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HUMAN-MADE SOUNDS IN INFORMAL LEARNING SPACES ON A UNIVERSITY CAMPUS

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Abstract. The university property management department has been facing a challenge with the strategic management of campus spaces due to the need for informal learning spaces (ILSs) to facilitate students' independent studies. However, there's limited research on how these ILSs perform, particularly concerning human-made sounds. This study delves into the impact of human-made sounds on students, considering their individual differences and positive experiences in various types of ILSs within an Australian university campus. The investigation includes open-ended questions to delve deeper into students' positive experiences with human-made sounds across different ILSs. The research findings demonstrate that the impact of human-made sounds on students is influenced by certain individual characteristics. Additionally, the study identifies three types of positive experiences regarding human-made sounds in ILSs for students: a sense of relaxation induced by human-made sounds, the sound-masking effect, and increased motivation for learning. This study could assist university property managers in understanding students' perceptions of human-made sounds and aid in strategic management of campus space that aligns with students' needs and preferences for ILSs, improving the overall learning environment and support student success.

Keywords: human-made sound, individual characteristic, informal learning space, questionnaire survey, thematic analysis, university campus.

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1. Introduction

The widespread accessibility and increasing utility of digital media are changing how information and communication technologies are used, which has had a vital impact on students' learning behaviors and the utilization of learning spaces (Parry et al., 2020; Kaklauskas et al., 2012; Zhang et al., 2022). Mobile and information technologies are becoming the core of individual experiences, transforming the learning environment from a passive background to an active agent that positively influences campus culture and students' behaviors (King, 2016). Studying at high education institutions is a basic route of knowledge and skills enhancement for built environment professionals (Tan et al., 2017). Classrooms and lecture halls are not the only places for students to learn and gain knowledge on campus and students have a preference for learning informally or independently in the public spaces on campus (Anggiani & Heryanto, 2018). Informal learning spaces (ILSs) have become the most popular learning and social spaces for students (Painter et al., 2013). The public image on contemporary university campuses has been prepared for students' informal learning activities with more flexibility, collaboration, engagement, and independence on the site (Hong et al., 2022; Ramu et al., 2022; Wang, 2022).

Learning at university is a complicated process, which is a product of interactions among students, lectures and various learning spaces (Hsu et al., 2022; Zhang et al., 2023). Compared with traditional classrooms, which have strict rules to control the sound environment and regulate students' behaviors, ILSs on university campuses are permissive spaces where students are allowed to conduct non-learning activities in addition to learning activities, resulting in the sounds generated in ILSs being diverse and complex. Sound environments have become more and more important in meeting diverse needs of students on university campuses (Hong et al., 2022; Li et al., 2021). Poor sound environments of education facilities affect students' performance, harm their feelings and negatively influence students' learning outcomes (Beh et al., 2022; Nja et al., 2023). Consequently, ILSs have brought various practical challenges to the property department of a university to facilitate students' independent studies.

Non-learning activities in ILSs lead to the production of many sounds created by users. In some studies related to learning or office environments, the effects of different categories of sound sources on uses have been explored. For example, Kang et al. (2017) explored users' perceived disturbance levels towards different sound sources in the office environment, including indoor and outdoor sound sources. Jo and Jeon (2022) illustrated effects of indoor soundscape perception based on audiovisual content on work-related quality. They focused on indoor sound sources which contain sounds produced by users and facilities. A comparative study on indoor soundscape assessment in the learning environment was explored by Topak and Ylmazer (2022). Existing indoor and outdoor sound sources are all included in their research. Until now, there is little research that specifically focuses on the effects of human-made sounds on university students. With the focus on ILSs in this study, human-made sounds are defined as the indoor categories of sound that are generated by students and can be heard by students in indoor spaces. The effects of human-made sounds are an important factor in defining the prerequisites of a good learning environment and distinguishing ILSs from other kinds of open-plan spaces.

The physical environment of ILSs directly influences users' productivity, health, and comfort (Rasheed et al., 2021). In informal learning processes, learning and socializing are two complementary elements, and ensuring a high-quality sound environment for a learning space is essential (Lee et al., 2022). Norazman et al. (2021) proposed that students' achievement is partly impacted by factors which include sound environments. As one of the most important physical attributes, the effects produced by sound are complex, including physiological, social, and psychological effects on users (Mahbub et al., 2010). It is necessary to evaluate the effects produced by human-made sounds because the potential effects of human-made sounds on users are closely related to students' subject responses to sound environments (Bansal et al., 2019).

2. Research hypotheses

The sound generated by learning activities is the most common sound occurring in ILSs on a university campus. This sound is a particular type of sound that distinguishes ILSs from other kinds of open-plan spaces. The sound generated by learning activities includes the sound of writing, the sound of flipping through books, and so on. Until now, there has been little research focused on the effects of sound generated by learning activities on students. Conversation sound has been shown in many studies to be one of the most uncontrollable sounds. It is also likely the most annoying sound (Jo & Jeon, 2022). Astolfi and Pellerey (2008) conducted in-depth exploration of conversation, proposing that, compared to continuous conversations, intermittent conversations tend to annoy users. In addition to speech-related sound, the sound of phones ringing also has a negative effect on the performance and satisfaction of users (Jo & Jeon, 2022). The sound produced by entertainment was of concern to Kang et al. (2017), who demonstrated that this is one of the most disturbing sounds. Topak and Ylmazer (2022) proposed that students evaluate the sound produced by keyboards as a part of learning environments. They also found that the sound of footsteps is evaluated as neither annoying nor relaxing.

These seven sounds mentioned above, including the sound produced by learning activities, the sound produced by entertainment, continuous conversation, intermittent conversation, the sound produced by phones ringing, the sound produced by keyboards and mouse clicking, and the sound produced by footsteps are identified as the most commonly present sounds in ILSs through the observation of the researchers in this study. Combining the fact that these seven sounds have been proven to have effects on users, these sounds are categoried as human-made sounds and will be further explored in this research.

The complex effects of sound in terms of auditory response have been described using certain attributes by many studies, defined as influence thinking (Banbury & Berry, 2005), distraction (Rane et al., 2022), and annoyance (Minichilli et al., 2018). Until now, most studies have focused on the negative effects brought by sounds occurring in open-public spaces, which include ILSs. Some studies have tried to explore the positive effects produced by sounds. For instance, Bennett (2007) found that a quiet environment is often considered not conducive to learning. Most students enjoy a learning environment that, along with some sounds and activities, makes them integrated into the learning environment. Topak and Ylmazer's (2022) research indicated that some students have positive responses towards educational facilities' sound environment, which were exemplified as promoting relaxation and motivation. Some students feel that when there are some sounds and activities around them, it can help them keep awake (Bennett, 2007). In this study, influencing thinking, being distracting, being annoying, keeping awake, keeping relaxed, and keeping motivated are used to describe the effects produced by sound environments in ILSs. Influencing thinking, being distracting, keeping awake, and keeping motivated are used to explore the impact of sound environments on students' learning. Being annoying and keeping relaxed are used to explore the impact of sound environments on students' emotions.

