Delft University of Technology

Profiling Students Based on the Overlap between IEQ and Psychosocial Preferences of Study Places

Hamida, A.B.; Eijkelenboom, A.M.; Bluyssen, P.M.

Important note
To cite this publication, please use the final published version (if applicable).
Please check the document version above.

Profiling Students Based on the Overlap between IEQ and Psychosocial Preferences of Study Places

Amneh Hamida *, AnneMarie Eijkelenboom and Philomena M. Bluyssen

Chair Indoor Environment, Faculty of Architecture and the Built Environment, Delft University of Technology, 2628 BL Delft, The Netherlands

* Correspondence: a.b.hamida@tudelft.nl

Abstract: Research has shown that students differ in their preferences of indoor environmental quality (IEQ) and psychosocial aspects of their study places. Since previous studies have mainly focused on identifying these preferences rather than investigating the different profiles of students, this study aimed at profiling students based on their IEQ and psychosocial preferences of their study places. A questionnaire was completed by 451 bachelor students of the faculty of Architecture and the Built Environment. A TwoStep cluster analysis was performed twice separately. First, to cluster the students based on their IEQ preferences, and second based on their psychosocial preferences. This resulted in three clusters under each cluster model. Then, the overlap between these two models was determined and produced nine unique profiles of students, which are: (1) the concerned perfectionist, (2) the concerned extrovert, (3) the concerned non-perfectionist, (4) the visual concerned perfectionist, (5) the visual concerned extrovert, (6) visual concerned non-perfectionist, (7) the unconcerned introvert, (8) the unconcerned extrovert, and (9) the unconcerned non-perfectionist. A number of variables was found to be significantly different among these profiles. This study's outcome indicates that studying the overlap between IEQ and psychosocial preferences is required to understand the different possible profiles of students.

Keywords: IEQ preferences; psychosocial preferences; twostep cluster analysis; study place; students' profiles

1. Introduction

Students in higher education spend their time carrying out study-related activities (e.g., individual studying) in indoor environments other than standard classrooms, such as informal learning/study places [1,2]. These places refer to spaces that are mainly used by students for performing such study-related activities [3]. Previous research has found that students generally conduct their study-related activities at home or in an educational building [4], and spend substantial time inside these places [5]. Therefore, understanding students' preferences of these places can help to provide indoor environments that support their academic performance and well-being [6,7]. These preferences can be related to indoor environmental aspects and psychosocial aspects [8].

Research on students' (primary, secondary, and university education) preferences is usually performed within the context of teaching-related activities (e.g., classroom setting) [9–18]. Few studies have examined university students' preferences of study places in informal learning settings (e.g., individual learning, collaborative learning outside the classroom) [19]. For example, Ramu et al. [1] explored students' preferences of informal academic study places on campus, and concluded that students were generally concerned about the layout and amenities (e.g., furniture) in these places. While both indoor environmental (e.g., lighting, temperature) and psychosocial (e.g., privacy, layout) preferences were included, the study was limited to study places used for collaborative study-

related activities and located in educational buildings. Beckers et al. [4] investigated the reasons behind students' choices to use a certain place (at home or educational building) for studying. These reasons were significantly correlated with students' preferences, their personal characteristics, and study-related activities. Most of the study-related activities were conducted at home, and students were found to prefer studying at home because they had the ability to control the indoor environmental quality (IEQ)-factors (e.g., indoor air, thermal, sound and lighting quality). Another study conducted by Cunningham and Walton [20] found that 52 percent of university students chose the university library as a study place because it provided a quiet environment. Furthermore, Roetzel et al. [21] revealed that students' preferences of their study places can change with the study-related activities they perform. For instance, Braat-Eggen et al. [22] indicated that university students did not prefer background sounds, such as speech, in an open-plan study environment while they were performing cognitive tasks (e.g., studying for an exam).

So far, these previous studies generalized the preferences that were identified among the student sample. However, different students have different preferences that may change over time [2,8]. For example, in a study performed by Liu and Luther [23], students showed differences in their psychosocial preferences, such as privacy and interactions. Additionally, university students from different faculties can have distinct preferences of study places, found by Wilson and Cotgrave [7]. Students of the art and design discipline scored higher important scores for room layout, the ability to adjust furniture, and controlling the environmental factors than students within the built environment and engineering faculties. This was linked to the personality traits among the students from various faculties. Therefore, it is important to understand how university students' preferences of their study places vary.

An integrated analysis approach, which takes into account the differences in preferences and needs of occupants (profiles) and the different stressors at the environmental level (pattern of stressors), was recently introduced in the field of IEQ [8,24]. The approach claims that in order to provide a good IEQ for all occupants, determining profiles of clusters at the human level and matching those profiles with patterns of environmental stressors (positive and negative) in a certain indoor environment could be the right way to go. In other words, to be able to determine the pattern of stressors at the environmental level, clustering occupants based on their preferences is required to first identify the profiles of clusters to better understand how they interact in an indoor environment [25]. So far, a number of studies in which groups of occupants were clustered according to their preferences and needs have shown differences among the profiles of these clusters [26,27].

Profiles of clusters have been determined for various scenarios and situations, such as home occupants [28,29], primary school children [12], office workers [26,30], and outpatient staff of hospitals [27]. In two of those studies, TwoStep cluster analysis was performed to produce profiles of clusters with regards to (1) IEQ comfort and preferences, and (2) psychosocial comfort and preferences [26,27]. The study on the outpatient staff [27] resulted in six profiles of clusters based on IEQ comfort and preferences, and three profiles of clusters based on psychosocial comfort and preferences. Similar to that, the study on office workers during COVID-19 [26] resulted in two separated models; IEQ preferences model (including four profiles of clusters) and the psychosocial preferences model (including six profiles of clusters). In the latter study, Eijkelenboom and Bluyssen [27] stated that as the overlap between IEQ preferences and psychosocial preferences models was limited, it is essential to study both in future studies.

Profiles of students based on their preferences of both IEQ and psychosocial aspects of their study places are still to be explored. Thus, in this study the question was raised whether profiles of clusters for university students based on both their IEQ, and psychosocial preferences of their study places can be determined. If so, what are the distinctive preferences and characteristics of each student's profile? Accordingly, in this study an attempt was made to cluster simultaneously students' profiles based on both IEQ and psychosocial preferences of their study places.

2. Materials and Methods

Bachelor students of the Faculty of Architecture and the Built Environment at TU Delft were recruited for a survey in March 2021, October 2021 and March 2022. They were asked in this survey about their IEQ and psychosocial preferences of their study place. Students' names and emails were provided by the course coordinators. A brief introduction to the questionnaire was given to the students by the coordinators on the same day of sending the questionnaire. Then, each student received a unique link to the questionnaire via an invitation email. In addition, the students were informed that they had ten days to answer the questionnaire. Five days after sending the questionnaire, a reminder was sent to those students who had not submitted the questionnaire yet. Furthermore, the expected time (approximately 30 min) for answering the questionnaire was stated in the consent form (the first page of the questionnaire).

