(1)

where \( MD_i \) indicates the mean depth of spatial unit \( i \), represents the shortest topological path from spatial unit \( i \) to any other unit \( j \) and \( n \) is the total number of spatial units.

In space syntactic terms, the degree of scatter or aggregation of one unit in relation to all other units in a spatial network is called integration. In other words, it represents the capacity of a spatial unit to attract traffic. The higher the integration value of a spatial unit, the stronger its connection with other spatial units. On the contrary, with low values all spatial units are alienated from each other and have a lack of connection. Integration is defined as follows (Hillier and Hanson, 1989):

\[ I_i = \frac{n \log_2 \left( \frac{n+2}{3} \right) - 1 + 1}{(n-1)(MD_i - 1)} \]  

(2)

The space syntax software DepthMap has been used in this research to produce a table with syntactic values matching the drawings to indicate the distribution of those values (Turner et al., 2001).

5. CONFIGURATION CHARACTERISTICS OF INFORMAL LEARNING SPACES

5.1 Spatial configuration analysis

This paper analyses the spatial configuration of Building D at the Geelong Waterfront campus of Deakin University as a case study building using space syntactic theory with the method known as convex space. The plan draining of each layer is separated into convex spaces using the CAD software. The partition of each convex spatial unit follows three basic principles. The core concept of a convex space was followed in which every point is visible from every other point within the space. Second, spatial boundaries that included walls, corners, pillars and bookshelves need to be considered. Finally, it is necessary to combine the distribution characteristics of learning activities with the separation of convex spaces.

The space syntactic values, including mean depth and integration, have been calculated for the case study building. A depth value shows how deep or shallow a spatial unit is compared to others and the higher the mean depth value, the lower the convenience. Similarly, an integration value reflects the accessibility of a space and the higher the integration value, the stronger the centrality of the spatial unit. The spatial configurations characteristics of all spatial units in the case study building are presented in Figure 3a and 3b for mean depth and integration values, respectively. These two values indicate the differences in the convenience and centrality of each spatial unit in all three types of informal learning spaces. Due to the page limit, the remaining analysis in this paper is limited to individual learning space units and results on collaborative and interactive learning space units are available from the authors upon request.
Table 1: Spatial configuration characteristics and students’ perception indexes

<table>
<thead>
<tr>
<th>Space</th>
<th>Integration</th>
<th>Mean depth</th>
<th>Seat occupation rate (%)</th>
<th>Fixed coefficient</th>
<th>Perception index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>0.8061</td>
<td>7.4337</td>
<td>27.78</td>
<td>1.869</td>
<td>14.86</td>
</tr>
<tr>
<td>A2</td>
<td>0.5653</td>
<td>10.2725</td>
<td>5.25</td>
<td>1.092</td>
<td>4.81</td>
</tr>
<tr>
<td>A3</td>
<td>0.6245</td>
<td>9.3033</td>
<td>7.29</td>
<td>1.374</td>
<td>5.31</td>
</tr>
<tr>
<td>A4</td>
<td>0.7749</td>
<td>7.6919</td>
<td>35.60</td>
<td>2.038</td>
<td>17.47</td>
</tr>
<tr>
<td>A5</td>
<td>0.7644</td>
<td>7.7567</td>
<td>34.50</td>
<td>2.038</td>
<td>16.93</td>
</tr>
<tr>
<td>A6</td>
<td>0.7525</td>
<td>7.8409</td>
<td>35.25</td>
<td>2.038</td>
<td>17.30</td>
</tr>
<tr>
<td>A7</td>
<td>0.7368</td>
<td>8.0000</td>
<td>51.20</td>
<td>2.585</td>
<td>19.81</td>
</tr>
<tr>
<td>A8</td>
<td>0.8404</td>
<td>7.1706</td>
<td>27.38</td>
<td>2.208</td>
<td>12.40</td>
</tr>
<tr>
<td>A9</td>
<td>0.8546</td>
<td>6.9915</td>
<td>17.92</td>
<td>2.208</td>
<td>8.12</td>
</tr>
<tr>
<td>A10</td>
<td>0.7940</td>
<td>7.5308</td>
<td>31.88</td>
<td>2.208</td>
<td>14.44</td>
</tr>
</tbody>
</table>

