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Informal Learning Spaces in Higher Education: Student Preferences and Activities

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Abstract: Informal learning spaces play a significant role in enriching student experiences in learning environments. Such spaces are becoming more common, resulting in a change to the spatial configuration of built environments in higher education. However, previous research lacks methods to evaluate the influence of the spatial design characteristics of informal learning spaces on student preferences and their activities within. This paper aims to tease out the spatial design characteristics of informal learning spaces to examine how they shape students' preferences in terms of their use of the spaces and what they do within them. The two case studies selected for this study, both in the UK, are the Diamond at the University of Sheffield, and the Newton at Nottingham Trent University. A mixed-methods study is applied, including questionnaires, observation, interviews, and focus groups. Six significant design characteristics (comfort, flexibility, functionality, spatial hierarchy, openness, and other support facilities) that influence student use of informal learning environments are identified. These can be used to inform future design strategies for other informal learning spaces in higher education.

Keywords: informal learning space; spatial organisation; student experience; student behaviour; student preference; spatial evaluation

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1. Introduction

Three new trends are emerging in higher education—increases in numbers, funding, and quality control [1]. All these aspects are having an impact on the architecture of higher education—the capability of accommodating student populations, spatial and corporate identity, and satisfaction of the customers (students). Historically, the development of the university campus was shaped by an emphasis on traditional instructional methods in formal learning spaces [2,3]. However, 'informal' learning spaces are emerging as an alternative and are increasingly considered as an essential spatial construct in the university setting. The design of informal learning spaces for students to spend time in between more formal education experiences such as lectures are booming as campuses seek to enhance their student experience offering. Due to the social nature of recreation in higher education, these types of experiences typically occurred in libraries, student cafeterias, and other socially oriented spaces. All these spaces were called informal learning spaces, or sometimes part of the Informal Learning Landscape [4,5].

Researchers gradually attempted to interpret the functional definition and the spatial design of informal learning spaces [6–11]. For example, Brown and Lippincott [12] indicate that informal learning spaces are any space outside the classroom that can be used for learning. However, the boundary between 'inside', 'outside', and 'between' formal learning spaces became blurred. This increased the emphasis on informal learning spaces, resulting in the creation of atrium spaces, reimaging corridors, and other circulation spaces, and the finding

of ways to layer learning activities on to spaces previously used for social activities, such as dining or playing [2]. More and more institutions made endeavours to create highly adaptable and integrated informal learning spaces instead of specialised learning spaces. To respond to this demand, social 'hubs', internal student 'streets', and other designated spaces that promote both social and learning-related activities outside the classroom are being built [13]. The spaces of the campus landscapes can be described as *'socially catalytic'* because they catalyse socialising and are key to fostering a sense of community and engagement [14]. How to design such a social catalyst becomes an important issue in the future of higher education environments. Existing research has demonstrated the significance and impact of the spatial design characteristics of learning environments upon student achievement [15–17] and student experiences [18–21] based on environmental behaviour theory. Different spatial design characteristics were explored to support learning, and numerous authors proposed either lists of design principles or sets of critical characteristics that contemporary learning spaces should exhibit (these are summarised in Table 1). However, the methods of evaluating informal learning spaces remain uncertain. Furthermore, empirical research on examining informal learning spaces is required to better understand student experiences and the activities undertaken within them.

Table 1. Spatial design characteristics of learning spaces that impact students' experiences, as drawn from literature.

Spatial Design Characteristics	Sources
Light; Acoustics; Temperature; Ventilation; Furniture (Colour/Material)	[3,6,10,16,17,22–24]
Mobility; Adaptability; Diversity; Flexibility	[2,6,8–10,13,19,22,25,26]
Socialising; Sense of Community; Informative; Attractiveness; Openness; Enclosure; Safety	[2,3,10,13,19,26,27]
Support group work and collaboration; Supports individual learning	[6,9,10,19]
Location (proximity to formal learning environment); Outside Views	[28]
Circulation; Legibility; Intelligibility; Privacy; Spacious	[9,17,27,29–33]
IT-rich environment; Wi-Fi Coverage; Plugs and Sockets; Food and Beverage	[6,12,21,22,26,34,35]

The aims of this research are to:

(1) conduct a mixed methods study to investigate student activities and preferences in informal learning spaces;
(2) provide an empirical evidence base to understand student activities and their selection and use of informal learning spaces in the higher education setting; and
(3) tease out the significant spatial design characteristics that influence how and why students use informal learning environments.

This exploration of spatial design is undertaken to create more effective informal learning spaces in higher education and to generate evidence to inform future designs.

2. Materials and Methods

This research employs a case study method to achieve these aims. A mixed-methods approach was undertaken, including observations, interviews, questionnaires, and focus groups. These were selected and refined based on a literature review and pilot tests, as shown in Phase 1 (as illustrated in Figure 1). More specifically, the literature review indicated how researchers identify spatial design characteristics that influence learning spaces (as illustrated in Table 1), which informed the generation of the research plan. The pilot allowed for testing and refinement of the methods. In Phase 2 (as illustrated in Figure 1), the mixed-methods approach was employed at the Diamond at the University of Sheffield and the Newton at Nottingham Trent University to gather empirical data, including students' preferences on the spatial design characteristics of informal learning spaces and their activities within. All the students included in the study were informally

approached, anonymised, and voluntarily offered to participate. More details are shown in the following sections.

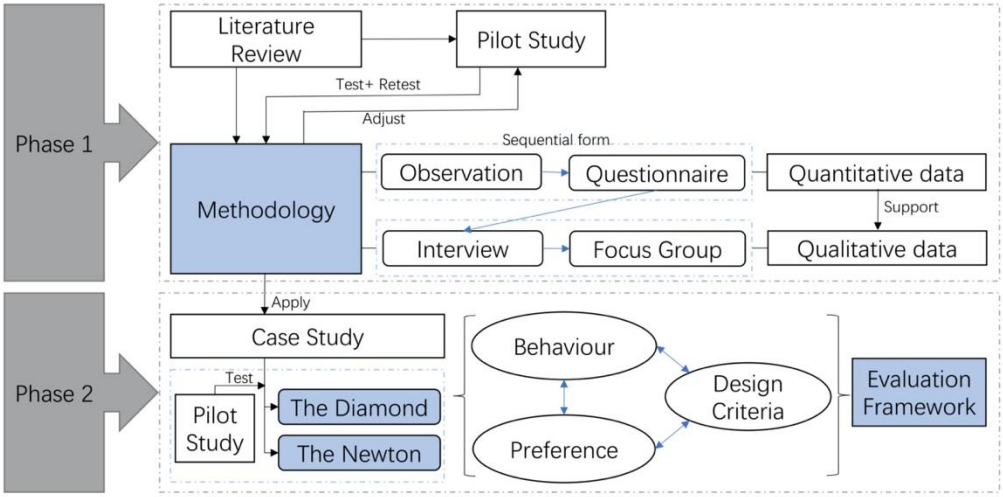

Figure 1. Research Design.

2.1. The Context of the Case Studies

The selection of the case studies was based on four sets of criteria: (1) accessibility for research, and proximity to the research team based in the Midlands, UK; (2) completion in the 21st century; (3) used by students from multiple disciplines (i.e., not only for one program or course); and (4) reputation and award-winning status in terms of the building design. Consequently, two cases, the Diamond at the University of Sheffield and the Newton at Nottingham Trent University, which provide suitable places to investigate the informal learning spaces in higher education, were selected.

Designed by Twelve Architects and completed in 2015, the Diamond offers students the opportunity to move between formal and informal learning situations. The enriched teaching and learning spaces are centralised and vertically organised around a four-floor height atrium and enlarged corridor spaces (as illustrated in Figures 2 and 3).

Figure 2. Atrium Space of the Diamond at University of Sheffield.