2.1. Questionnaire

The questionnaire, entitled "My Study Place", is based on previously validated questionnaires that were used for office workers such as the OFFICAR questionnaire [31], the preferences of office workers questionnaire [26], and the outpatient questionnaire staff [27]. The "My Study Place" questionnaire, built in the Qualtrics XM platform in both English and Dutch, consists of seven sections: personal information, psycho-social aspects, most used study place, preferences, comfort perception, lifestyle, and health. Appendix A includes details of the sections and sub-sections of the questionnaire. For example, the preferences section includes an IEQ preferences sub-section that comprises eight variables. This question is stated as "Please rate on a scale from 1 to 10, the importance of each of the following aspects for your study performance at your study place1: not important at all; 10: extremely important-e.g., temperature".

2.2. Participants

The questionnaire was completed by bachelor students of the faculty of Architecture and the Built Environment in March 2021, October 2021, and March 2022. In March 2021, 409 first-year bachelor students completed the questionnaire, in which two sections—the mostly used study place and the preferences—were not included, but the questions related to time spent at home during weekdays and weekend were included. In October 2021, the questionnaire (including these two sections, but excluding the questions related to time spent at home) was sent again to these students, of which 127 completed it. Nonetheless, 127 students were not sufficient to conduct the TwoStep cluster analysis. Accordingly, the "My Study Place" questionnaire including all seven sections was sent to another 472 bachelor students in March 2022, of which 347 students completed the questionnaire. Then, all the results were combined in one dataset with 474 (347 + 127) students. Subsequently, 22 students were excluded because they did not answer the preferences questions. Additionally, one student aged 49 years was excluded from the data set. Hence, the final dataset that was used for the analysis included 451 students.

2.3. Ethical Aspects

The Human Research Ethics Committee (HREC) at the Delft University of Technology approved the application to conduct this study on the 31st of January 2022. A consent form was included at the beginning of the questionnaire, stating all data will be treated anonymously. This form also mentioned that students could skip any part of the questionnaire if they felt uncomfortable answering it.

2.4. Data Management and Analysis

The data were exported from the Qualtrics XM platform to SPSS version 26.0 software (SPSS Inc, Chicago, IL, USA) for data analysis. Descriptive statistics were performed to calculate the frequencies, percentages, maximum, minimum and standard deviation

(SD), and mean of the variables related to demographics, emotional state, IEQ comfort perception, psychosocial perception, IEQ preferences and the importance of IEQ-related items to study better, and psychosocial preferences.

TwoStep cluster analysis is a segmentation method that enables the creation of profiles of clusters based on any form of data, including categorical data [32]. This method was also used in previous studies within the domain of IEQ to determine profiles of clusters [12,24–28]. Accordingly, TwoStep cluster analysis was performed and validated twice and separately to create two distinct cluster models. The first TwoStep cluster analysis was performed to cluster the students based on their IEQ preferences, while the second one clustered them based on their psychosocial preferences. The input variables for the IEQ preferences model comprised eight variables: ventilation and fresh air, temperature, view to the outside, sounds from the outside, sounds from the inside, smells, artificial light, and daylight. The input variables for the psychosocial preferences model comprised nine variables: storage, cleanliness, amenities, chair type, presence and company of others, size of the room, bonding or identifying with the place, ability to adapt or control the place, and privacy. The settings of the TwoStep cluster analysis were based on selecting log-likelihood, determination of the number of clusters automatically, and Akaike's information criterion (AIC). Once the cluster model was generated, four validation steps were conducted: (1) silhouette measure of the cluster model is larger than 0.2 (fair and above); (2) Chi-square tests were performed to examine the relationship between the input variables of the cluster analysis and the final cluster model, with *p*-value less than 0.05 considered as statistically significant; (3) the predictor importance scores of the input variables were larger than 0.02; and (4) the dataset was randomly split half (50%) to re-run the final solution model on each half to ensure that both solutions were similar to the final solution.

After the TwoStep cluster analysis, descriptive analysis was conducted to calculate the frequencies, percentages, and SD for different variables of each cluster (e.g., health, IEQ perception, IEQ preferences). To compare differences between the clusters, Chi-square and ANOVA tests were used (for nominal and continuous variables, respectively). Each student belongs to two clusters, a cluster of IEQ preferences, and a cluster of psychosocial preferences, resulting in clusters of students with the same IEQ preferences but different psychosocial preferences, and vice versa. Hence, it is important to investigate the overlap between the two models to better understand in detail the profile of students within these two models. The overlap between the two cluster models was identified using cross-tabulation. In addition, frequencies, percentages, and SD for different variables of each profile within the overlap between the two models were calculated. The significant differences between the variables among the different profiles were tested using Chi-square and ANOVA tests. Chi-square calculations with less than 5 in one cell were excluded from the analysis.

3. Results

3.1. Students Characteristics

Table 1 presents several characteristics (e.g., age, gender, time spent at home, study place, and lifestyle) of the respondents in 2021 and 2022. Since only the mean time spent at home was significantly different between the two groups; students in 2021 spent more time at home than students in 2022, this study mainly focused on questions related to study places and excluded the questions related to students' homes, such as building-related symptoms. The mean age of the 451 students was 20 years old. The ratio of female to male students was 1.6. Students within this study spent their studying time mostly at their homes (74%), while 26% of them stayed in educational buildings for studying. The students stayed at their homes around 17 h per day during weekdays, and 16 h per day during the weekend.

Table 1. Students characteristics in 2021 and 2022.

	All Students	Students in 2021	Students in 2022	*p*-Value
Invited	878	409	472	**-**
Respondents	474	127	374	**-**
Response rate (%)	54.0	31.1	79.2	**-**
Age-mean (SD)	19.8 (1.6)	19.6 (1.1)	19.8 (1.8)	0.61
Gender-n (%)				0.70
Male	175 (39.0)	43 (40.6)	132 (38.5)	-
Female	274 (61.0)	63 (59.4)	211 (61.5)	-
Time spent at home during weekdays-mean (SD)				-
Weekdays	16.9 (3.6)	20.4 (2.8)	15.8 (3.1)	*p* < 0.001
Weekend	15.8 (4.2)	17.5 (4.2)	15.2 (4.0)	*p* < 0.001
Study place-n (%)				0.26
Home	333 (73.8)	85 (79.4)	248 (72.1)	-
Educational building	116 (25.7)	22 (20.6)	94 (27.3)	-
Lifestyle-n (%)				
Smoking	134 (29.7)	22 (20.6)	112 (32.5)	0.12
Alcohol	384 (85.1)	92 (86.0)	292 (84.9)	0.74
Physical activity	407 (90.2)	98 (91.6)	309 (89.8)	0.59