A positive sound environment perception can promote students' concentration, attention, focus, and mood in a learning environment (Topak & Ylmazer, 2022). Acun and Yilmazer (2018) found that users in an open-plan office prefer neither a quiet nor a noisy environment. However, although these studies suggest that some sound environments may bring about positive effects, few studies have analyzed which sounds can bring about positive effects or what kind of positive effects. In this study, the six effects of human-made sounds are called: influencing thinking, being distracting, being annoying, keeping awake, keeping relaxed, and keeping motivated. However, the effects of these human-made sounds on students based on

students' individual differences are not clear. Therefore, the first hypothesis in this study is as follows:

Hypothesis 1: Human-made sounds have significantly different effects on students based on student's individual characteristics.

As the educational concept shifts from a teacher-centered approach to a student-centered approach in higher education, the effects of learning spaces on students have been paid increasing attention and it has become important to focus on students' environmental experiences (Matthews et al., 2011). Current students are exposed to the Internet and interactive digital technology, and their behaviors and environmental experiences could result from their overstimulated brains. Students have developed the ability to switch their attention and do multiple tasks comfortably at the same time. Repeated engagement in multiple tasks which need continual attention shifts, which leads to students' brains being chronically overexcited. Human-made sound stimulation can help students stay wake and arouse their excitement, which may be able to explain why human-made sounds can bring about some positive experiences Studying in quiet spaces without human-made sound stimulation will become boring and make students get tired easily, just as they may be easily bored listening to lectures.

Therefore, this study speculates that when choosing ILSs independently, students will consider the availability of certain stimulating environmental features, such as human-made sounds, to help them have positive experiences when learning in the ILSs. In this research, students' positive experience of human-made sounds is defined as the positive feeling brought about by human-made sounds. It is a complex psychological feeling felt by students by means of auditory sensations. Hence, this study formulates the following hypothesis:

Hypothesis 2: The auditory sensations brought by human-made sounds can provide students with positive experiences, such as relaxation, sound-masking effect and increased learning motivation.

3. Research methodology

The research methodology of this research consists of three parts: questionnaire design, analysis methods for questionnaire, and data collection and statistical description. An empirical study was conducted to carry out this research at the Geelong Waterfront Campus of Deakin University in Australia. Ethics approval was granted by Deakin University before the study commenced, indicating that ethical considerations were in accordance with data collection, analysis, and storage.

3.1. Questionnaire design

A questionnaire survey has been adopted to explore the effects of human-made sounds on students based on students' individual differences, as well as students' positive experiences of human-made sounds in different ILSs. The questionnaire consisted of three parts. The first part covered the participants' individual characteristics. There are several studies have examined the relationship between the learning environment and individual differences. The effects of learning environment on users differ according to their gender and birthplace (Wu et al., 2021), enrollment type (Montgomery, 2014), the type of task in which the users are engaged (Cunningham & Walton, 2016; Villa & Labayrade, 2016), expected duration of stay (Hunter & Cox, 2014), visit frequency (Cunningham & Walton, 2016), and study location (Beckers et al., 2016; Vanichvatana, 2020), Based on the above-existing research, individual characteristics of this study include gender, enrollment type, birthplace, work category, expected duration of stay, visit frequency, and location selection. Differences between students in these individual characteristics may reflect differences in various perceptual properties, implying differences in response to the sound environments in ILSs.

To explore the effects of human-made sounds on students, the second part of the questionnaire was designed to evaluate the effects produced by the different human-made sounds in the form of multiple-choice questions. Human-made sounds include the sound produced by learning activities, the sound produced by entertainment, continuous conversation and intermittent conversation, the sound produced by phones ringing, the sound produced by keyboards and mouse clicking, and the sound produced by footsteps. The effects of human-made sounds on students included influencing thinking, being distracting, being annoying, keeping awake, keeping relaxed, and keeping motivated. For each human-made sound, students chose one or more effects brought about by this sound. Appendix A provides detailed information about the questionnaire design, including information on the participants' individual characteristics, the human-made sounds that occurred in the ILSs, and the effects produced by each human-made sound.

Open-ended questions were designed for Part 3 as the information provided by students was the most valuable in understanding their subjective experiences of the human-made sounds. As presented in Appendix A, based on students' selection of multiple answers for each sound source in Part 2, students were asked three open-ended questions in Part 3. The first question was: "Can you explain why human-made sounds can have positive effects on you, including keeping you awake, relaxed, and motivated?", followed by the question: "Can you describe the positive effects brought about by the human-made sounds in this space besides keeping you wake, relaxed, and motivated?" The last question focused on students' subjective experiences by asking: "Do you have anything else to describe about the positive effects produced by human-made sounds in informal learning spaces?"

3.2. Analysis methods for questionnaire

Chi-square goodness-of-fit tests were used to evaluate how the seven different human-made sounds are related to students' individual characteristics. Before chi-square

goodness-of-fit tests, chi-square tests were run to explore the independence between all individual characteristics and the effects caused by different human-made sounds. As a type of statistical procedure, the chi-square test is used to determine the level of independence between categorical variables. It is intended for feature tests that are independent of one another (Ratul et al., 2022). In this study, the categorical variables of gender, birthplace, and location selection only had two groups, so chi-square goodness-of-fit tests were used to analyze the significant differences between these categorical variables and the human-made sounds. The chi-square goodness-of-fit test allows researchers to check the adequacy of a specified model by evaluating the discrepancy between the dataset and the hypothesized model (Vital & Patil, 2021).

The data obtained from the open-ended questions in Part 3 was then analyzed using thematic analysis. Braun and Clarke (2006) defined thematic analysis as a method for identifying, analyzing, and reporting themes in data. It organizes and describes the data in rich detail and even interprets various aspects of the research questions. By focusing on meaning across a dataset, thematic analysis allows researchers to see and make sense of collective or shared meanings and experiences. It is notable that identifying unique meanings and experiences found only within a single data item is not the focus of thematic analysis. The method is a way of identifying what is common to the way a topic is talked or written about and of making sense of those commonalities. The themes that thematic analysis allows researchers to identify need to be important in relation to the research question.