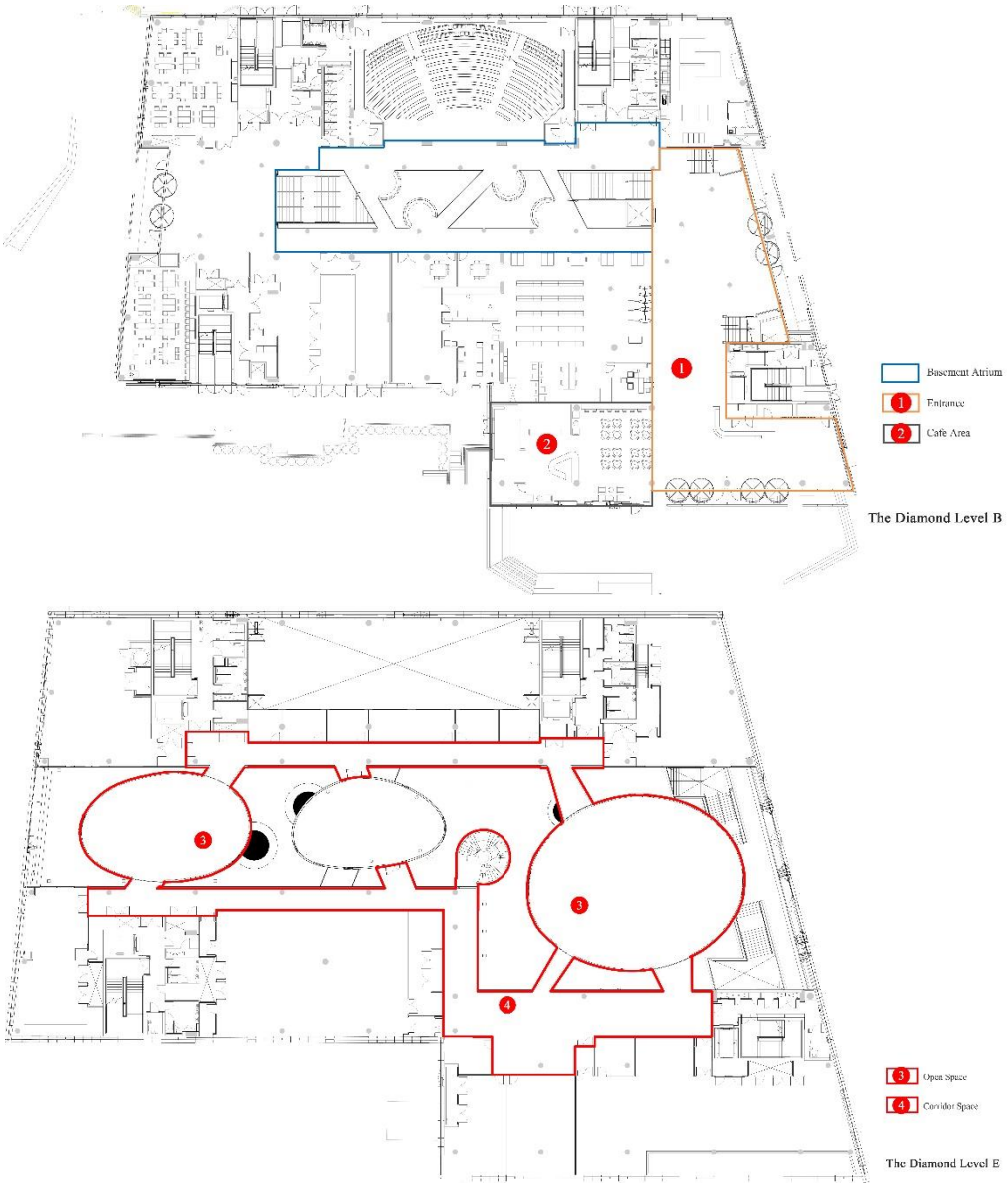

Figure 3. Floor plan of Diamond with different functional zones (Level B and Level E).

Designed by the Hopkins Architects in 2009, The Newton is a circulatory space, providing an environment for student socialising as well as informal learning activities. The heart of this area is organised beneath a glazed roof with a wooden structure within an atrium known as the Central Court (as illustrated in Figures 4 and 5). With large lecture spaces, computer rooms, and small seminar spaces around, the Central Court is seen as an in-between learning space. With a student service centre, a careers hub, three food outlets, and one main canteen, the Central Court supports student campus life.

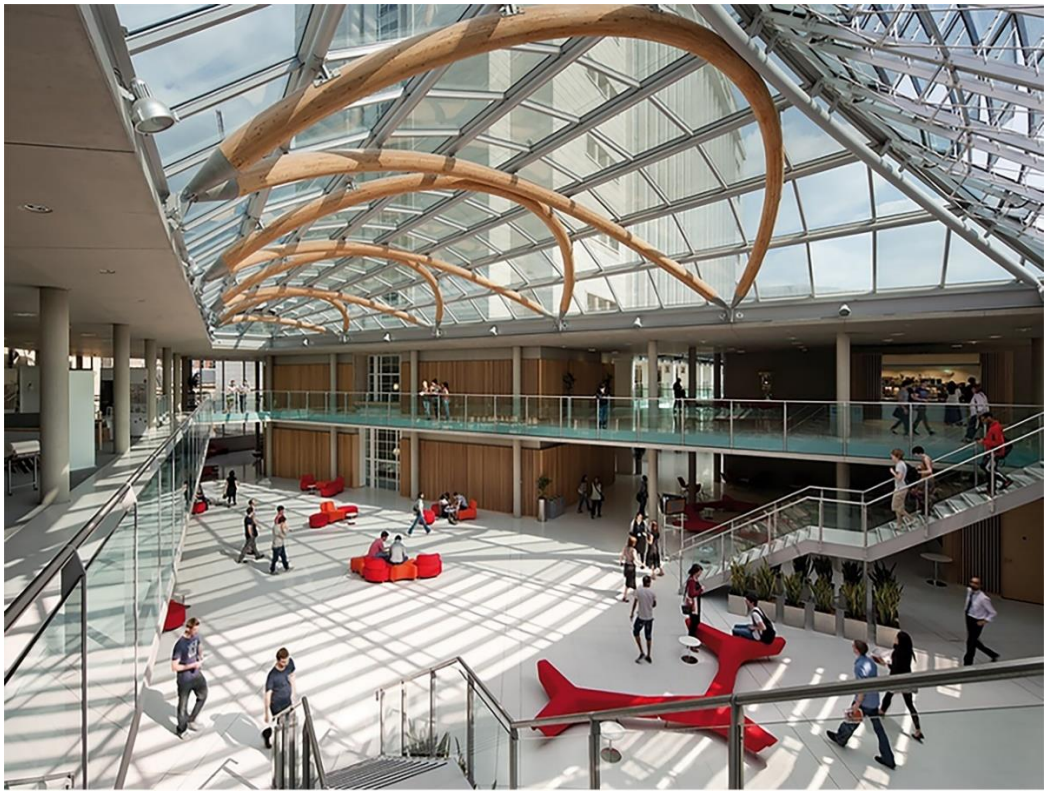

Figure 4. Central Court of Newton at Nottingham Trent University.

2.2. Observations

Fieldwork at the Diamond (as illustrated in Table 2) took place over 20 working days, spread across 4 weeks before the Easter vacation (from 8 March to 31 March 2017). The study at the Newton (as illustrated in Table 2) was carried out on one day as a pilot study and in 12 working days across four weeks from the 19th of April to the 10th of May 2017. Based on the pilot study, one session took place in the evening and three in the day during every weekday observed at the Diamond, while only three sessions took place in the daytime at the Newton due to its closure at night. Each 'session' lasted two hours made up of six 20-min time periods each of which incorporated four 'walk-by' observations once every five minutes [19]. Walk-bys and timed observations were implemented to identify users' location, to count the number of users, and to identify the activities users engaged in. In total, four volunteer postgraduate students were recruited to help carrying out the observations. The informal learning spaces are divided into four functional zones, Entrance Space, Café Area, Corridor Space, and Open Space.