3.2. Students' Preferences of Their Study Places

Figure 1 presents the mean and SD values of the eight IEQ preferences aspects. Daylight (8.4 ± 1.5) was the most important aspect of the whole study sample. This is followed by both view to the outside (8.2 ± 1.8) and temperature (8.2 ± 1.3). In contrast, smells (6.2 ± 2.3), artificial light (6.2 ± 2.0), and sounds from the outside (6.3 ± 2.2) were the least important IEQ aspects. Figure 2 illustrates the mean and SD values of the nine psychosocial preference aspects. Amenities (8.0 ± 1.5) and cleanliness (7.6 ± 1.7) were the most important psychosocial aspects of the study place. On the other hand, students in this study reported the lowest scores on three psychosocial aspects: presence and company of others (5.3 ± 2.5), bounding or identifying with the place (5.4 ± 2.5), and size of the room (5.5 ± 2.0).
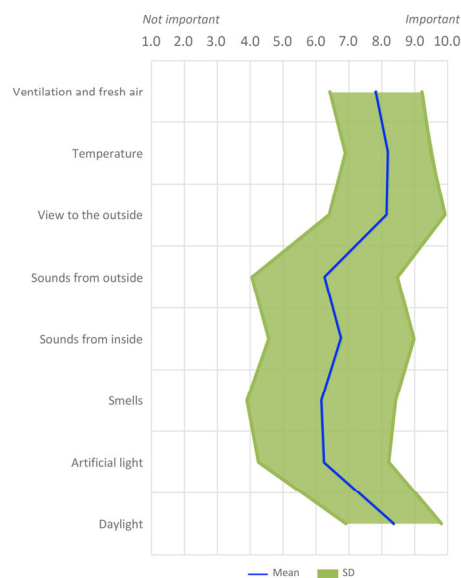
Figure 1. IEQ preferences of study places.
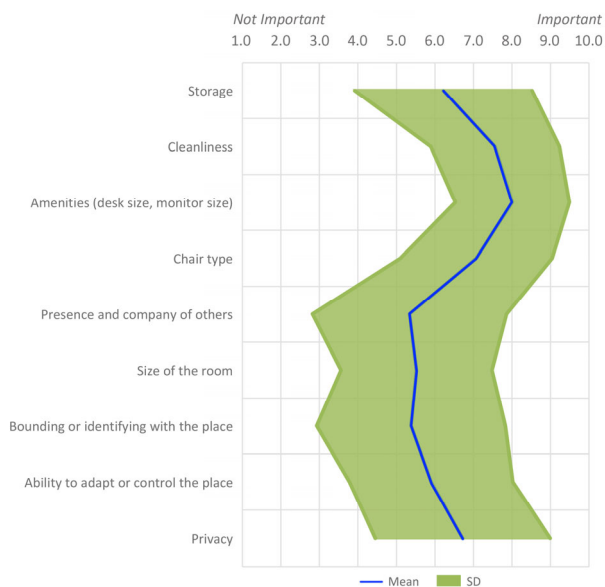
Figure 2. Psychosocial preferences of study places.

3.3. TwoStep Cluster Analysis

TwoStep cluster analysis was carried out to categorize profiles of students based on their IEQ preferences and separate psychosocial preferences in their study places. This was carried out by using the original variables that consists of eight variables of the IEQ preferences and nine variables for the psychosocial preferences. The results of the TwoStep cluster analysis resulted in two models: the IEQ preferences model, and the psychosocial preferences model. Each of these two models comprised three distinct clusters. The Silhouette coefficient was fair for both models; 0.3 for the IEQ preferences model, and 0.2 for the psychosocial preferences model.

The predictor importance of the eight input variables for the IEQ preferences model, as well as the nine input variables for the psychosocial preferences model, was found to be strong and larger than 0.02. Additionally, after randomly splitting the dataset into two halves, only a few changes were found between the two halves and the final solution (Table 2). Furthermore, all eight IEQ preference variables were found to be statistically significant in relation to the IEQ preferences model ($p < 0.05$). Similarly, the nine psychosocial preference variables were found to be statistically significant in relation to the psychosocial preferences model.

Table 2. Predictor importance of the input variables for both models.

	Predictor Importance	Final Solution	First Half Solution	Second Half Solution
IEQ preferences model	0.60–1.00	Daylight (1.00) Sounds from inside (0.80) View to the outside (0.75) Smells (0.68)	Sounds from the inside (1.00) View to the outside (0.84) Daylight (0.62)	Sounds from the inside (1.00)
	0.30–0.59	Sounds from the outside (0.57) Ventilation and fresh air (0.30)	Smells (0.52) Sounds from the outside (0.42)	Daylight (0.58) View to the outside (0.44) Smells (0.40)

	0.02–0.29	Artificial light (0.21) Temperature (0.20)	Ventilation and fresh air (0.21) Temperature (0.07) Artificial light (0.03)	Sounds from the outside (0.40) Ventilation and fresh air (0.20) Artificial light (0.20) Temperature (0.06)
Psychosocial preferences model	0.60–1.00	Bonding or identifying with the place (1.00) Ability to adapt or control the place (0.91) Size of the room (0.71) Cleanliness (0.63)	Presence and company of others (1.00) Ability to adapt or control the place (0.78) Privacy (0.71)	Ability to adapt or control the place (1.00) Bonding or identifying with the place (0.82)
	0.30–0.59	Storage (0.54) Presence and company of others (0.51) Chair type (0.36) Amenities (0.33) Privacy (0.30)	Size of the room (0.56) Bonding or identifying with the place (0.54) Storage (0.53) Chair type (0.43) Amenities (0.38) Cleanliness (0.30)	Storage (0.53) Amenities (0.52) Size of the room (0.52) Presence and company of others (0.52) Chair type (0.47) Privacy (0.35)
	0.02–0.29	-	-	Cleanliness (0.22)

3.3.1. IEQ Preferences Model

The clusters of the IEQ preference clusters are described in Table 3 and Appendix B. Table 3 only includes the variables that were statistically different among the clusters within the IEQ preferences model ($p < 0.05$). The IEQ preferences model resulted in three clusters: IEQC1 (concerned with all IEQ aspects), IEQC2 (concerned with daylight and view to the outside), and IEQC3 (concerned with only temperature). These three clusters scored a high importance level for daylight (ranged from 7.0 to 9.0), view to the outside (ranged from 6.7 to 9.0), and temperature (ranged from 7.8 to 8.7).

Table 3. Descriptives of IEQ clusters.

	IEQC1	IEQC2	IEQC3	*p*-Value
N (%within the total sample)	159 (35.5)	149 (33.3)	140 (31.3)	-
Gender -N (%within cluster level)				*p* < 0.001
Male	42 (26.4)	63 (42.6)	68 (48.9)	-
Female	117 (73.6)	85 (57.4)	71 (51.1)	-
Study place-N (%within cluster level)				**0.007**
Home	103 (64.8)	117 (78.5)	110 (78.6)	-
Educational building	55 (34.6)	31 (20.8)	30 (21.4)	-
IEQ preferences-mean (SD)				
Ventilation and fresh air	8.5 (1.1)	7.7 (1.3)	7.2 (1.6)	*p* < 0.001
Temperature	8.7 (1.1)	7.8 (1.3)	8.0 (1.3)	*p* < 0.001
View to the outside	8.7 (1.3)	9.0 (1.1)	6.7 (1.9)	*p* < 0.001
Sounds from the outside	7.6 (1.7)	4.8 (1.9)	6.3 (2.1)	*p* < 0.001
Sounds from the inside	8.1 (1.4)	5.0 (2.1)	7.2 (1.8)	*p* < 0.001
Smells	7.8 (1.4)	4.9 (2.0)	5.7 (2.2)	*p* < 0.001
Artificial light	7.1 (1.7)	6.0 (2.0)	5.5 (1.9)	*p* < 0.001
Daylight	9.0 (0.9)	9.0 (0.9)	7.0 (1.4)	*p* < 0.001
Importance of IEQ-related aspects-mean (SD)				
Lamp on my desk	6.6 (2.3)	5.9 (2.4)	6.2 (2.2)	**0.026**
Personal desk ventilation and fresh air	7.6 (2.2)	7.1 (2.2)	6.4 (2.0)	*p* < 0.001