In accordance with Braun and Clarke's six-phase procedure for thematic analysis, the researcher first became familiar with the data. In this stage, they read and re-read the data, and noted down their initial ideas. Stage 2 was the generation of initial codes, which were interpreted to provide and identify labels for the characteristics of the data that were potentially relevant to the research question. Then the data identified by the same code was collated together. The following three stages, including searching for themes, reviewing themes, and defining and naming themes, aimed to identify the sub-themes and themes related to the research questions. A theme captures something important about the data in relation to a research question (Braun & Clarke, 2006). The codes created in stage 2 were linked and grouped into potential sub-themes and themes. Each sub-theme and theme was reviewed by the researcher to ensure that it reflected not only the relevant coded extract, but also the entire dataset. Then the themes were finally defined and refined by attributing clear definitions and names to them. Stage 6 was the production of the report, which aims to tell the story of the data in a way that convinces readers of the strength and validity of the data analysis. In this study, the themes refer to students' positive experiences of the human-made sounds in different ILSs.

3.3. Data collection and statistical description

An empirical study has been conducted to carry out the above-described research at the Geelong Waterfront Campus of Deakin University in Australia. The campus, which was originally built for wool stores in the 19th century, has been extensively renovated to create a modern and impressive education property. As shown in Figure 1, Building D on the campus was selected as the case study building because it provides various spaces for students to choose for a variety of needs individually or in groups. This case study building is a complex facility with classrooms, computer laboratories, a library, an atrium space, a cafeteria, offices, indoor parking, and in-between spaces in addition to ILSs. The first floor of the building mainly contains a staff parking area, a computer lab, a few staff offices, and a public cafeteria. These spaces are not popular for learning activities and thus the first floor has been excluded in this study. All ILSs on floors 2, 3, and 4, which are abbreviated to F2, F3, and F4, respectively, in this paper, are labeled from A1 to A26 in Figure 1.

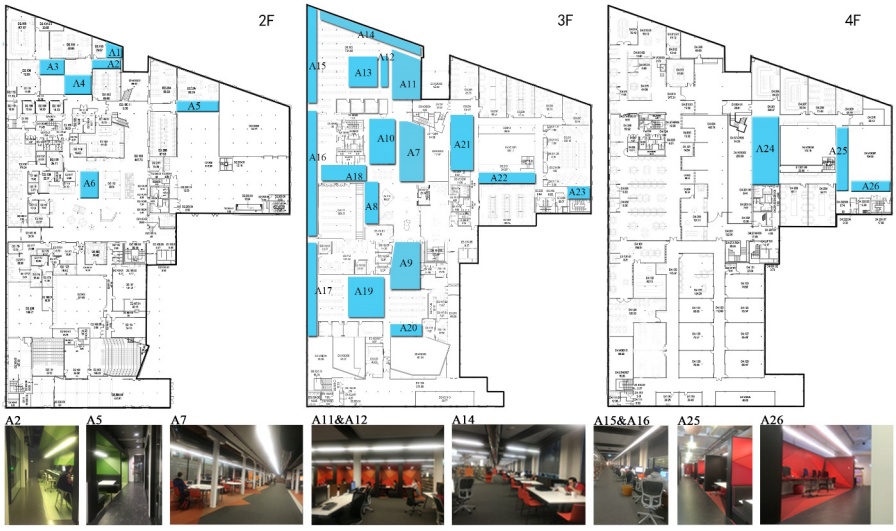

Figure 1. Distribution of all ILSs on each floor in Building D of Geelong Waterfront Campus of Deakin University

Table 1. Individual characteristics of surveyed students

Individual characteristic	Descriptive statistics % (no.)			
Gender	Male	Female		
	42.5%	57.5%		
Enrollment type	Bachelor	Master's	PhD	
	60.3%	26.0%	13.7%	
Birthplace	Australia	Not Australia		
	48.9%	51.1%		
Work category	Examination preparation	Course assignment	Academic research	Other
	8.7%	69.9%	19.2%	2.3%
Expected duration of stay	<1 h	1–3 h	>3 h	
	3.2%	31.1%	65.8%	
Visit frequency	Daily	Weekly	Monthly	
	39.7%	54.8%	5.5%	
Location selection	At home	At university		
	14.2%	85.5%		

The questionnaire survey was conducted in the morning from 9:00 to 10:00 am and the late afternoon from 3:00 to 4:00 pm. These time periods were selected because the focus spaces in this study were sporadically occupied then and so students could choose their spaces according to their needs rather than making passive selection of spaces, which helped to ensure that students' choices were more autonomous and truthfully reflected their space preferences. A total of 264 questionnaires were received of which 219 were valid, making a valid response rate of 82.95%. The invalid questionnaires were those not completed, with highly repetitive answers to multiple questions, or with unwilling selection of preferred ILSs. The latter represents those students who selected the option "I do not like this location" for the question: "Why do you choose to study at this location?". Therefore, the valid answers in the questionnaire data only included those students who thought that their locations were their favourite ILSs or satisfactory choices if not the best. The percentages of these two types of students were 61.2% and 38.8%, respectively.

The individual characteristics of the students who participated in the questionnaire survey are presented in Table 1.

It is worth pointing out that no participant chose the option "prefer not to say" for the item "gender" in the questionnaire or the option "others" for the item "enrollment type". For simplicity, "prefer not to say" and "others" are not included in Table 1 and neither is taken into account in the remainder of this paper. The proportions of male and female students were 42.5% and 57.5%, respectively, and the proportions of Australian and non-Australian students were 48.9% and 51.1%, respectively. The enrollment type of most respondents was a bachelor's degree with a percentage of 60.3% and only 13.7% of them were PhD students. About 69.9% of participants went to the ILSs to do course assignments, and 19.2% and 8.7% were working on academic research and examination preparation, respectively. More than half of them (65.8%) expected to stay in the ILSs for more than three hours and only 3.2% of students stayed for less than one hour. Up to 94.5% of participants came to the ILSs weekly or daily, of whom 39.7% came every day. When choosing a learning space, 85.5% of participants preferred to study at university rather than at home. The survey data on expected duration of stay, visit frequency, and location selection indicates that ILSs are the most important learning spaces for most students. These results also verify that the ILSs on university campuses play a vital role in student learning activities.

4. Effects of human-made sounds on students based on their individual characteristics

The effects of each human-made sound on students based on their individual characteristics are explored. The *p*-values and chi-square values (χ^2) shown in Table 2 present significant differences between the individual characteristics and the effects caused by the different human-made sounds (p-value < 0.05), which include significant differences between enrollment types and the sound caused by learning activities (χ^2 = 22.470, p-value = 0.013). Table 2 also presents significant differences between birthplace and the sound produced by learning activities (χ^2 = 12.193, p-value = 0.032), between birthplace and the sound produced by entertainment (χ^2 = 16.916, p-value = 0.005), between birthplace and continuous conversation (χ^2 = 18.740, p-value = 0.002), and between birthplace and the sound produced by phones ringing (χ^2 = 31.240, p-value = 0.000). Significant differences between work category and the sound caused by learning activities (χ^2 = 24.575, p-value = 0.046) and between visit frequency and the sound generated by phones ringing (χ^2 = 21.811, p-value = 0.016) are also shown in Table 2.