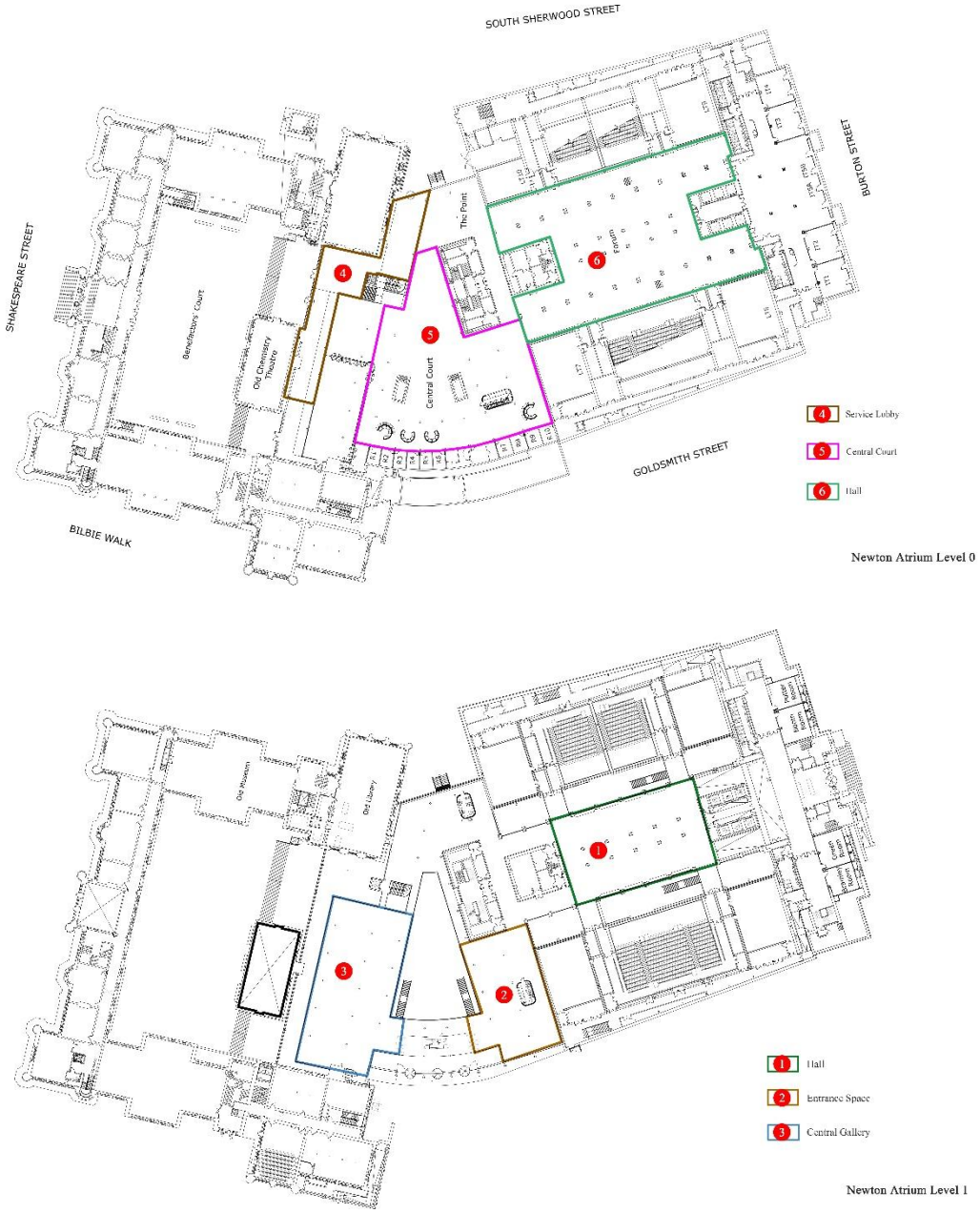

Figure 5. Floor plan of Newton with different functional zones (Level 0 and Level 1).

Table 2. Observation schedule of Diamond at University of Sheffield (8–31 March) and Newton at Nottingham Trent University (19 April–10 May).

	6 March Monday	**7 March Tuesday**	**8 March Wednesday**	**9 March Thursday**	**10 March Friday**	**11 March Saturday**	**12 March Sunday**
8–10 am			Pilot Study	Pilot Study	Entrance Space	N/A	N/A
12–2 pm			Pilot Study	Pilot Study	Café Area	N/A	N/A
5–7 pm			Pilot Study	Pilot Study	Open Level C	N/A	N/A
8–10 pm			Pilot Study	Pilot Study	Corridor Level D	N/A	N/A
	13 March Monday	**14 March Tuesday**	**15 March Wednesday**	**16 March Thursday**	**17 March Friday**	**18 March Saturday**	**19 March Sunday**
8–10 am	Corridor Level D	Open Level C	Café Area	Corridor Level E	Open Level F	N/A	N/A
12–2 pm	Entrance Space	Corridor Level D	Open Level C	Open Level E	Corridor Level E	N/A	N/A
5–7 pm	Café Area	Entrance Space	Corridor Level D	Corridor Level F	Open Level E	N/A	N/A
8–10 pm	Open Level C	Café Area	Entrance Space	Open Level F	Corridor Level F	N/A	N/A
	20 March Monday	**21 March Tuesday**	**22 March Wednesday**	**23 March Thursday**	**24 March Friday**	**25 March Saturday**	**26 March Sunday**
8–10 am	Corridor Level F	Open Level E	Corridor Level D	Entrance Space	Café Area	N/A	N/A
12–2 pm	Open Level F	Corridor Level F	Open Level C	Corridor Level D	Entrance Space	N/A	N/A
5–7 pm	Corridor Level E	Open Level F	Café Area	Open Level C	Corridor Level D	N/A	N/A
8–10 pm	Open Level E	Corridor Level E	Entrance Space	Café Area	Open Level C	N/A	N/A
	27 March Monday	**28 March Tuesday**	**29 March Wednesday**	**30 March Thursday**	**31 March Friday**	**1 April Saturday**	**2 April Sunday**
8–10 am	Open Level C	Open Level F	Corridor Level E	Open Level E	Corridor Level F	N/A	N/A
12–2 pm	Café Area	Corridor Level F	Open Level F	Corridor Level E	Open Level E	N/A	N/A
5–7 pm	Entrance Space	Open Level E	Corridor Level F	Open Level F	Corridor Level E	N/A	N/A
8–10 pm	Corridor Level D	Corridor Level E	Open Level E	Corridor Level F	Open Level F	N/A	N/A
	17 April Monday	**18 April Tuesday**	**19 April Wednesday**	**20 April Thursday**	**21 April Friday**	**22 April Saturday**	**23 April Sunday**
8–10 am			Pilot Study	Service Lobby	Hall in Level 1	N/A	N/A
12–2 pm			Pilot Study	Hall in Level 0	Entrance Space	N/A	N/A
5–7 pm			Pilot Study	Central Court	Central Gallery	N/A	N/A
8–10 pm			Pilot Study	N/A	N/A	N/A	N/A
	24 April Monday	**25 April Tuesday**	**26 April Wednesday**	**27 April Thursday**	**28 April Friday**	**29 April Saturday**	**30 April Sunday**
8–10 am	Hall in Level 0	Hall in Level 1	Mini Open Day	Central Court	Entrance Space	N/A	N/A
12–2 pm	Hall in Level 1	Central Court	Mini Open Day	Hall in Level 1	Central Gallery	N/A	N/A
5–7 pm	Service Lobby	Hall in Level 0	Mini Open Day	Central Gallery	Hall in Level 1	N/A	N/A
8–10 pm	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 2. *Cont.*