Control of surrounding sounds	7.7 (1.6)	5.6 (2.2)	6.8 (1.9)	$p < 0.001$
Control of shading	7.8 (1.7)	6.5 (2.2)	7.2 (1.7)	$p < 0.001$
Control of room ventilation	7.8 (1.6)	6.2 (2.0)	6.5 (2.0)	$p < 0.001$
Control of room temperature	7.7 (1.5)	6.7 (1.9)	6.8 (2.0)	$p < 0.001$
Headphones	7.7 (2.4)	7.3 (2.6)	6.6 (2.4)	0.004

3.3.2. Psychosocial Preferences Model

Descriptions of the psychosocial preference clusters are presented in Table 4 and Appendix C. Table 4 only illustrates the variables that were found to be statistically different among the three clusters within the psychosocial preferences model ($p < 0.05$). This model consists of three distinct clusters: PSC1 (Preference for most of psychosocial aspects), PSC2 (preference for presence and company of others), and PSC3 (preference only for amenities and cleanliness). Generally, the students within these clusters reported a high importance for two aspects, which are cleanliness (ranged from 7.1 to 9.0) and amenities (ranged from 7.5 to 8.9).

Table 4. Descriptive of psychosocial clusters. .

	PSC1	PSC2	PSC3	*p*-Value
N (%within the total sample)	110 (25.0)	186 (42.3)	144 (32.7)	-
Lifestyle-N (%within cluster level)				
Smoking	21 (19.0)	56 (26.9)	52 (36.1)	0.025
Alcohol	85 (77.3)	161 (86.6)	128 (88.9)	0.021
Study place-N (%within cluster level)				$p < 0.001$
Home	98 (89.1)	117 (62.9)	110 (76.4)	-
Educational building	12 (10.9)	68 (36.6)	33 (22.9)	-
Psychosocial preferences-mean (SD)				
Storage	8.1 (1.3)	5.6 (2.1)	5.6 (2.5)	$p < 0.001$
Cleanliness	9.0 (1.0)	7.1 (1.4)	7.1 (1.8)	$p < 0.001$
Amenities	8.9 (1.1)	7.9 (1.2)	7.5 (1.8)	$p < 0.001$
Chair type	8.0 (1.7)	7.4 (1.5)	6.0 (2.3)	$p < 0.001$
Presence and company of others	5.1 (2.4)	6.6 (2.0)	4.0 (2.4)	$p < 0.001$
Size of the room	6.4 (1.8)	6.2 (1.5)	4.1 (1.8)	$p < 0.001$
Bonding or identifying with the place	6.6 (1.8)	6.3 (2.0)	3.3 (2.0)	$p < 0.001$
Ability to adapt or control the place	7.2 (1.6)	6.4 (1.7)	4.2 (1.9)	$p < 0.001$
Privacy	8.1 (1.4)	6.2 (2.2)	6.3 (2.4)	$p < 0.001$

3.4. Overlap between the IEQ and the Psychosocial Preferences Model

The overlap between the IEQ and psychosocial preferences model resulted in nine distinct profiles that are illustrated in Figure 3. Descriptions of these profiles, presented in Table 5, are statistically significantly different between the profiles. A comprehensive description for these nine groups is illustrated in Appendix D.

In general, all nine profiles are concerned with three IEQ preferences, which are daylight (ranged from 6.6 to 9.3), view to the outside (ranged from 6.4 to 9.1), and temperature (ranged from 7.6 to 8.9). Pertaining to the psychosocial preferences, most of the profiles scored high importance levels for two aspects: amenities (ranged from 7.4 to 8.9) and cleanliness (ranged from 6.8 to 9.0). Therefore, the description for each profile is based on highlighting which profile scored the highest and/or lowest importance level for both IEQ and psychosocial preferences among all profiles.

Each name of the nine profiles consists of two parts: the first part is related to IEQ preferences, and the second part is related to psychosocial preferences. The IEQ preferences part consists of one of three names that are; (1) concerned, which means all IEQ preferences are important, (2) visual concerned, which implies that daylight and view to

the outside are important, and (3) unconcerned, which indicates that almost all IEQ preferences are not very important except for temperature. The psychosocial preferences part includes one of the four categories; (1) perfectionist, which implies high importance levels for most of the psychosocial aspects, (2) extrovert, which reflects the high importance level for the presence and company of others, (3) introvert, which means that privacy is highly important, (4) non-perfectionist, which indicates that most of the psychosocial aspects are not highly important, except amenities.
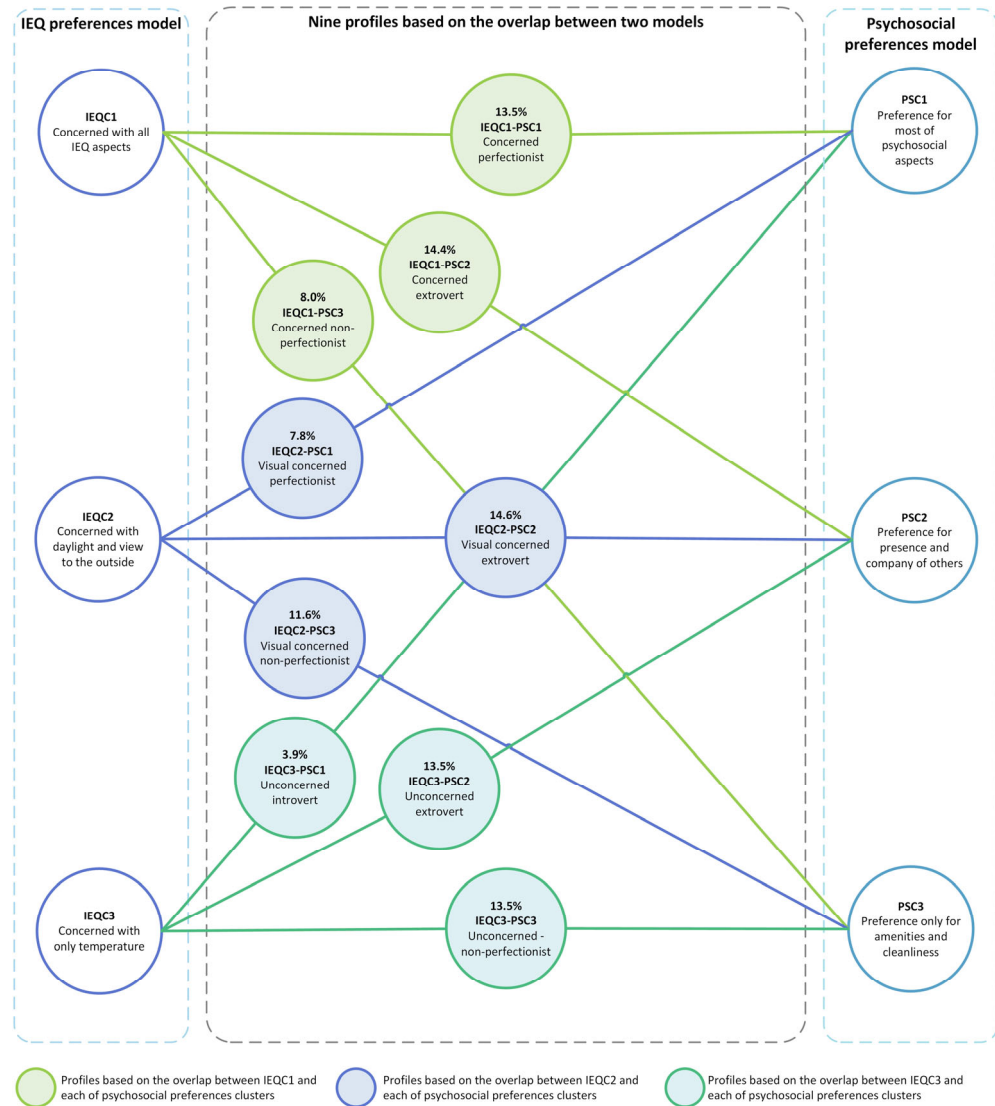