5.2 Students’ perception of spatial configurations in individual learning spaces

After calculation of the seat occupation rate, the integration values, mean depth values and seat occupation rates of each individual learning spatial unit are compared in Table 1. The unit space numbers A1 to A15 represent the serial number corresponding to each individual learning space. The table shows that students’ perception index can reach at least 2.20% and up to 19.81%, depending on the integration and depth values corresponding to each spatial unit. When the integration value gradually increased from 0.7153 to 0.8546, the students’ perception index decreased, while students’ perception index was very low when the integration value was lower than 0.62453. As the depth value increased from 6.9915 to 8.2332, the students’ perception index rose, and the rate became very low when the depth value was 9.3033 or higher.
5.3 Discussion

Table 1 shows that individual learning spaces have a negative correlation with the integration value, while they have a positive correlation with the depth value. This means that students who are engaged in individual learning activities are more likely to choose spaces with low centrality and few people walking through. Therefore, students who focus on studying alone or quietly tend to concentrate here. However, it is worth noting that when the integration value is too low and the depth value is too high, the space is not a good choice for students who study alone. The individual learning space that students need is not an absolutely quiet learning space. A similar conclusion was made earlier that open-plan spaces on a university library were very popular for academic activities and they argued that the social nature of open spaces is one of its main qualities which attracts students to study here Bryant et al. (2009). Many individual learners seek to secure a quiet spot within the social study environment so that they can feel integrated into the learning environment while in the process of independent learning.

Moreover, most users in the library feel comfortable with the noise level and if a space is too quiet, users do not like to study there. This may also explain why the spaces A1 and A7 (Table 1) have higher student perception indexes. This type of space is located in an area with a high integration value but, due to its own characteristic of being semi-closed, its integration value is relatively low. The semi-closure provides students with a territorial sense of space while also improving the possibility of interacting with others, so it can more easily meet diverse demands. This finding is also supported by the research of Waxman (2006) at coffee bars, where customers tended to sit in a place with a physical structure on one side. Despite a lack of verbal communication, people still felt socially connected when they sat alone. To sum up, it is considered that a space with a certain sense of territory, located in an area with high integration, is the kind of space that individual learning students show a preference for.

A further explanation for the low student perception index in spaces with very low integration and very high depth values is the absence of the surveillance effect in the learning environment. A similar idea called magnetism proposed by Francisco (2006) claims that students are attracted by others who are doing similar activities in informal learning spaces. Being surrounded by other users and getting involved in the atmosphere seems to inspire students to work more effectively. When the integration value is too low or the depth value is too high, the probability of users arriving is extremely low and this is likely to create a sense of spatial separation. As a direct result, this type of space is not conducive to stimulating student enthusiasm for independent learning. Like spatial units A2, A3, A13 and A15 shown in Table 1, the investigation data reflects an extremely low student perception index. Students do not like to study in these spaces if they have other choices.

In addition, it is noticed in Table 1 that the student perception indexes of spatial units A4, A5 and A6 are obviously higher than those of most other units. This may be partially because of their positions with window views, at which students can look at the external greenery and landscape through windows while studying or during study breaks. The beautiful natural scenery can facilitate students’ learning more effectively and pleasantly. These results also indicate that, in addition to the indoor environment and space configuration, outdoor environment should be taken into account while designing and managing universities’ informal learning spaces for students. Previous studies on workplaces also showed that there exists a positive relationship between a green window view and decreased levels of stress (Lottrup et al., 2013). The authors have an intention to expand the current research to include the external environment in research at the next stage.

6. CONCLUSIONS

Learning spaces on university campuses are frequently discussed in design research, but there seems to be little focus on how the configuration of spaces might influence the section and satisfactory of students within the context of informal learning. This research has investigated students’ perceptions of configuration designs in informal learning spaces on university campuses. An empirical study based on the Geelong Waterfront campus of Deakin University has been carried out to explore how the configuration features of individual informal learning spaces affect students’ approaches and choices. Space syntactic theory has been applied in order to formulate the configuration characteristics of informal learning spaces according to mean depth and integration values, and students’ perception indexes of designed spaces based on students’ behavioural observations have been used to represent students’ perceptions. The research findings indicate that the individual learning behaviours of students tend to favour spaces with low integration and high depth values, but they avoid completely quiet spaces. The research approach and outcomes presented in this paper will enable designers and managers of university learning spaces to improve their configuration characteristics and so the quality of onsite students’ learning outcomes.
References