	1 May Monday	02 May Tuesday	3 May Wednesday	4 May Thursday	5 May Friday	6 May Saturday	7 May Sunday
8–10 am	Bank Holiday	Central Gallery	Service Lobby	Entrance Space	Hall in Level 0	N/A	N/A
12–2 pm	Bank Holiday	Service Lobby	Hall in Level 0	Service Lobby	Central Court	N/A	N/A
5–7 pm	Bank Holiday	Entrance Space	Hall in Level 1	Hall in Level 0	Service Lobby	N/A	N/A
8–10 pm	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	8 May Monday	**9 May Tuesday**	**10 May Wednesday**	**11 May Thursday**	**12 May Friday**	**13 May Saturday**	**14 May Sunday**
8–10 am	Central Gallery		Central Court			N/A	N/A
12–2 pm	Entrance Space		Central Gallery			N/A	N/A
5–7 pm	Central Court		Entrance Space			N/A	N/A
8–10 pm	N/A		N/A			N/A	N/A

2.3. Questionnaires

The questionnaires were structured to examine: (a) student experiences in the informal learning spaces, which included the frequencies of 22 social and informal learning activities, 8 time periods where students use the social and informal learning spaces, and 15 reasons for selecting and using social informal learning spaces; (b) student preferences of the spatial design characteristics of the informal learning spaces, which assessed the design characteristics and performance and student opinions on social informal learning spaces, and (c) personal background information, which inquires about whether they were an international student, gender, department, mode of study, level of study, year in school, and accommodation type.

A 5-point Likert Scale was employed on questions (i.e., 1 = strongly disagree; 2 = disagree; 3 = no comment; 4 = agree; and 5 = strongly agree), which examined the frequencies of student activities and attitudes of the spatial design characteristics numerically (see Appendix A—Questionnaire Form). The questionnaires were delivered and collected in person by providing an incentive (a chocolate bar) in the informal learning spaces. Ethics approval for the study was obtained from the University of Nottingham.

Through communications with the building managers of both buildings, it was estimated that daily use in the Diamond is 1500 people, and in the Newton, 1000 people. Of these populations, 10% were selected as the sample for the questionnaire given the resources and timeframe available to the research team. Consequently, in total 261 questionnaires (157 at the Diamond and 104 at the Newton) were collected. 148 valid questionnaires at the Diamond were collected with 94.3% efficiency, and 97 valid questionnaires at the Newton were collected with 93.3% efficiency (as illustrated in Table 3). The response rate was 98.1%.

Table 3. Personal background information of two case studies by questionnaires.

Category	Diamond	Newton
Total number of questionnaires	157	104
Valid questionnaires	148	97
Male/Female	63/85	40/57
International/Local	71/77	19/78
Undergraduates/Postgraduates	102/46	86/11
Lecture-based/Studio-based/Lab-based	122/6/20	90/3/4

Data analysis of the questionnaires was initially conducted in Microsoft Excel and crosstabulation was employed. SPSS software was used for the statistical analysis of data. Cronbach's alpha was used as an estimate of the reliability of the scales in questionnaires. The value of the Cronbach's Alpha of this questionnaire was 0.845, which indicates good reliability. Kaiser–Meyer–Olkin (KMO) measured sampling adequacy of the validity in three dimensions: the construct of frequencies of student activities (KMO = 0.718, $p < 0.000$), the construct of preferences of the spatial design characteristics (KMO = 0.660, $p < 0.000$), and the construct of spatial satisfaction (KMO = 0.785, $p < 0.000$), representing that the questionnaire was valid. After testing the reliability and validity of questionnaires, the results were analysed by multiple response analysis and principal component analysis.

2.4. Interviews

Semi-structured interviews were also employed in the Diamond and the Newton. The research found out that interviews with 12 and 7 participants (ID1-12 and IN1-7) in the Diamond and the Newton, respectively, were sufficient to reach the data saturation, which is the point at which no new information is obtained in the data from the completion of additional interviews [36]. Interviewees were the students who used the informal learning spaces and agreed to share their ideas and views on this research. Most of the questions were based on existing research on the users' activities and preferences in the learning environment and public spaces [20,37]. The data from the interviews were collected face-to-face after the process of questionnaire and observation. The interviews were recorded for revisiting and reflection on the information provided. All the records of the interviews were scripted into Microsoft Word and analysed using NVivo 11 software. Open coding was employed to record the preferences and the spatial design characteristics of the informal learning spaces to generate the probes of the focus group.

2.5. Focus Groups

A focus group for each case study was also employed. Recruitment posters were displayed around the spaces, and questionnaire participants were also sent emails to invite them to participate further in the research. Focus group participants were recruited that were familiar with the informal learning spaces and were carefully selected to ensure that they have different personal background information (considering gender, department, mode of study, level of study, year in school, etc.). Nine participants were selected as participants for the focus group at the Diamond, and five participants at the Newton. The participant information of the focus group at the Diamond and the Newton are listed in Table 4.

Table 4. Participant information of focus groups at Diamond (PD1-9) and at Newton (PN1-5).

Participants	Gender	Age	Subject
PD1	Female	24	Architectural Design
PD2	Male	24	Robotics
PD3	Male	28	Architecture
PD4	Female	23	Finance Economics
PD5	Female	23	Financial Economics
PD6	Female	24	Financial Economics
PD7	Female	24	Landscape Architecture
PD8	Male	26	Advanced Software Engineering
PD9	Male	28	Architectural Design
Participants	**Gender**	**Age**	**Subject**
PN1	Female	26	Interior Architecture
PN2	Female	19	Business Management & Marketing
PN3	Female	23	Interior Architecture
PN4	Female	24	Interior Architecture
PN5	Female	21	Business Account & Marketing

3. Results

3.1. Time Period of Regular Use in the Informal Learning Spaces

How long the students can stay in the informal learning spaces and how many students keep staying there can indicate their efficiency and the attraction of the environment. The time period of regular use in the informal learning spaces at the Diamond and the Newton are analysed by using a multiple response analysis using SPSS BIM 23 software, and the comparison can be seen in Figure 6.

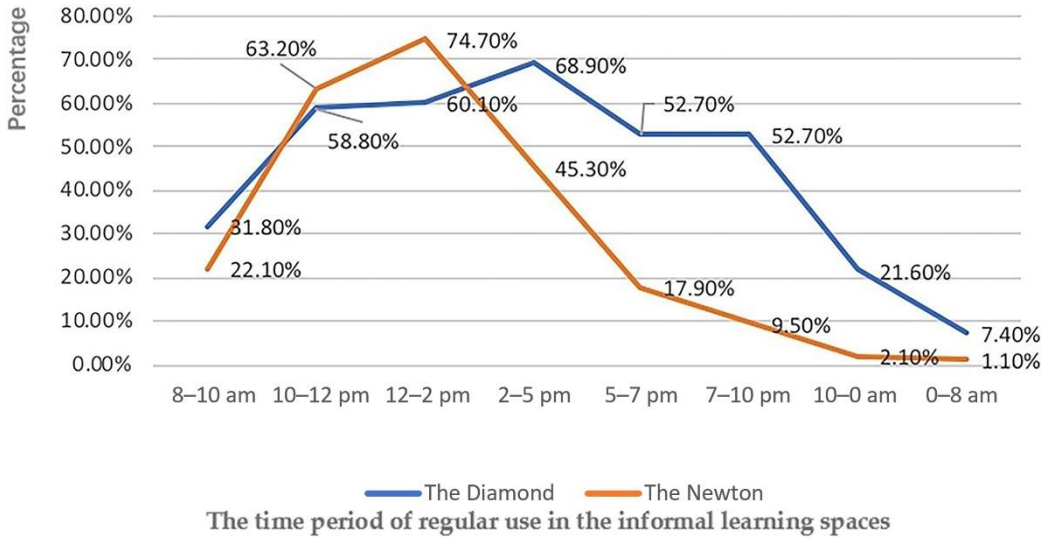

Figure 6. Percentage of students selecting time periods of when they regularly use informal learning spaces of Diamond and Newton, from questionnaire.