Figure 3. The nine profiles of students based on the overlap between the IEQ preferences model and psychosocial preferences model.

Table 5. Description of the overlap profiles between the two clusters models.

	IEQC1-PSC1	IEQC1-PSC2	IEQC1-PSC3	IEQC2-PSC1	IEQC2-PSC2	IEQC2-PSC3	IEQC3-PSC1	IEQC3-PSC2	IEQC3-PSC3	*p*-Value
N (%within the total sample)	59 (13.5)	63 (14.4)	35 (8.0)	34 (7.8)	64 (14.6)	48 (11.0)	17 (3.9)	59 (13.5)	59 (13.5)	-
Age										*p* < 0.001
Mean (SD)	19.6 (1.8)	19.7 (1.9)	19.6 (1.1)	19.9 (1.2)	19.7 (1.2)	19.7 (1.5)	20.1 (0.9)	20.0 (2.1)	19.8 (1.4)	-
Maximum	29	31	24	23	24	26	22	23	23	-
Minimum	17	17	18	18	18	18	19	18	18	-
Gender– N (%within profile level)										*p* < 0.001
Male	17 (28.8)	18 (28.6)	6 (17.1)	16 (47.1)	26 (40.6)	19 (39.6)	10 (58.8)	24 (40.7)	32 (54.2)	-
Female	42 (71.2)	45 (71.4)	29 (82.9)	18 (52.9)	38 (59.4)	28 (58.3)	7 (41.2)	34 (57.6)	27 (45.8)	-
Recently experienced events-N (%within profile level)										
Positive events	22 (37.3)	22 (34.9)	9 (25.7)	8 (23.5)	18 (28.1)	12 (25.0)	5 (29.4)	14 (23.7)	16 (27.1)	**0.012**
Lifestyle-n (%within profile level)										
Alcohol	44 (74.6)	53 (87.3)	32 (91.4)	28 (82.4)	56 (87.5)	43 (89.6)	13 (76.5)	50 (84.7)	51 (86.4)	*p* < 0.001
Physical activity	53 (89.8)	58 (92.1)	33 (94.3)	32 (94.1)	60 (93.8)	43 (89.6)	12 (70.6)	52 (88.1)	51 (86.4)	*p* < 0.001
PANAS-Mean (SD)										
Positive affect	17.8 (2.7)	17.1 (2.6)	17.6 (2.2)	18.3 (2.4)	17.4 (2.5)	17.4 (2.6)	17.9 (2.4)	16.9 (2.3)	17.1 (2.9)	*p* < 0.001
Negative affect	11.9 (3.0)	11.6 (3.1)	12.1 (3.0)	11.7 (2.7)	11.4 (2.8)	11.0 (3.1)	11.7 (3.1)	11.8 (3.0)	10.9 (3.1)	*p* < 0.001
Health-n (%within										

	IEQC1-PSC1	IEQC1-PSC2	IEQC1-PSC3	IEQC2-PSC1	IEQC2-PSC2	IEQC2-PSC3	IEQC3-PSC1	IEQC3-PSC2	IEQC3-PSC3	*p*-Value
profile level)										
Depression	12 (20.3)	12 (19.0)	7 (20.0)	6 (17.6)	12 (17.7)	11 (22.9)	5 (29.4)	9 (15.3)	17 (28.8)	*p* < **0.001**
Anxiety	17 (28.8)	19 (30.2)	7 (20.0)	8 (23.5)	12 (18.8)	15 (31.3)	5 (29.4)	11 (18.6)	13 (22.0)	*p* < **0.001**
IEQ perception-n (%within profile level)										
Dissatisfied with air freshness	31 (52.5)	41 (65.1)	21 (60.0)	20 (58.8)	35 (54.7)	32 (66.7)	9 (52.9)	30 (50.8)	44 (74.6)	**0.011**
Dissatisfied with air smell	27 (45.8)	28 (44.4)	17 (48.6)	12 (35.3)	40 (62.5)	19 (39.6)	6 (35.3)	26 (44.1)	26 (44.1)	**0.003**
IEQ preferences mean (SD)										
Ventilation and fresh air	8.6 (1.1)	8.3 (1.1)	9.0 (1.1)	7.8 (1.3)	7.7 (1.4)	7.6 (1.2)	7.5 (1.5)	7.3 (1.2)	7.1 (1.9)	*p* < **0.001**
Temperature	8.7 (1.1)	8.6 (1.0)	8.9 (1.1)	8.1 (1.5)	7.8 (1.3)	7.6 (1.3)	8.4 (1.7)	7.9 (1.2)	8.1 (1.4)	*p* < **0.001**
View to the outside	8.6 (1.3)	8.8 (1.2)	8.7 (1.4)	9.1 (0.9)	8.9 (1.0)	9.2 (1.1)	7.1 (1.7)	6.9 (1.9)	6.4 (1.9)	*p* < **0.001**
Sounds from the outside	7.8 (1.4)	7.5 (1.8)	7.4 (2.1)	5.6 (1.9)	4.8 (1.7)	4.3 (1.9)	6.9 (2.0)	6.1 (2.0)	6.4 (2.1)	*p* < **0.001**
Sounds from the inside	8.2 (1.3)	7.9 (1.4)	8.2 (1.5)	4.9 (2.2)	5.1 (1.9)	5.0 (2.2)	7.4 (1.7)	7.1 (1.6)	7.2 (2.0)	*p* < **0.001**
Smells	7.9 (1.4)	7.8 (1.3)	7.5 (1.7)	5.3 (1.7)	5.1 (1.8)	4.3 (2.1)	6.5 (2.4)	5.7 (1.8)	5.6 (2.4)	*p* < **0.001**
Artificial light	7.2 (1.9)	7.0 (1.5)	6.8 (1.6)	6.6 (1.9)	5.9 (1.7)	5.5 (2.1)	6.1 (2.1)	5.5 (1.5)	5.5 (2.2)	*p* < **0.001**
Daylight	9.0 (0.9)	9.0 (0.9)	8.8 (1.0)	9.3 (0.7)	8.8 (0.9)	9.0 (1.0)	7.2 (1.3)	7.1 (1.2)	6.6 (1.6)	*p* < **0.001**
Psychosocial preferences-mean (SD)										
Storage	7.8 (1.3)	5.3 (2.2)	6.3 (2.6)	8.4 (1.1)	5.6 (2.1)	5.4 (2.3)	8.2 (1.3)	5.9 (1.9)	5.4 (2.5)	*p* < **0.001**