Table 2. Chi-square test results between each human-made sound and students' individual characteristics

Human-made sound		Gender	Enrollment type	Birth place	Work category	Expected duration of stay	Visit frequency	Location selection
Learning activities	*p*-value	0.618	0.013*	0.032*	0.046*	0.272	0.679	0.479
	chi-square	3.539	22.470	12.193	24.575	12.205	7.489	4.506
Entertainment	*p*-value	0.517	0.216	0.005**	0.244	0.261	0.864	0.690
	chi-square	4.228	13.148	16.916	18.362	12.372	5.392	3.067
Continuous	*p*-value	0.803	0.081	0.002**	0.568	0.689	0.491	0.382
conversation	chi-square	2.320	16.704	18.740	13.445	7.377	9.440	5.289
Intermittent	*p*-value	0.506	0.107	0.061	0.484	0.552	0.354	0.536
conversation	chi-square	4.309	15.761	10.573	14.559	8.793	11.051	4.097
Phones ringing	*p*-value	0.133	0.101	0.000**	0.796	0.557	0.016*	0.709
	chi-square	8.455	15.944	31.240	10.365	8.737	21.811	2.943
Keyboards &	*p*-value	0.692	0.336	0.231	0.339	0.680	0.271	0.299
mouse clicking	chi-square	3.050	11.278	6.870	16.665	7.470	12.218	6.077
Footsteps	*p*-value	0.809	0.735	0.297	0.463	0.391	0.930	0.314
	chi-square	2.278	6.901	6.101	14.847	10.578	4.355	5.922

Note: * Correlation significant at 0.05 level (two-tailed). ** Correlation significant at 0.01 level (two-tailed).

Table 3. Effect of different human-made sounds that have significant differences based on students' individual characteristics

Human-made sound	Effect	Individual characteristic				chi-square	*p*-value
		Birthplace					
		Australian	Non-Australian				
Learning activities	Keeping awake	11	29			8.100	0.004**
Entertainment	Influencing thinking	5	26			14.226	0.001**
Continuous conversation	Influencing thinking	9	35			15.364	0.001**
Phones ringing	Influencing thinking	5	25			13.333	0.001**
	Being annoying	44	75			8.076	0.004**
		Enrollment type					
		Bachelor	Master's	PhD			
Learning activities	Keeping awake	30	17	4		19.882	0.001**
	Keeping relaxed	28	8	1		31.838	0.001**
	Keeping motivated	39	10	7		33.464	0.001**
		Work category					
		Examination preparation	Course assignment	Academic research	Other		
Learning activities	Influencing thinking	0	18	39	1	37.483	0.001**
	Being distracting	5	13	30	3	35.510	0.001**
	Being annoying	2	12	20	2	10.667	0.005**
	Keeping awake	3	31	6	0	35.450	0.002**
	Keeping motivated	2	43	11	0	49.750	0.001**
		Visit frequency					
		Daily	Weekly	Monthly			
Phones ringing	Influencing thinking	37	18	5		25.900	0.001**
	Being distracting	34	58	7		39.455	0.001**
	Being annoying	54	62	3		51.647	0.001**

Note: ** Correlation significant at 0.01 level (two-tailed).

After determining the significant differences in terms of the effect of each human-made sound based on students' individual characteristics, which specific effects of each human-made sound had significant differences based on students' individual characteristics is explored. Table 2 shows that four of the seven human-made sounds, including the sound caused by learning activities, the sound caused by entertainment, the sound of continuous conversation, and the sound caused by phones ringing, had significant differences in terms of students' enrollment type, birthplace, work category, and visit frequency. Appendix B only present the numbers of students who have significant differences in terms of the effects

of each human-made sound on their individual characteristics based on the results shown in Table 2. Based on the numbers of students presented in Appendix B, chi-square goodness-of-fit tests were then used to analyze the significant differences between each kind of effect produced by the sound of learning activities, the sound of entertainment, the sound of continuous conversation, and the sound of phones ringing in terms of individual characteristics including enrollment type, birthplace, work category, and visit frequency.

As shown in Table 3, the *p*-values and chi-square values (χ^2) show a significant difference between Australians and non-Australians in terms of the effect of keeping awake produced by the sound of learning activities (χ^2 = 8.100, *p*-value = 0.004). Non-Australians perceived that this sound brought a feeling of keeping awake, significantly higher than for Australians. The sounds caused by entertainment and continuous conversation had differential effects based on students' birthplace. More non-Australians believed that the sounds caused by entertainment and continuous conversation influenced thinking, compared with Australians (χ^2 = 14.226 and 15.364, *p*-value = 0.001 and 0.001, respectively). Meanwhile, more non-Australians believed that the sound caused by phones ringing influenced thinking and made them feel annoyed when compared with Australians (χ^2 = 13.333 and 8.076, *p*-value = 0.001 and 0.004, respectively).

In terms of the different enrollment types, compared with master's and PhD students, bachelor students were more likely to think that the sound caused by learning activities could help keep them awake, keep them relaxed, and keep them motivated (χ^2 = 19.882, 31.838 and 33.464, *p*-value = 0.001, 0.001, and 0.001, respectively). In terms of different work categories, the sound caused by learning activities had a differential effect based on the different work categories. Compared to other work categories, students doing course assignments were more likely to give positive feedback on the sound generated by learning activities, including the feelings of keeping awake and keeping motivated (χ^2 = 35.450 and 49.750, *p*-value = 0.002 and 0.001, respectively). Students doing academic research had a strong correlation with the negative feelings of influencing thinking, being distracted, and being annoyed (χ^2 = 37.483, 35.510 and 10.667, *p*-value = 0.001, 0.001, and 0.005, respectively). The effects of the sound of phones ringing on students who came to ILSs at different frequencies are also different. Compared with students who came to ILSs monthly, students who came to ILSs daily and weekly were more likely to feel the sound caused by phones ringing influenced thinking, were distracting, and were annoying (χ^2 = 25.900, 39.455 and 51.647, *p*-value = 0.001, 0.001, and 0.001, respectively).

5. Students' positive experiences of human-made sounds in different ILSs

Students' positive experiences of the human-made sounds in ILSs were analyzed through open-ended questions in Part 3 of the questionnaire. After all the data from the participants was translated into transcripts, thematic analysis to refer to students' positive experiences of human-made sounds in different ILSs was conducted and the results are presented in Table 4. The refined themes were: a sense of relaxation induced by human-made sounds, and increased motivation for learning. Two sub-themes were further identified for each of these three themes.