The number of students using the Diamond maintains a high percentage for a long time (over 50% from 10 am–10 pm). However, 50% of the respondents use the Newton only from 10 am–2 pm. This result is informed by the functional characterisation and operation of the two informal learning spaces. The Diamond is organised as a learning space where the learning process is well-considered. The informal learning spaces at the Diamond provide more opportunities for all the students who wish to stay longer. At the Diamond, students are free to access with their student cards 24/7 throughout the year. Comparatively, the function of the Newton is to link different departments and support students' transition from lecture to lecture. Moreover, the Newton is a place for students to have a rest at lunchtime. Therefore, the peak time of use at the Newton is lunchtime. The Newton is closed when there is no lecture at night-time. Consequently, it provides a relatively dark environment and less support for the students staying in due to lights being reduced in low occupancy periods.

3.2. Reasons for Student Selecting and Using the Informal Learning Spaces

Students have their own preferences regarding choosing a space. In terms of the spatial design characteristics and spatial organisation of higher educational informal learning spaces, the investigation based on the questionnaires identified reasons that influence these choices. Students were able to choose from 15 reasons in terms of why they use the informal learning spaces (see Appendix A—Questionnaire Form), and the percentages of students selecting these reasons for using the informal learning spaces at the Diamond and the Newton are marked blue and orange, respectively (as illustrated in Figure 7). Consequently, comfortable lighting (81.8%), other support (such as Wi-Fi, etc.) (80.4%), functionality (support individual and group work) (68.2%), spatial hierarchy (67.6%), openness (64.9%), comfortable temperature (62.2%), and flexibility (52.7%), are the top seven influential design characteristics for students selecting and using the informal

learning spaces at the Diamond, while spatial hierarchy (80.4%), comfortable lighting (73.2%), other support facilities (such as Wi-Fi, etc.) (67%), openness (62.9%), comfortable temperature (60.8%), flexibility (54.6%), and functionality (53.6%), were the seven most important design characteristics at the Newton.

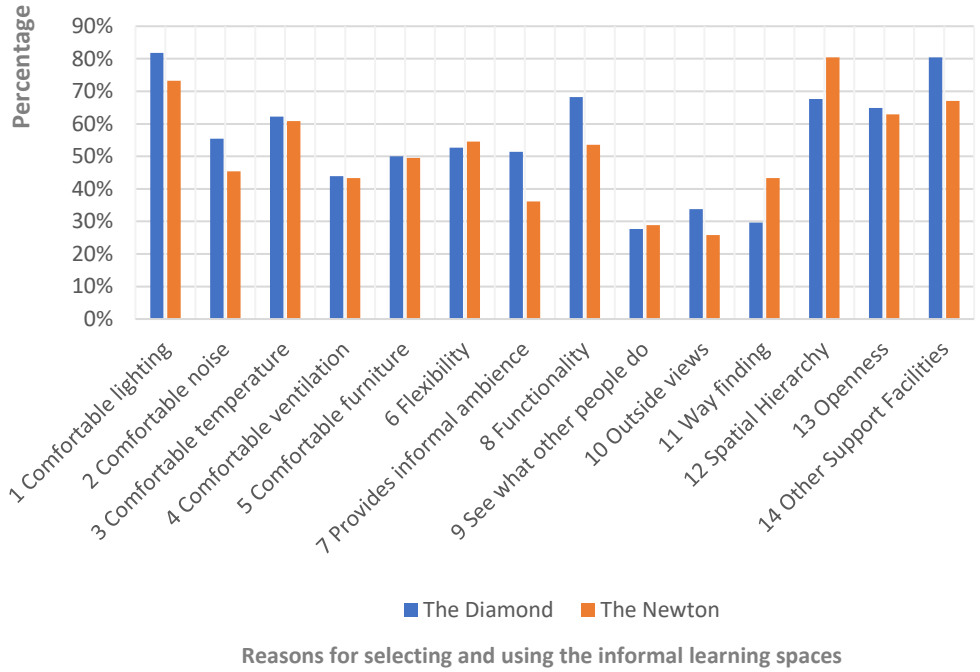

Figure 7. Percentage of 14 reasons for selecting and using informal learning spaces of Diamond and Newton, from questionnaire.

The same seven reasons were mentioned by over 50% of responders in both case studies even though they are in a different order. Based on the questionnaires, these seven design characteristics can be seen as important aspects to evaluate and consider in the design of informal learning spaces. Drawing from this quantitative analysis, along with the interviews, focus groups, and the literature review, six spatial design characteristics of comfort, flexibility, functionality, spatial hierarchy, openness, and other support facilities are highlighted and discussed in the following section.

4. Discussion: Student Preferences in the Informal Learning Space

4.1. Comfort

Comfort is a sense of physical or psychological ease [38]. Comfort in terms of lighting, acoustics, and temperature in educational buildings were widely researched [39–41]. Most research focuses on comfort in formal learning spaces, such as classrooms, while the research on the informal learning spaces is limited.

Slightly more students chose to use the spaces at the Diamond due to the level of lighting comfort than at the Newton—but in both, lighting was one of the most important factors influencing choice of space, with over 70% of students in both buildings identifying this. Compared with that of purely socialising activities, informal learning activities require a brighter environment. Due to a preference for natural light and poor artificial lighting provided at the Newton, students used the informal learning spaces at the Newton more frequently in the daytime than at night. As one of participants (PN 1) noted, she prefers to work in the Newton atrium because: *"there's lots of natural light to work in."* One of participants (PN 5) also noted: *"I like the sunshine. So, no matter what season it is, I like the central court because the central court provides sufficient (natural) light."* A participant in the Diamond (PD2) noted: *"I like the windows as they let in a lot of light"*. However, students tended to do learning activities at the Diamond for a longer period due to the better

artificially lit environment at the Diamond, which provides lighting comfort in the day and at night.

The student perception of the acoustics suggests that the acoustic level is a bigger driver to where students work at the Diamond than that at the Newton. Most of the background noise was generated from group discussions or collaboration activities in the open space as well as the corridor space at the Diamond. These were lower than the sounds of students participating in socialising activities and passing through the spaces, which was a more frequent activity at the Newton. As one interviewee in the Newton complained: *"I find the background noise a bit irritating, so I always have my headphones in."* However, students that chose to study in the open space and corridor space of the Diamond were tolerant of the background noise. In the focus group, one participant (PD3) stated that,

> *"Well, besides loud noises made on purpose, sounds from the surroundings have little effect on me. It really doesn't matter if the discussion occurred in the booked private room or simply in the open study place. In fact, I prefer working with some background sounds."*

There are also plenty of silent studying rooms at the Diamond for students who are not comfortable with background noise. However, over half of the students were involved in more socialising activities at the Newton and more people passing through the informal learning spaces at the Newton were recorded during the observations. Consequently, the students who were undertaking learning activities felt impacted by the noise of socialising activities and by the people passing through the space. To stimulate informal learning activities, it is important to create a place where students can realise the place is designed for informal learning activities rather than for just socialising activities. The learning atmosphere therefore requires careful control of acoustic levels, as demonstrated by the findings here.

Temperature is also an important design criterion for informal learning spaces. The respondents at the Diamond and the Newton mentioned the importance of keeping appropriate temperatures in the learning environment. To this point, the glass curtain walls and rooftops contribute to the dilemma. From one side, the transparent walls and rooftops provide natural lighting, which was highlighted by respondents in the focus groups as positive (PN5 and PD7). However, from another perspective, they can also negatively affect the indoor temperature of the building by providing a passage for unwanted thermal gain, which can cause discomfort and overheating.