	IEQC1-PSC1	IEQC1-PSC2	IEQC1-PSC3	IEQC2-PSC1	IEQC2-PSC2	IEQC2-PSC3	IEQC3-PSC1	IEQC3-PSC2	IEQC3-PSC3	*p*-Value
Cleanliness	9.0 (1.1)	7.4 (1.2)	7.7 (1.8)	9.0 (1.0)	7.0 (1.5)	7.0 (1.7)	9.0 (0.9)	6.8 (1.3)	6.8 (1.9)	*p* < **0.001**
Amenities	8.9 (1.2)	8.0 (1.1)	7.8 (2.0)	8.9 (0.9)	7.9 (1.3)	7.4 (1.8)	8.9 (1.0)	7.8 (1.1)	7.4 (1.5)	*p* < **0.001**
Chair type	8.1 (1.7)	7.6 (1.5)	6.5 (2.6)	7.8 (1.7)	7.3 (1.5)	5.7 (2.2)	7.9 (1.9)	7.2 (1.4)	6.1 (2.1)	*p* < **0.001**
Presence and company of others	5.3 (2.4)	6.9 (2.0)	4.8 (2.8)	4.5 (2.4)	6.5 (2.2)	3.8 (2.3)	5.4 (2.5)	6.3 (1.8)	3.6 (2.2)	*p* < **0.001**
Size of the room	6.4 (1.9)	6.4 (1.3)	4.0 (1.8)	6.1 (1.6)	6.2 (1.7)	4.1 (1.8)	6.6 (1.9)	6.0 (1.5)	4.0 (1.8)	*p* < **0.001**
Bonding or identifying with the place	6.8 (1.6)	6.5 (1.9)	3.0 (1.8)	6.3 (1.9)	6.3 (2.3)	3.2 (2.2)	6.2 (2.1)	6.3 (1.9)	3.5 (2.0)	*p* < **0.001**
Ability to adapt or control the place	7.4 (1.6)	6.4 (1.7)	3.9 (1.6)	7.0 (1.6)	6.6 (1.6)	4.3 (1.9)	7.2 (1.6)	6.3 (1.7)	4.2 (2.0)	*p* < **0.001**
Privacy	8.2 (1.4)	6.5 (2.0)	6.5 (2.7)	7.9 (1.3)	5.9 (2.5)	6.2 (2.4)	8.5 (1.6)	6.4 (2.1)	6.4 (2.4)	*p* < **0.001**
Importance of IEQ-related aspects-mean (SD)										
Chair seat heating	5.0 (2.8)	3.8 (2.3)	4.0 (3.4)	3.8 (2.7)	4.5 (2.8)	3.3 (2.6)	4.5 (2.6)	3.6 (2.3)	2.8 (2.4)	*p* < **0.001**
Chair backrest eating	4.9 (2.8)	4.0 (2.5)	3.9 (3.4)	3.7 (2.8)	4.6 (3.1)	3.1 (2.7)	4.5 (3.1)	3.7 (2.7)	2.8 (2.6)	*p* < **0.001**
Heating on my desk	4.4 (2.7)	3.6 (2.5)	3.1 (2.6)	3.8 (2.9)	4.2 (2.8)	2.7 (2.3)	3.9 (2.7)	3.6 (2.3)	2.6 (2.6)	*p* < **0.001**
Lamp on my desk	6.9 (2.2)	6.4 (2.2)	6.6 (2.8)	7.1 (2.0)	5.5 (2.1)	5.8 (2.7)	6.9 (2.2)	6.2 (2.0)	6.3 (2.3)	*p* < **0.001**
Personal desk ventilation and fresh air	8.1 (1.7)	7.0 (2.4)	7.7 (2.3)	7.3 (1.9)	7.1 (2.3)	7.1 (2.3)	6.4 (2.5)	6.2 (2.0)	6.5 (1.9)	*p* < **0.001**
Control of surrounding sounds	8.1 (1.5)	7.3 (1.5)	7.6 (1.8)	6.7 (2.2)	5.4 (1.8)	5.0 (2.2)	6.7 (2.2)	6.6 (1.7)	7.1 (1.8)	*p* < **0.001**

	IEQC1-PSC1	IEQC1-PSC2	IEQC1-PSC3	IEQC2-PSC1	IEQC2-PSC2	IEQC2-PSC3	IEQC3-PSC1	IEQC3-PSC2	IEQC3-PSC3	*p*-Value
Control of shading	8.2 (1.6)	7.4 (1.6)	7.9 (1.9)	7.2 (2.0)	6.2 (2.1)	6.4 (2.4)	7.4 (1.8)	7.2 (1.6)	7.3 (1.7)	*p* < **0.001**
Control of room ventilation	8.2 (1.2)	7.6 (1.6)	7.4 (1.9)	7.0 (2.0)	6.1 (1.8)	6.0 (2.1)	7.3 (1.7)	7.0 (1.5)	6.0 (2.2)	*p* < **0.001**
Control of room temperature	8.3 (1.1)	7.4 (1.7)	7.3 (1.4)	7.5 (1.7)	6.3 (1.9)	6.7 (1.7)	8.3 (2.0)	6.8 (2.0)	6.7 (1.7)	*p* < **0.001**
Headphones	7.4 (2.6)	7.6 (2.3)	7.9 (2.4)	7.5 (2.4)	7.7 (1.3)	6.6 (2.9)	7.2 (2.0)	6.6 (2.2)	6.6 (2.6)	*p* < **0.001**
Presence of plants	7.0 (2.3)	5.9 (2.6)	4.8 (2.3)	7.0 (2.0)	5.7 (2.4)	5.5 (2.6)	6.9 (2.5)	5.6 (2.3)	4.0 (2.8)	*p* < **0.001**
Personal control over the most used study place- mean (SD)										
Temperature	4.6 (1.7)	3.8 (1.9)	4.3 (2.1)	5.3 (1.3)	4.5 (1.8)	4.4 (1.7)	4.7 (1.3)	4.3 (1.9)	4.5 (1.7)	*p* < **0.001**
Ventilation	5.1 (1.7)	3.9 (2.2)	4.9 (1.9)	5.5 (1.5)	4.6 (1.9)	4.6 (1.9)	5.8 (1.5)	4.4 (1.8)	4.8 (1.8)	*p* < **0.001**
Shading from the sun	5.2 (2.0)	4.2 (2.1)	4.6 (2.3)	5.1 (2.0)	4.3 (2.2)	4.4 (2.1)	5.4 (1.7)	5.0 (2.0)	4.5 (2.1)	*p* < **0.001**
Lighting	5.4 (2.0)	4.3 (2.2)	4.8 (2.2)	5.9 (1.4)	4.8 (2.1)	5.0 (1.9)	6.0 (1.0)	5.0 (2.0)	5.0 (2.1)	*p* < **0.001**
Noise	3.3 (1.6)	2.4 (1.1)	3.0 (1.4)	3.8 (1.8)	3.1 (1.5)	2.9 (1.4)	3.1 (1.4)	2.9 (1.5)	2.8 (1.5)	*p* < **0.001**

3.4.1. Overlap between IEQC1 with Psychosocial Clusters

The overlap between the IEQC1 and the three psychosocial clusters resulted in three profiles: IEQC1-PSC1: the concerned perfectionist; IEQC1-PSC2: the concerned extrovert; and IEQC1-PSC3: the concerned the non-perfectionist.