5.1. A sense of relaxation induced by human-made sounds

The first theme is a sense of relaxation induced by human-made sounds and it is divided into two sub-themes: relaxation from the learning environment and relaxation from entertainment. Compared with formal learning spaces, which have less relaxing learning environments, ILSs provide students with relaxed learning environments. As shown in Table 4, one student described the reason they chose a noisy learning environment: "In a causal and noisy learning environment, I can study at my own pace and do not feel the pressure of studying in a quiet space" (participant in ILS A10). ILSs with different human-made sounds become an outlet for students to release their pressure.

Relaxation from entertainment was also one of the reasons that attracted students to the ILSs. Sometimes students just wanted to do other activities unrelated to learning. As presented in Table 4, one student who had just finished a long day of lectures said that: "Sometimes I just want to relax or take it easy, especially after a long day of lectures. This kind of learning space helps me escape the pressure of the course. The background environment makes me feel relaxed, chatting, watching movies, or even humming along … and nobody cares" (participant in ILS A24). Some students seemed to be attracted to learning spaces where they could make noise because the ability to make noise enabled them to enjoy a relaxed environment. In addition to providing learning opportunities, ILSs also provide students with the possibility of entertainment.

5.2. Sound-masking effect

The second theme is the sound-masking effect, which is divided into two sub-themes: acquisition of sound privacy and noise-masking comfort. Acquisition of sound privacy is one of the most important indicators which affected the comfort of communication. Sound privacy can be obtained through the partition or isolation of spaces, or the masking of meaningless sound (Tamesue et al., 2006). Since this study focuses on students' positive experiences of human-made sounds, the acquisition of sound privacy is explored from the perspective of the sound-masking effect. Some ILS units such as A10 are situated in active and public areas with a variety of human-made sounds generated by learning and non-learning activities. This kind of ILS can obtain good sound privacy with the masking effects of various sounds. One student said: "I like to be in a noisy space when I have some academic discussions that I do not want to be heard by others" (participant in ILS A12).

The sound-masking effect also occurred when students' conversation was rendered less audible due to the presence of other types of sound. In this condition, some types

of sounds became acceptable. Sometimes students chose ILSs where they could make noise in a relaxed environment without the stress of disturbing others. One student said: "I like this space because I can eat, or causally chat with my friends in the process of learning. I do not need to worry about disturbing others, because all students here are the same as me" (participant in ILS A7). In a noisy learning environment, the effect of one's own sound seems to be weakened by the various sounds made by other students. As a result, students feel comfort and freedom when making noise such as answering the phone or discussing questions.

5.3. Increased motivation for learning

The third theme is increased motivation for learning and is divided into two sub-themes: the company of other students and integration into the learning atmosphere.

The company of other students meant those students who preferred to be surrounded by others when choosing a learning space; as one student said: "I come here to study for the company of other students and the sounds they make always remind me of their presence" (participant in ILS A17). Different from individual learning and collaborative learning, under the company of other students, a student studies along with other students who are studying, sharing a learning space but learning separately rather than participating in a joint project.

Some students preferred to be able to integrate into the learning atmosphere through background sound while maintaining visual privacy. Table 4 presents one student's description: "Study booth is private enough for me to concentrate on learning. It prevents me seeing students moving, eating, and talking, but still lets me merge into the buzzing learning environment" (participant in ILS A19). Vo (2015)'s

Table 4. Representative data for each sub-theme

Theme	Sub-theme	Data
A sense of relaxation induced by human-made sounds	Relaxation from learning environment	"I do not like sounds of learning activities, but I feel relaxed when I hear people talking, moving, or making phone calls." (Participant in ILS A14) "I like to study in a relaxed and noisy environment, because too many people intensely working make me nervous. I never care what kind of sounds other people make." (Participant in ILS A7) "In a causal and noisy learning environment, I can study at my own pace and do not feel the pressure of studying in a quiet space." (Participant in ILS A10)
	Relaxation from entertainment	"Sometimes I just want to relax or take it easy, especially after a long day of lectures. This kind of noisy environment helps me escape the pressure of the course. The background environment makes me feel relaxed, chatting, watching movies, or even humming along … and nobody cares." (Participant in ILS A24)
Sound-masking effect	Acquisition of sound privacy	"Sometimes my friends and I like to rant out or share the latest gossip. In this kind of space, I feel no one is going to hear what we are talking about. It is like our conversation is being buried in the buzzing noise." (Participant in ILS A9) "I like to be in a noisy space when I have some academic discussions because I do not want to be heard by others." (Participant in ILS A12)
	Noise-making comfort	"I like this space because I can eat or causally chat with my friends in the process of learning. I do not need to worry about disturbing others, because all students here are the same as me." (Participant in ILS A9) "I feel uneasy when I make some noise in a very quiet learning environment because every sound seems to be amplified in this environment, such as answering the phone … or eating. But in this space, sounds produced by others can mask what I am doing, so I feel very safe and relaxed." (Participant in ILS A21) "Sometimes I like to study in a noisy environment so that I can talk with my friends without making people feel bothered by our conversation." (Participant in ILS A18) "I like this space because I can eat, or causally chat with my friends in the process of learning. I do not need to worry about disturbing others, because all students here are the same as me." (participant in ILS A7)
Increased motivation for learning	Company of other students	"I do not like being the only one studying here. I feel better knowing others are awake, especially when I hear the sound of keyboards or mouse clicking." (Participant in ILS A15) "I come here to study for the company of other students and the sounds they make always remind me of their presence." (Participant in ILS A14) "I like people around me and talking." (Participant in ILS A17) "I zone out easily when the learning environment is too quiet." (Participant in ILS A2)
	Integration into learning atmosphere	"Even as a silent audience, I feel like I am participating in their learning." (Participant in ILS A16) "Study booth is private enough for me to concentrate on learning. It avoids me seeing students moving, eating, and talking, but still lets me emerge into the buzzing learning environment." (Participant in ILS A19) "I like to study here because others' academic discussions give me access to broader exposure to academic opportunities and enrich my learning experiences." (Participant in ILS A4) "I feel present and connected with the surroundings through the background sounds, such as people talking or phones ringing." (Participant in ILS A25)

study explained this need, finding that visual distraction was more negative toward students' performance than audio distraction. Many students tried to minimize visual distraction but still feel present in or connected with the learning environment through human-made sounds. Other students preferred a vibrant environment because they felt that appropriate noise made it easier for them to concentrate on their studies and improved work productivity. As one student said: "Even as a silent audience, I feel like I am participating in their learning" (participant in ILS A16). Arousal theory can be used to explain acquisition of work productivity brought about by the stimulation of human-made sound in ILSs. People's performance develops in an inverted U-shape as the stimulation increases. Performance is at its best when the level of stress or stimulation reaches a certain intensity (Broadbent, 1978; Szalma & Hancock, 2011). The role of arousal theory shows that some sounds may improve rather than degrade performance, which means that the learning was best when the students were stimulated by the level of sound. In other words, the auditory sensations brought by human-made sounds can provide students with positive experiences, such as relaxation, sound-masking effect and increased learning motivation.