4.2. Flexibility

Flexibility is a previously identified characteristic of education spaces, allowing students to adapt their physical environments to accommodate individual preferences [8,9]. The two cases, the Diamond and the Newton, provide significant flexibility of their informal learning spaces (as illustrated in Figure 8).

(**left**) (**right**)

Figure 8. Reconfigurable tables and removable chairs allow students to shape their learning spaces individually or by group in open space at Diamond (**left**) and corridor space at Newton (**right**).

The open space and the corridor space of the Diamond and the Newton support different group sizes of student learning and socialising activities, provide ample models of the boundary control, possess the ability to reconfigure their learning space, and enhance diverse ambiences. Respondent (PN3) expressed the significance of the adaptable and removable furniture and how it influenced their activities in the informal learning space at the Newton:

> *'. . . It is quite a flexible area. For example, furniture settings can be changed according to different activities. . . . The functional partition can also be changed by the arrangement of the movable walls. From a functional perspective, this area is very practical.'*

The respondent (PD3) also indicated that the adaptation of social activities and learning activities are also important:

> *'I think the Diamond is like a "Learning Place" compared with a "library". Now, I like this atmosphere after I got used to studying in this environment. In this place, I can find both silent areas and space for group discussion if needed.'*

Based on this research, the impact of the diverse movement flow upon student experiences in the informal learning spaces can be noted. The extended informal learning space at the Newton can hold many students passing through and undertaking socialising activities.

4.3. Functionality

It is inevitable that informal learning spaces possess student socialising spaces and accommodate social activities. Through observation, it was noted that there were different types and degrees of informal learning activities in the Diamond and Newton, which were based on the nature of the work: the intensity of that work (and thus, the need for seclusion), or the extent to which progress resulted from discussions with others. Learning activities, such as individual revision, coursework preparation, and studying alone, demand seclusion and avoiding distraction. This requires a relatively stable and quiet learning environment. However, some of the learning activities, such as group discussion and so on, require communication. The function of the informal learning spaces at the Newton creates a socialising ambience to encourage peer-to-peer learning, group study, and discussions. As one of participants (PN5) noted: *"Even though they also have their own space, the common areas are next to these spaces to support students who are from different department students' learning activities and socialising. The common area is especially designed to encourage interaction."* These results cannot articulate how to better design informal learning spaces, however, through the analysis, there are differences between the cases. Even though they are both informal learning spaces leveraging circulation areas, they play a different role in their educational complexes. Hence, more specific advice on the different types and roles of informal learning spaces should be discussed separately in future studies.

4.4. Spatial Hierarchy

Spatial hierarchy refers to spatial legibility, accessibility, and privacy. From one side, students require a space that is easily understood, and they can easily find where they want to go. The atriums at the Diamond and the Newton are both located in the centre of the educational complex, which provides a hub to link together different destinations. The setting of spatial hierarchy from open space to corridor space to lecture room provides a sense of layering, which contributes to the legibility of the space. Consequently, students could not feel *"too many confusions"* (PN2) in terms of orientating themselves. Furthermore, student services of the university provide inductions regarding understanding the spaces: *" . . . we have induction week when we first come here. The induction week covers all the map information and wayfinding, etc."* (PN2).

From another perspective, the more formal the learning process, the more the students prefer to study in a more silent and private part of the learning space, or in a place where there is less contact with their surroundings. An appropriate spatial configuration can enhance a sense of privacy through the control of the boundary and the reconfiguration of

the learning settings. To this point, the diverse learning settings and spatial configuration at the Diamond provide students with private spaces to facilitate more formal learning activities. Based on the observations at the Diamond, the students preferred to do more learning activities in the spatial capsule, a small private learning space in the open area where the arrangement of the furniture shaped a learning unit in the open area. Besides, the flexibility of the informal learning space also contributes to privacy through the student's self-organisation of the spatial configuration.

4.5. Openness

The atrium is often seen as an in-between space. In informal learning environments, it can provide a *'visual antidote'* [42] for students emerging from lecture halls and classrooms. The visual antidote attracts students to decide what they want to do, whether they prefer to remain or to leave and to use the informal learning spaces, and which time period they want to get involved in the atrium. The spatial configuration of the atrium brings people into space and gives them reasons to converse, share ideas, or enjoy lingering in different areas of the environment.

These spontaneously occurring activities are encouraged in the atrium, which provides a socialising ambience for space. The feedback collected from focus groups confirms that the openness provides a space where occupants have good views and a relaxing experience. With this relaxed feeling, students can be "*rejuvenated*" (PN4) from the long periods of studying and undertake activities like group study or collaboration, where they speak to another person or undertake activities that require collaboration.

Furthermore, the open ambience at the Diamond provides a sense of learning community. Even though there are discussion activities in the space, the students undertaking individual study are tolerant of the distraction caused by the surrounding discussions to some extent. A respondent (ID3), at the Diamond, gave this explanation:

> *'In a silent study, I find it's harder to concentrate. Whether there's people talking or a bit of background noise, it helps me focus in on my work more.'*

Furthermore, the openness of informal learning spaces supports people watching and movement through the space, and the enjoyment of social life. Spatially, the openness reinforces an image that enriches student experiences in the campuses and an *'increased impression of the university'* (PN1). These enhanced spatial experiences improve the value of the informal learning space. As another participant (PN 3) mentioned:

> *' . . . I think the atrium space is the most important space for students. No matter if you have experiences in studying here or never come here before, it is the first place where people are paying attention to. . . . It is also a place of students' showroom.. I think it is the first impression of the space (Central Court at the Newton). ...'*

The participants also believed that staying in the atrium for a while before or after lecture helped them to relax. Meanwhile, the atrium is not only a place for gathering and multiple activities, but also a place to create memories. The participants were proud of having *'the fantastic learning environment'* at the Diamond (PD2) and the Newton (PN1). Universities therefore also have an opportunity to recruit students by promoting these atria spaces as a visual attraction (as illustrated in Figure 9).

(**left**) (**right**)

Figure 9. Openness of atrium in educational complexes of Diamond (**left**) and Newton (**right**).

The openness of informal learning spaces can support social interactions. Socialising activities, including casual chatting, taking a break from studies with friends, eating, attending events such as exhibitions, open days, coursework shows, finding the space as a route to a lecture room, gathering to go to another place together, people watching, etc., are observed as evidence to prove the existence of socialising activities occurring within the informal learning spaces. Meanwhile, this socialising ambience seems to be a key learning preference expressed by learners who viewed it as, *'designed as a place where students do whatever they want to do' (PN2)* at the Newton. These activities are seen as essential in these environments, with face-to-face social interaction being important to student experience [43]. One respondent (PD3) described this learning style at the Diamond in his own words:

> *' . . . we are in group discussions and, whatever you want to say and to do, you can do it in here . . . It is very convenient.'*

Meanwhile, another respondent (PN4) claimed that the socialising ambience made them feel 'rejuvenated' at the Newton. Furthermore, they provide for intermittent exchange: to study alone, but with occasional interaction with others. This type of student activity refers to learners undertaking their individual coursework but staying near to or next to peers who are known to them. This behaviour was also reported by Harrop and Turpin [21] who termed it *'working alongside'* (p. 16).

This provides a great place to support diverse activities. Meanwhile, the openness of the extended corridor space at the Newton was described as providing, *'sufficient and adequate furniture, provides opportunities for conversations that develop within the group discussion and a quick rush over certain details after lectures'* (PN5). This is also supported by O'Neill [13] as partly the reason why corridor spaces in both cases are used as learning spaces.

The spatial volume of the atrium provides an openness and multilayered quality, but there is a lack of research on how these characteristics impact individual preferences. Researchers evaluated the openness of atria spaces using 3D Isovists, which is a method of using a mathematical way to quantify the spatial openness of the atrium [44–46], but more research to examine this in the context of informal learning spaces is needed.