- IEQC1-PSC1: the concerned perfectionist.

The concerned perfectionist profile comprises 59 students (14%), of which 29% are male and 71% are female students. These students are the largest group that experienced positive events (37%). In terms of lifestyle, this group has the lowest number of students that consume alcohol (75%). Regarding the IEQ preferences, the concerned perfectionist students rated the highest importance for sounds from the inside (8.2), smells (7.9), sounds from the outside (7.8), and artificial light (7.2). Furthermore, they rated the highest importance (as compared to the other groups) for six IEQ-related items, which are control of room temperature (8.3), control of room ventilation (8.2), control of shading (8.2), control of surrounding sounds (8.1), personal desk ventilation and fresh air (8.1) and presence of plants (7.0). As this profile overlaps with PSC1 who are concerned with all psychosocial

preferences (except presence and company of others), it is the most concerned with cleanliness (9.0), amenities (8.9), chair type (8.1), ability to adapt or control the place (7.4), and bonding or identifying with the place (6.8).

- IEQC1-PSC2: the concerned extrovert.

The concerned extrovert profile consists of 63 students (14%), of which the percentages of male and female students are similar as the concerned perfectionist profile (29% and 71%, respectively). This profile is the second highest group that experienced recently positive events (35%). Regarding health, students within this profile are the second highest group that suffered from anxiety (30%). It can be noted that these students are the group to have the least control over all IEQ factors in their most used study place. Pertaining to IEQ preferences, the concerned extrovert students are concerned about all IEQ aspects, especially daylight (9.0) and view to the outside (8.8). As this profile overlaps with PSC2, it is the profile that is most concerned with the presence and company of others in their study places (6.9), while they rated the lowest importance for storage (5.3).

- IEQC1-PSC3: the concerned non-perfectionist

The concerned non-perfectionist profile comprises 35 students (8%), which includes the lowest percentage of male students (17%) and the highest percentage of female students (83%). Nearly half of them (45%) were feeling relaxed when they were completing the questionnaire. It can be noted that this profile rated the highest for negative affect (12.1). With regards to their lifestyle, students within this profile are the highest in terms of alcohol consumption (91%), as well as doing physical activity (94%). In terms of IEQ preferences, the concerned non-perfectionist students rated the highest importance for ventilation and fresh air (9.0), temperature (8.9) and sounds from the inside (8.2). Regarding IEQ-related items, these students rated the highest importance for headphones (7.9). As this profile overlaps with PSC3, which rated the least importance scores for most of the psychosocial preferences, it is the least concerned with bonding or identifying with the place (3.0), ability to adapt or control the place (3.9) and size of the room (4.0).

3.4.2. Overlap between IEQC2 with Psychosocial Clusters

The overlap between the IEQC2 and the three psychosocial clusters resulted in three profiles: IEQC2-PSC1: the visual concerned perfectionist; IEQC2-PSC2: the visual concerned extrovert; and IEQC2-PSC3: the visual concerned non-perfectionist.

- IEQC2-PSC1: the visual concerned perfectionist

The visual concerned perfectionist profile is the second smallest profile size that comprises 34 students (8%), of which 47% are male students and 53% are female students. It is the profile that least experienced recently positive events (23%), while it rated the highest positive affect (18.3). Most of the students (97%) within this profile spent their studying time at their homes. Pertaining to IEQ perception, these students comprise the profile that is least dissatisfied with air smell (35%). With regards to the IEQ preferences, the visual concerned perfectionist students rated the highest importance for daylight (9.3) and view to the outside (9.1). Regarding the IEQ-related items, these students rated the highest importance for lamp on my desk (7.1), and the presence of plants (7.0). With regards to psychosocial preferences, they rated the highest importance for cleanliness (9.0), amenities (8.9) and storage (8.4). In addition, the visual concerned perfectionist students scored a high importance level for privacy (7.9).

- IEQC2-PSC2: the visual concerned extrovert

The visual concerned extrovert profile is the largest profile size consisting of 64 students (15%), of which 41% of them are male students and 59% are female students. They tended to feel relaxed while they were answering the questionnaire (35%). Regarding IEQ perception, the visual concerned extrovert students are the most dissatisfied with air smell (63%) in their most used study places. However, view to the outside (8.9) and daylight (8.8) are the highest important IEQ preference aspects for these students. Pertaining to the

IEQ-related items, these students are the least concerned with personal desk ventilation and fresh air (5.5). Furthermore, they rated the lowest importance scores for the IEQ-related items control of shading (6.2) and control of room temperature (6.3). On the other hand, they are the second profile that scored a high importance score for headphones (7.7). In terms of psychosocial preferences, this profile is the least concerned with privacy (5.9). However, it is the second highest profile that is concerned with the presence and company of others (6.5).

- IEQC2-PSC3: the visual concerned non-perfectionist

The visual concerned non-perfectionist profile comprises 48 students (11%), in which the reported percentages of male and female students (40% and 58%, respectively) are similar to the visual concerned extravert profile. The visual concerned non-perfectionist students are the highest group that suffered from anxiety (31%). With regards to IEQ preferences, they rated the lowest importance for sounds from the outside (4.3), smells (4.3), sounds from the inside (5.0), artificial light (5.5), and temperature (7.6) among the other profiles. However, these students scored high importance levels for the view to the outside (9.2) and daylight (9.0) Furthermore, they rated the lowest importance for two IEQ-related items which are control of room sounds (5.0) and control of room ventilation (6.0). However, personal desk ventilation and fresh air (7.1) is the highest important IEQ-related item for this profile. Pertaining to psychosocial preferences, this profile rated the lowest importance for chair type (5.7). Although the amenities (7.4) aspect was scored the lowest importance level by the visual concerned non-perfectionist students, it was considered the highest important psychosocial aspect.

3.4.3. Overlap between IEQC3 with Psychosocial Clusters

The overlap between the IEQC3 and the three psychosocial clusters resulted in three profiles: IEQC3-PSC1: the unconcerned introvert; the unconcerned extrovert; and the unconcerned non-perfectionist.