6. Conclusions and discussion

This study focuses on students in ILSs at the Geelong Waterfront Campus of Deakin University. Two hypotheses are proposed to examine the effects of human-made sounds on these students. The partial acceptance of Hypothesis 1 suggests that a quiet learning environment does not always correlate with effective learning, as human-made sounds impact students differently based on their individual characteristics. The acceptance of Hypothesis 2 indicates that students respond positively to the sound environment, which enhances their learning motivation.

To satisfy diverse sound environment needs of different students in ILSs, the creation of various types of learning spaces to is essential. University property management departments need to take into account students' individual differences, including gender, birth location, enrollment type, and work category, is crucial to providing comfortable learning environments for diverse student groups. For example, in terms of gender differences, offering female-friendly learning spaces to accommodate the higher privacy needs of female students is important. Considering students from different birth locations and countries, ILSs can be designed incorporating various international design styles to enhance a sense of spatial belonging for non-Australian students, providing them with a sense of emotional comfort. Concerning the differences in spatial requirements based on enrollment type and work category, learning spaces suited to the needs of different educational levels and work categories should be designed. For instance, more specialized research spaces such as quiet and private spaces can be provided for PhD students, while more social and interactive learning spaces can be offered to bachelor and master's students. Furthermore, it is essential to create a variety of ILSs to meet the diverse needs of students, including spaces with high privacy for individual learning and spaces with high interactivity for collaborative learning. On one hand, in ILSs with high privacy, measures for privacy protection, such as the design of study booths and study areas with closable doors, should be provided. On the other hand, in ILSs with high interactivity, designs should encourage collaborative interaction through suitable spatial layouts and furniture arrangements. Providing these diverse learning spaces at different locations on campus would enable students to choose the most suitable place for their preferences and needs.

Dividing learning spaces into different sound zones based on students' various activities is crucial. University property management departments can provide different spaces suitable for quiet study, collaboration and discussion, or occasional interaction. Utilising tools such as movable screens, partitions, or furniture that allow students to adjust the sound environment can also provide greater flexibility for learning. Furthermore, offering students sound-control tools like headphones, white-noise machines, and noise-cancelling headphones would help them manage the sound environment independently when necessary. In addition, providing guidelines to students about sound environments, including how to effectively utilize various sound environments for learning, is essential. Promoting the presence of positive sounds in learning spaces, including noises generated by learning activities such as keyboard sounds, would encourage active engagement in a rich learning environment. Finally, learning space administrators need to ensure good sound quality in learning spaces, including effective sound isolation and absorption equipment to minimise noise disturbance. Providing information about different types of learning spaces to students through signage or space index guides would assist them in selecting spaces that suited their learning needs. Conducting regular surveys to assess students' satisfaction with the sound environments in learning spaces and gathering feedback would enable continuous improvement in the design and functionality of these spaces, ensuring these ILSs meet students' sound environment needs.

Hypothesis 1, that human-made sounds have significantly different effects on students based on their individual characteristics, is partially accepted. ILSs on campus have better sound environments than the open-plan spaces in general public buildings because ILSs can provide ambient human-made sounds related to learning or non-learning activities. During the learning process, a quiet learning environment does not necessarily mean that students can concentrate on learning. Therefore, in the context of the cost–benefit assessment of sound-control procedures, the first thing that university property management departments need to do is to understand how students perceive and react to different human-made sounds and it is necessary to concentrate on controlling human-made sounds that bring about more prominent negative effects.

Hypothesis 2, that the auditory sensations brought by human-made sounds can provide students with positive experiences, such as relaxation, sound-masking effect and increased learning motivation, is accepted. Three types of students' positive experiences of human-made sounds in different ILSs were described in this research, including a sense of relaxation induced by human-made sounds, a sound-masking effect, and increased motivation for learning. This finding shows the positive effects of ILSs with rich human-made sounds. Students' participation in ILSs even when not communicating with others seems to inspire positive experiences of human-made sounds. This study could assist university property managers in understanding students' perceptions of human-made sounds and aid in strategic management of campus space that aligns with students' needs and preferences for ILSs, which will consequently improve the overall learning environment and support student success.

Author contributions

Jia Zhang contributed to the conception and design of methodology, data collection and analysis, as well as drafting and revising the manuscript. Ding Ding contributed to revising the manuscript. Jiachao Chen contributed to data interpretation. Chunlu Liu contributed to the conception and design of methodology, along with drafting and revising the manuscript. Mark Luther, Jilong Zhao and Changan Liu contributed to revising the manuscript.

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References

Acun, V., & Yilmazer, S. (2018). A grounded theory approach to investigate the perceived soundscape of open-plan offices. *Applied Acoustics*, *131*, 28–37. https://doi.org/10.1016/j.apacoust.2017.09.018

Anggiani, M., & Heryanto, B. (2018). A study of informal space on campus by looking at student preferences. *IOP Conference Series Materials Science and Engineering*, *453*, Article 012029. https://doi.org/10.1088/1757-899X/453/1/012029

Astolfi, A., & Pellerey, F. (2008). Subjective and objective assessment of acoustical and overall environmental quality in secondary school classrooms. *The Journal of the Acoustical Society of America*, *123*(1), 163–173. https://doi.org/10.1121/1.2816563

Banbury, S. P., & Berry, D. C. (2005). Office noise and employee concentration: Identifying causes of disruption and potential improvements. *Ergonomics*, *48*(1), 25–37. https://doi.org/10.1080/00140130412331311390

Bansal, S., Biswas, S., & Singh, S. K. (2019). Holistic assessment of existing buildings: Indian context. *Journal of Building Engineering*, *25*, Article 100793. https://doi.org/10.1016/j.jobe.2019.100793

Beckers, R., Van der Voordt, T., & Dewulf, G. (2016). Learning space preferences of higher education students. *Building and Environment*, *104*, 243–252. https://doi.org/10.1016/j.buildenv.2016.05.013

Beh, H. J., Rashidi, A., Talei, A., & Lee, Y. S. (2022). Developing engineering students' capabilities through game-based virtual reality technology for building utility inspection. *Engineering, Construction and Architectural Management*, *29*(7), 2854–2877. https://doi.org/10.1108/ECAM-02-2021-0174