4.6. Other Support Facilities

Higher education is experiencing a rapid change in the 21st century. Consequently, the potential of new digital technologies is listed as one of the main characteristics of higher education practice [47,48]. The use of technology is perceived to meet not only current but future needs as well [49]. The informal learning spaces, designed to offer a combination of spaces that support individual activity and research as well as social learning activities, should enhance the impact of technology [50]. The quantitative analysis through questionnaires indicated that the IT- 'rich' environment at the Diamond is a bigger driver of use than at the Newton (as illustrated in bar 14 in Figure 7). Even though the usage of IT-rich environment involved a mixed pattern of use that supported research, communication, and other learning-related activities [51], this research cannot articulate how the technology helps students to engage in informal learning activities. However, it does influence students' choice of space and experience: *"I feel the space supports us well. Lots of tables are provided with lots of plugin and sockets. If you have your own computer, you can work here for a long time with sufficient electrical support. If you bring your battery charger for the phone, you can charge when you are waiting for your friends there." (PN2)*

Furthermore, the provision of the food and beverages outlets can contribute to making a space attractive to learners [12,26], especially to those who intended to stay for a longer time. Observations demonstrated that even though the café area supported almost all the dietary related activities at the Diamond, students were allowed to take snacks and even meals, such as sandwiches, into the other spaces in informal learning environment.

5. Conclusions

The design of the 21st-century learning environments in higher education to promote student learning experiences as well as meet the evolutional requirements of pedagogical theory attracted more and more attention, yet still requires further exploration and research. In particular, the design characteristics of informal learning spaces need to be considered from a holistic perspective, considering the spectrum of students' activities and their preferences. Nevertheless, the evaluation of the design characteristics of the informal learning spaces is affected by a dearth of empirical research. This research examined student preferences influencing their use and activities in informal learning spaces. The research suggests the needs and preferences of users to be better considered in the spatial design strategies for the informal learning spaces so that they can effectively contribute to the design of their facilities. The results of this research highlight six key spatial design characteristics, including comfort, flexibility, functionality, spatial hierarchy, openness, and other support facilities, that influence the use and activities of students in informal learning spaces. This exploration of spatial characteristics sheds new light on designing higher education informal learning spaces and how they can be analysed to generate empirical evidence. However, more comprehensive studies are required to enhance our understanding of these spaces and how students use them in different buildings, contexts, and climates.

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Appendix A. Questionnaire Form

You are invited to complete a questionnaire about your experiences of social spaces in the Newton Atrium at the Nottingham Trent University | the Diamond at the University of Sheffield. It should take approximately 10 min and some open questions will also be asked. As part of my PhD research I am exploring the impact of social spaces on students' experiences. The research will contribute to my advanced research study, be written up and submitted as a PhD thesis at the University of Nottingham.

All the data collected will be anonymous. Your name will not be linked to any of the data collected, and you will not be identified in the writing in the research. Your participation is entirely voluntary, and you can choose to stop taking part at any time you wish. The research was approved by UoN Department of Engineering ethics committee through a research ethics application. If you have any further enquiries, please contact me Xianfeng Wu: xianfeng.wu@nottingham.ac.uk

My research supervisors are:

Katharina Borsi: katharina.borsi@nottingham.ac.uk

Tim Heath: tim.heath@nottingham.ac.uk

By completing the questionnaire overleaf, you consent to take part in the research and give permission for me to access, analyse, and report the data that you provide.

Thank you for your time.

(1) Questions about activities.

a. How often have you done these activities in this social space per week? You can tick (✓) at the space given.

Subject	Scale				
	Never	**Slightly Frequently**	**Frequently**	**More Frequently**	**Most Frequently**
Focused Informal Learning (paper-based or book-based self-study)					
1. Prepared coursework	1	2	3	4	5
2. Discussed ideas from reading books or lectures	1	2	3	4	5
3. Worked with others on coursework	1	2	3	4	5
4. Study alone	1	2	3	4	5
Intermittent Exchange (information interchange)					

Subject		Scale				
		Never	**Slightly Frequently**	**Frequently**	**More Frequently**	**Most Frequently**
5.	Talked about career plans	1	2	3	4	5
6.	Study alone, but with occasional interaction with others	1	2	3	4	5
7.	Worked with others on activities other than coursework	1	2	3	4	5
8.	Received prompt feedback from the faculty on your academic performance	1	2	3	4	5
9.	Tutored or taught other students	1	2	3	4	5
10.	Had serious conversations with students of a different program or department than your own	1	2	3	4	5
Focused Socialising						
11.	Took a call	1	2	3	4	5
12.	Used of tablet, laptop, or phone	1	2	3	4	5
13.	Casual Chatting	1	2	3	4	5
14.	Took a break from studies with friends	1	2	3	4	5
Dietary Related Activities						
15.	Had a meal	1	2	3	4	5
16.	Had a snack	1	2	3	4	5
Serendipitous Encounter (Seeing, greeting, or short chats with each other because of encounter)						

Subject		Scale				
		Never	**Slightly Frequently**	**Frequently**	**More Frequently**	**Most Frequently**
17.	Met a friend of someone you know, but neither of you planned to	1	2	3	4	5
Ambient Sociality						
18.	Attended events such as Exhibitions, Open Days, or Coursework Shows	1	2	3	4	5
19.	Found the space as a way to a lecture room or gathering for going to another place together	1	2	3	4	5
20.	Used as a meeting point before or after lectures	1	2	3	4	5
21.	People watching	1	2	3	4	5
22.	Had a rest	1	2	3	4	5

b. During what time do you regularly use this social space? Please tick (✓) the time period when you use social spaces. You can tick (✓) more than one.

Time	Please tick (✓) if yes
8 am to 10 pm	
10 am to 12 pm	
12 pm to 2 pm	
2 pm to 5 pm	
5 pm to 7 pm	
7 pm to 10 pm	
10 pm to 0 am	
0 am to 8 am	

(2) Questions about the spatial experiences and perception of social informal learning spaces in higher education.

a. I select and use this social space because the space … Please tick (✓) the reason(s) of you select and use this social space. You can tick (✓) more than one.

I select and use this social space because the space . . .	Please tick
1. Provides comfortable light environments	
2. Provides comfortable noise environments	
3. Provides comfortable temperature	
4. Provides comfortable ventilation	
5. Provides comfortable colour/material of furniture	
6. Is flexible, adaptable, and diverse	
7. Provides informal ambience	
8. Support individual and group work	
9. Provides good view of seeing what other people are doing	
10. Provides good outside views	
11. Makes people feel easy for way finding	
12. Is easily accessible	
13. feels generous, open, and spacious.	
14. Provides other support (such as Wi-Fi, enough plugs and sockets, IT-rich environment)	
15. Other, please specify: _____	

b. Based on my experience, I think . . . Please rate how agree the following subjects described and tick how the height of the space (its vertical dimension) enhances this perception.

Subject	Scale				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Physical Comfort (Light)					
The space provides good natural light.	1	2	3	4	5
The space provides sufficient lighting after dark.	1	2	3	4	5
The space provides a good comprehensive light environment.	1	2	3	4	5
Physical Comfort (Acoustic)					
The noise level of the space is good for socialising.	1	2	3	4	5
The noise level of the space is good for informal learning activities.	1	2	3	4	5
Physical Comfort (Temp/Ventilation)					
The temperature of the space is adequate for socialising.	1	2	3	4	5
The temperature of the space is adequate for informal learning activities.	1	2	3	4	5

Subject	Scale				
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Windows and air condition can be controlled by myself.	1	2	3	4	5
Physical Comfort (Colour/Material of Furniture)					
The colours of furniture support a comfortable learning environment.	1	2	3	4	5
The materials of furniture support a comfortable learning environment.	1	2	3	4	5
The furniture is light weight and movable for reconfiguring according to its use by individuals or groups.	1	2	3	4	5
Flexibility (Adaptability)					
The space can be easily reconfigured in a short period of time for group and individual work.	1	2	3	4	5
The space is usable 24/7 and maximises use over time.	1	2	3	4	5
Flexibility (Diversity)					
The space supports a diversity of learning styles.	1	2	3	4	5
The space offers a combination of spaces that supports socialising and informal learning activities.	1	2	3	4	5
The availability of food and drink is important for using this space.	1	2	3	4	5
Ambience					
The space feels welcoming.	1	2	3	4	5
The space provides a good sense of learning community.	1	2	3	4	5
The space is attractive.	1	2	3	4	5
The space is stimulating.	1	2	3	4	5
The space is contemplative.	1	2	3	4	5
Functionality					
The space supports group work and collaboration.	1	2	3	4	5
The space supports individual study and learning.	1	2	3	4	5
The space provides opportunities for socialising.	1	2	3	4	5
The space provides opportunities to meet peers, friends, and acquaintances.	1	2	3	4	5

Subject	Scale				
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
The space supports casual learning activities.	1	2	3	4	5
The space appeals to students from different courses and encourages interdisciplinary learning.	1	2	3	4	5
Situation					
The space supports discussions about course content following lectures or seminars.	1	2	3	4	5
The space provides good outside views.	1	2	3	4	5
Adjacency					
The space makes people feel easy for way finding.	1	2	3	4	5
The staircase is accessible and destination reachable.	1	2	3	4	5
The broader, open staircase allows for travel between floors at a more leisure pace.	1	2	3	4	5
Hierarchy					
The circulation is helpful to increase opportunities for socialising (students can easily and accessibly meet up in this area because of sufficient and efficient staircases and lifts.)	1	2	3	4	5
The circulation is helpful to increase opportunities for informal learning (students can easily have discussions after courses or lectures in this area because of the convenient staircases and lifts.)	1	2	3	4	5
The location of the space is easily accessible.	1	2	3	4	5
Openness					
The space feels generous, open, and spacious.	1	2	3	4	5
The space provides good visibility of the activities of other people.	1	2	3	4	5

Subject	Scale				
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
The space is bright.	1	2	3	4	5
Other Support					
The space provides good Wi-Fi coverage.	1	2	3	4	5
There are enough plugs and sockets available.	1	2	3	4	5
The toilet is easily accessible.	1	2	3	4	5
The space provides an IT-rich environment.	1	2	3	4	5
The space provides food and beverage.	1	2	3	4	5
The space provides a sense of safety (provides evacuation marks/stair railing/guardrail/entrance guard/staff support/card only system).	1	2	3	4	5

(3) If you have any additional comments that you would like to make about any aspect of the building and your working environment, please note them here.

If relevant to a particular question, please give the question number.

(4) Questions about personal background information.

- Are you an international student? Please circle: Yes/No
- Gender, please circle: Male/Female/wish not to say
- Which department do you study or work in? Please write down: _____
- Mode of Study, please circle: Full-time/Part-time
- Level of Study, please circle: PhD/Undergraduate/Masters
- Type of Programme, please circle: Lecture-based/Studio-based/Lab-based
- Year (How many years have you studied here), please circle: less than 1/1-2/3-more

Appendix B. Interview Form

(1) Introduction

a. Welcome and introduction of interviewer
b. Objective Informal learning refers to student learning outside of designated class time. The objective of the informal interviews is to gather information for a research project investigating students' perceptions on how social informal learning spaces impact on student experience.
c. Process I will be taking audio record during the interview so I can revisit and reflect on the information provided. We respect your right to privacy. Our Ethical Clearance ensures that any information that is obtained in connection with this study and that could be identified as relating to you will remain confidential. If you decide to participate in the interview, you are free to discontinue participation at any time without prejudice.

(2) Questions

Personal Background Information

1. Could you please introduce yourself?
   (a) What's your occupation?
   (b) Which department are you in? What's your subject? Which year are studying?
   (c) Where is your nearest classroom or workplace?

Frequency, Activity, and Reasons

2. What brings you here?
3. Which types of activities do you normally do there?

If yes, please answer the following questions.
If not, skip questions 3 and proceed to question 4.

4. Which types of activities do your friends normally do there?
5. How often do you use this space as a whole? Why?

Student perceptions of social spaces/role in student experience

6. Who do you (all) think this space was designed for?

Use of space:

7. How do you (all) think this space should be used?
8. How do you (all) use it?
9. How do you think using the social informal learning space impacts on students' academic performance?
10. What are the three most important things about this space that you would not want to change?
11. What are the three most important things that you would like to change or add on these spaces?

Student voice:

12. What is your favourite social informal learning spaces story/memory?

Appendix C. Focus Group Form

Focus Groups Discussion Guide: The Impact of Informal Learning Spaces upon student experiences (1 h)

- Consent forms (xN per set of groups)
- Recorder (smart phone & iPad)
- Focus Group Registration Form

Time	
	Welcome and Introduction Provide respondents with: • Consent forms • Pens • Ask respondents to complete permission forms and collect in.
5 min	• Welcome participants and explain general purpose of the discussion: "Thanks very much for coming. This group is being run to understand your thoughts about the design quality of your learning experience at university/college and your ideas about it for the future. This is one of a series of groups being run with students as part of wider research project. The information will be used to help us improve the quality of students learning experiences and to better support a social informal learning spaces in the future."

Time	
5 min	• Explain confidentiality of opinions shared. • Explain that it is not a test and that we want an honest an open discussion. Explain that the group will: - Start off with a general discussion of university life - Move on to explore your expectations of different aspects of your learning experience in the social informal learning spaces - How things were whilst you were there - How you think things can be improved for students • The group will last about 1 h • Explain the presence and purpose of recording equipment (to help facilitator write up notes later rather than during the focus group) and ask for permission. • Explain that discussion notes will be analysed, and no personal data will be shared. • Set out ground rules (speaking up, one at a time, respect for others' opinions, etc.) • Go through any health and safety procedures for the building, timed fire alarms, etc. • Explain that I am a PhD student in the University of Nottingham and that all work is conducted ethically and in accordance with the UoN code of conduct • Explain that as participants in the research, the respondents are entitled to a copy of the final report if requested • Start recording
5 min	**Icebreaker** • Moderator to introduce themselves • Ask each person to please briefly: - Introduce themselves - Where they come from - which Subject, School & Department they study - which year they are in - If needed to break ice: What's your summer plan? Where is your hometown? What's your favourite food?
20mins	Students' experiences (preferences and activities) Question: a) What do you think of the space? b) How do social informal learning spaces support social & learning activities? Probes: peer learning/collaboration/support/Different degrees of informal learning process
15 min	**Design Quality** Ask respondents to identify key design quality of a successful social informal learning spaces based on their own experiences of learning and socialising activities by themselves and discuss what they wrote. Question: Thinking about the experiences of learning or socialising activities here, describe the characteristics of a successful social informal learning spaces. Prompts—this could include the likes of: The Physical Comfort: Light/Acoustics/Temperature/Ventilation/Furniture (Colour/Material) The Flexibility: Mobility/Adaptability/Diversity/Flexibility The Ambience: Socialising/Sense of Community/Informative /Attractiveness /Openness /Enclosure /Safety The Functionality: Support group work and collaboration/Supports individual learning The Situation: Location (continue classroom discussions immediately following class time)/Outside Views The Spatial Hierarchy: Circulation/ Legibility/Intelligibility/Privacy/Spacious The Other Support: IT-rich environment/Wi-Fi Coverage/Plugs and Sockets/Food and Beverage
15 min	**Space In-Between** Questions: What influence the design of the atrium gives you in the social informal learning spaces?
	Thank and Close • Thank them for all their help in this group.

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