Bennett, S. (2007). First questions for designing higher education learning spaces. *The Journal of Academic Librarianship*, *33*(1), 14–26. https://doi.org/10.1353/pla.2011.0033

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Broadbent, D. E. (1978). The current state of noise research: Reply to poulton. *Psychological Bulletin*, *85*(5), 1052–1067. https://doi.org/10.1037/0033-2909.85.5.1052

Cunningham, M., & Walton, G. (2016). Informal learning spaces (ILS) in university libraries and their campuses: A Loughborough University case study. *New Library World*, *117*(1/2), 49–62. https://doi.org/10.1108/NLW-04-2015-0031

Hong, S., Kim, Y., & Yang, E. (2022). Indoor environment and student productivity for individual and collaborative work in learning commons: A case study. *Library Management*, *43*, 15–34. https://doi.org/10.1108/LM-06-2021-0055

Hsu, C. H. C., Chin, D. C. W., & Yau, O. K. T. (2022). Usage of informal learning spaces among students from academic units with versus without dedicated buildings on campus. *Journal of Learning Spaces*, *11*(1), 1–12.

Hunter, J., & Cox, A. (2014). Learning over tea! Studying in informal learning spaces. *New Library World*, *115*(1/2), 34–50. https://doi.org/10.1108/NLW-08-2013-0063

Jo, H. I., & Jeon, J. Y. (2022). Influence of indoor soundscape perception based on audiovisual contents on work-related quality with preference and perceived productivity in open-plan offices. *Building and Environment*, *208*, Article 108598. https://doi.org/10.1016/j.buildenv.2021.108598

Kaklauskas, A., Daniūnas, A., Amaratunga, D., Urbonas, V., Lill, L., Gudauskas, R., D'amato, M., Trinkūnas, V., & Jackutė, I. (2012). Life cycle process model of a market-oriented and student centered higher eudcation. *International Journal of Strategic Property Management*, *16*(4), 414–430. https://doi.org/10.3846/1648715X.2012.750631

Kang, S., Ou, D., & Mak, C. M. (2017). The impact of indoor environmental quality on work productivity in university open-plan research offices. *Building and Environment*, *124*, 78–89. https://doi.org/10.1016/j.buildenv.2017.07.003

King, J. G. (2016). Extended and experimenting: Library learning commons service strategy and sustainability. *Library Management*, *37*(4/5), 265–274. https://doi.org/10.1108/LM-04-2016-0028

Lee, S.-M., Park, C.-J., & Haan, C.-H. (2022). Investigation of the appropriate reverberation time in learning spaces for elderly people using speech intelligibility tests. *Buildings*, *12*, Article 1943. https://doi.org/10.3390/buildings12111943

Li, Z., Zhang, Q., Fan, F., & Shen, S. (2021). A comprehensive comfort assessment method for indoor environmental quality in university open-plan offices in severe cold regions. *Building and Environment*, *197*, Article 107845. https://doi.org/10.1016/j.buildenv.2021.107845

Mahbub, A. S., Kua, H.-W., & Lee, S.-E. (2010). A total building performance approach to evaluating building acoustics performance. *Architectural Science Review*, *53*(2), 213–223. https://doi.org/10.3763/asre.2009.0032

Matthews, K. E., Andrews, V., & Adams, P. (2011). Social learning spaces and student engagement. *Higher Education Research & Development*, *30*(2), 105–120. https://doi.org/10.1080/07294360.2010.512629

Minichilli, F., Gorini, F., Ascari, E., Bianchi, F., Coi, A., Fredianelli, L., Licitra, G., Manzoli, F., Mezzasalma, L., & Cori, L. (2018). Annoyance judgment and measurements of environmental noise: A focus on Italian secondary schools. *International Journal of Environmental Research and Public Health*, *15*(2), Article 208. https://doi.org/10.3390/ijerph15020208

Montgomery, S. E. (2014). Library space assessment: User learning behaviors in the library. *The Journal of Academic Librarianship*, *40*(1), 70–75. https://doi.org/10.1016/j.acalib.2013.11.003

Nja, C. O., Anari, M. I., Erim, C. M., Idiege, K. J., Ilhami, A., Ukah, J. U., Eneyo, O. E., Uwe, U. E., & Cornelius-Ukpepi, B. U. (2023). Learning space, students' collaboration, educational outcomes, and interest: Exploring the physical, social and psychological mediators. *Heliyon*, *9*(4), Article e15456. https://doi.org/10.1016/j.heliyon.2023.e15456

Norazman, N., Che Ani, A. I., Ismail, W. N. W., Hussain, A. H., & Abdul Maulud, K. N. (2021). Indoor environmental quality towards classrooms' comforts level: Case study at Malaysian secondary school building. *Applied Sciences*, *11*(13), Article 5866. https://doi.org/10.3390/app11135866

Painter, S., Fournier, J., Grape, C., Grummon, P., Morelli, J., Whitmer, S., & Cevetello, J. (2013). *Research on learning space design: Present state, future directions: Report from the recipients of the 2012 Perry Chapman Prize*. Society of College and University Planning. https://research.ebsco.com/linkprocessor/plink?id=25a4fbf7-6a51-3b94-9d81-78b7b7147ab2

Parry, D. A., le Roux, D. B., & Bantjes, J. R. (2020). Testing the feasibility of a media multitasking self-regulation intervention for students: Behaviour change, attention, and self-perception. *Computers in Human Behavior*, *104*, Article 106182. https://doi.org/10.1016/j.chb.2019.106182

Ramu, V., Taib, N., & Massoomeh, H. M. (2022). Informal academic learning space preferences of tertiary education learners. *Journal of Facilities Management*, *20*(5), 679–695.

Rane, M., Coleman, P., Mason, R., & Bech, S. (2022). Quantifying headphone listening experience in virtual sound environments using distraction. *EURASIP Journal on Audio Speech & Music Processing*, *30*, 1–14. https://doi.org/10.1186/s13636-022-00262-7

Rasheed, E. O., Khoshbakht, M., & Baird, G. (2021). Time spent in the office and workers' productivity, comfort and health: A perception study. *Building and Environment*, *195*, Article 107747. https://doi.org/10.1016/j.buildenv.2021.107747

Ratul, I. J., Wani, U. H., Nishat, M. M., Al-Monsur, A., Ar-Rafi, A. M., Faisal, F., & Kabir, M. R. (2022). Survival prediction of children undergoing hematopoietic stem cell transplantation using different machine learning classifiers by performing Chi-squared test and hyper-parameter optimization: A retrospective analysis. *Computational and Mathematical Methods in Medicine*, *2022*(1), Article 9391136. https://doi.org/10.1155/2022/9391136

Szalma, J. L., & Hancock, P. A. (2011). Noise effects on human performance: A meta-analytic synthesis. *Psychological Bulletin*, *137*(4), 682–707. https://doi.org/10.1037/a0023987

Tamesue, T., Yamaguchi, S., & Saeki, T. (2006). Study on achieving speech privacy using masking noise. *Journal of Sound & Vibration*, *297*(3–5), 1088–1096. https://doi.org/10.1016/j.jsv.2006.05.012

Tan, A., Udeaja, C., Babatunde, S. O., & Ekundayo, D. (2017). Sustainable development in a construction related curriculum – quantity surveying students' perspective. *International Journal of Strategic Property Management*, *21*(1), 101–113. https://doi.org/10.3846/1648715X.2016.1246387

Topak, S. A., & Yılmazer, S. (2022). A comparative study on indoor soundscape assessment via a mixed method: A case of the high school environment. *Applied Acoustics*, *189*, Article 108554. https://doi.org/10.1016/j.apacoust.2021.108554

Vanichvatana, S. (2020). Who uses home as informal learning spaces: A Bangkok private university case study. *World Journal on Educational Technology*, *12*(1), 37–47. https://doi.org/10.18844/wjet.v12i1.4416

Villa, C., & Labayrade, R. (2016). A suitable and energy-efficient luminous environment for a shared office. *Lighting Research and Technology*, *48*(6), 755–770. https://doi.org/10.1177/1477153515578309

Vital, R.-A., & Patil, P. N. (2021). Chi-Square type Goodness-of-Fit Test for hazard rate. *Statistics in Biosciences: International Chinese Statistical Association*, *13*(1), 77–89. https://doi.org/10.1007/s12561-020-09285-0

Vo, N. T. B. (2015). *College students' choice of informal learning spaces* [Doctoral dissertations, University of Missouri-Columbia]. MOspace Institutional Repository. https://doi.org/10.32469/10355/46838

Wang, J. (2022). Research on the relationship between informal learning and the regeneration of public spaces on Chinese university campuses: Taking Xian Jiaotong-Liverpool University as an example. In C. Piselli, H. Altan, O. Balaban, & P. Kremer (Eds.), *Innovating strategies and solutions for urban performance and regeneration* (pp. 289–301). Springer. https://doi.org/10.1007/978-3-030-98187-7_21

Wu, X., Kou, Z., Oldfield, P., Heath, T., & Borsi, K. (2021). Informal learning spaces in higher education: Student preferences and activities. *Buildings*, *11*(6), Article 252. https://doi.org/10.3390/buildings11060252

Zhang, J., Ding, D., Liu, C., Luther, M., Zhao, J., & Liu, C. (2022). Privacy and interaction preferences of students in informal learning spaces on university campus. *Facilities*, *40*(9/10), 638–655. https://doi.org/10.1108/F-11-2021-0119

Zhang, J., Liu, C., Luther, M., Chil, B., Zhao, J., & Liu, C. (2023). Students' sound environment perceptions in informal learning spaces: A case study on a university campus in Australia. *Engineering, Construction and Architectural Management*. https://doi.org/10.1108/ECAM-02-2023-0118

Appendix A. Questionnaire

A1. Questions about students' individual characteristics
(1) Gender: Male; Female; Prefer not to say.
(2) Enrollment type: Bachelor; Master's; PhD; Other.
(3) Birthplace: Australia; Non-Australia.
(4) Work category: Examination preparation; Course assignment; Academic research; Other.
(5) Expected duration of stay: Less than one hour; Between one and three hours; Above three hours.
(6) Visit frequency: Daily; Weekly; Monthly.
(7) Location selection: At home; At university.

A2. Questions about effects of each human-made sound (multiple answers)
(1) Sound caused by learning activities: Influencing thinking; Being distracting; Being annoying; Keeping awake; Keeping relaxed; Keeping motivated.
(2) Sound caused by entertainment: Influencing thinking; Being distracting; Being annoying; Keeping awake; Keeping relaxed; Keeping motivated.
(3) Sound of continuous conversation: Influencing thinking; Being distracting; Being annoying; Keeping awake; Keeping relaxed; Keeping motivated.
(4) Sound of intermittent conversation: Influencing thinking; Being distracting; Being annoying; Keeping awake; Keeping relaxed; Keeping motivated.
(5) Sound caused by phones ringing: Influencing thinking; Being distracting; Being annoying; Keeping awake; Keeping relaxed; Keeping motivated.
(6) Sound caused by keyboards & mouse clicking: Influencing thinking; Being distracting; Being annoying; Keeping awake; Keeping relaxed; Keeping motivated.
(7) Sound caused by footsteps: Influencing thinking; Being distracting; Being annoying; Keeping awake; Keeping relaxed; Keeping motivated.

A3. Open-ended questions according to selection of multiple answers for each sound source above
(1) Can you explain why human-made sounds can have positive effects on you, including keeping you awake, relaxed, and motivated?
(2) Can you describe the positive effects brought about by the human-made sounds in this space besides keeping you wake, relaxed, and motivated?
(3) Do you have anything else to describe about the positive effects produced by human-made sounds in informal learning spaces?

Appendix B. Number of students of each effect of different human-made sounds based on students' individual characteristics

Human-made sound	Effect	Enrollment type			Birthplace		Work category			
		Bachelor	Master's	PhD	Australian	Non-Australian	Examination Preparation	Course assignment	Academic research	Other
Learning activities	Influencing thinking	19	15	13	24	34	0	18	39	1
	Being distracting	9	14	9	23	28	5	13	30	3
	Being annoying	12	4	10	20	16	2	12	20	2
	Keeping awake	30	17	4	11	29	3	31	6	0
	Keeping relaxed	28	8	1	8	9	1	15	2	1
	Keeping motivated	39	10	7	34	22	2	43	11	0

		Birthplace	
		Australian	Non-Australian
Entertainment	Influencing thinking	5	26
	Being distracting	55	49
	Being annoying	33	44
	Keeping awake	13	12
	Keeping relaxed	20	15
	Keeping motivated	10	6

		Birthplace	
		Australian	Non-Australian
Continuous conversation	Influencing thinking	9	35
	Being distracting	45	43
	Being annoying	53	61
	Keeping awake	10	9
	Keeping relaxed	13	6
	Keeping motivated	1	5

		Birthplace		Visit frequency		
		Australian	Non-Australian	Daily	Weekly	Monthly
Phones ringing	Influencing thinking	5	25	37	18	5
	Being distracting	46	53	34	58	7
	Being annoying	44	75	54	62	3
	Keeping awake	3	7	1	6	1
	Keeping relaxed	1	5	1	3	1
	Keeping motivated	2	5	2	3	5