- IEQC3-PSC1: the unconcerned introvert

The unconcerned introvert profile is the smallest profile size that comprises 17 students (4%), of which the percentage of male students (59%) is higher than the percentage of female students (41%). The study places for the majority of these students (94%) were located at their homes. Regarding lifestyle, the unconcerned introvert students are the second lowest group that consumes alcohol (77%), and the profile that takes part in the least physical activities (71%). On the contrary, they are the group that suffered most from depression among the other profiles (29%), as well as one of the profiles that suffered most from anxiety (29%). Pertaining to the IEQ perception, this profile reported the least dissatisfaction percentage with the air smell of their study places (35%). In terms of the IEQ-related items, this profile is the most concerned with control of temperature (8.3). In contrast, the unconcerned introvert students are the second profile that is not concerned with personal desk ventilation and fresh air (6.4). However, they do have the highest control over lighting (6.0), ventilation (5.8), and shading from the sun (5.4) in their study places. With regards to the psychosocial preferences, of the four aspects, these students rated these aspects as the highest importance: cleanliness (9.0), amenities (8.9), privacy (8.5), and size of the room (6.6).

- IEQC3-PSC2: the unconcerned extrovert

The unconcerned extrovert profile is considered as a large profile size that consists of 59 students (14%), of which the female students' percentage (58%) is higher than the male students' percentage (41%). These students recorded the highest percentage of feeling neutral while they were completing the questionnaire (28%). They are the second lowest profile to experience recently positive events (24%). Furthermore, they rated the lowest positive affect (16.9). It can be noted that this profile has the least students that suffered from both depression (15%) and anxiety (19%). In terms of IEQ preferences, the

unconcerned extrovert students are the least concerned with artificial light in their study places (5.5). Nonetheless, temperature (7.9) is the most important IEQ preference. With regards to IEQ perception, the unconcerned extrovert students reported the least dissatisfaction percentage with air freshness (50%). Pertaining to the IEQ-related items, these students rated both personal ventilation and fresh air the least important (6.2) and headphones (6.6). Nevertheless, control of shading (7.2) and control of room ventilation (7.0) are the most important items for them. Regarding the psychosocial preferences, this profile rated of lowest importance cleanliness (6.8) in their study places. However, the unconcerned extrovert profile is one of the profiles that rated the highest importance for the presence and company of others (6.3).

- IEQC3-PSC3: the unconcerned non-perfectionist

The unconcerned non-perfectionist profile has the same profile size as the unconcerned extrovert profile, with 59 students (14%), of which the percentage of male students (54%) is higher than the percentage of female students (46%). Students within this profile rated the lowest negative affect score among other profiles (10.9). Regarding health, this profile is the second highest group that suffered from depression (29%). Pertaining to IEQ perception, this profile that is dissatisfied the most with air freshness (75%). In terms of IEQ preferences, the unconcerned non-perfectionist students are the least concerned with artificial light (5.5), view to the outside (6.4), daylight (6.6), and ventilation and fresh air (7.1). On the other hand, they are only concerned about temperature (8.1). With regards to IEQ-related items, they rated the least importance for the presence of plants (4.0), control of room ventilation (6.0) and headphones (6.6). Nonetheless, they are concerned about the control of shading (7.3) and surrounding sounds (7.0). Regarding the psychosocial preferences, this profile of students is the least concerned with the presence and company of others (3.6) and the size of the room (4.0). While amenities (7.4) and cleanliness (6.8) are the most important for these students, they are rated the least important among other profiles.

4. Discussion

4.1. Comparison with Previous Studies

The majority of students (74%) within this study spent most of their studying time at their homes. A previous study indicated that a home can be considered as an off-campus informal study place, and that most students studied at home as well before the COVID-19 outbreak [33].

Students in this study were generally concerned with three IEQ preferences: daylight, view of the outside, and temperature in their study places. Furthermore, they rated high importance levels for two psychosocial aspects: amenities and cleanliness. Previous studies found similar findings with regards to these preferences. For example, temperature [34] and daylight [3,25] (which is also known as natural lighting) were found to be important criteria by university students in informal study places. Due to the development of the information and communication technologies (ICT), amenities including PCs and laptops were considered important aspects by students in informal study places [3]. In addition, the presence of windows, which also refers to the view to the outside, was also preferred by university students for their study places at the library [35]. Cleanliness has also been affirmed to be an important aspect for students in informal study places such as university libraries [36] and university campus facilities [37]. While students in the current study rated a high importance score for the view to the outside, university students in another study rated a low importance score for the window view in the university library [36]. Yet, in another two studies [38,39], university students tended to choose their study places in the campus library that is close to the window. The latter outcome is similar to the findings of the current study: students generally preferred to have a view to the outside in their study places, whether at home or on campus. A previous study concluded that window views of the natural environment outside (e.g., green spaces) have a positive

psychological impact on university students in terms of recovery from attentional fatigue [40]. During COVID-19 lockdown, the poor view to the outside negatively affected the mental health of university students while they were staying at home [41]. Hence, these preferences have a significant role in fulfilling students' preferences, as well as promoting their health.

In a study conducted by Zhang et al. [12], six profiles of primary school children based on their IEQ preferences and needs in classrooms were determined. While the most important three environmental aspects for these children were "hearing the teacher", "fresh air", and "air temperature", university students from the faculty of architecture were mainly concerned with visual aspects including "daylight" and "view to the outside". In both studies, one IEQ profile was concerned with light or visual aspects, although the primary school children were mainly concerned with artificial light and the university students with natural light. Furthermore, in both studies, one profile was concerned with all IEQ aspects and one profile was not concerned with any of the IEQ-aspects. The difference can be seen in the additional profiles concerned with sound, thermal and air quality aspects. These differences could be associated with the population. In other words, the respondents in this study were all bachelor students of the faculty of Architecture studying to become an architect, a profession in which visual aspects are important. On the contrary, primary school children comprise pupils that are yet to choose their profession or field of study.

4.2. Students' Profiles Based on the Overlap between the Two Cluster Models

While previous studies on office workers [26] and outpatient staff [27] conducted the cluster analysis separately based on IEQ preferences/perception and psychosocial preferences, the present study explored the overlap among the IEQ preferences and psychosocial preferences clusters. This resulted in several advantages. For instance, the number of variables that were significantly different among the profiles was higher than in the separated cluster models. In this study, health (e.g., depression) was not significantly different among both cluster models (IEQ and psychosocial preferences). However, this variable was found to be significantly different among the nine profiles resulting from the overlap. According to the study of office workers [26], the health variables such as anxiety were only significantly different among the IEQ clusters, while not found to be significantly different among the psychosocial preferences clusters. Similarly, in the study on outpatient staff [27], some variables only varied significantly among the IEQ clusters (e.g., preference for control of temperature), while it was not significantly different among the psychosocial clusters. Therefore, the overlap facilitates a more detailed understanding of the distinct characteristics among the profiles. IEQ, as well as psychosocial preferences, is also important to support comfort; combined profiles contribute to more realistic insights.

Students that had similar IEQ preferences within IEQC1, who were mainly concerned with all IEQ aspects, showed differences in various psychosocial aspects. The results showed that concerned perfectionist students were concerned with all IEQ preferences (specifically sounds and smells), as well as all the psychosocial preferences, except the presence and company of others. On the contrary, the concerned extroverts rated similar importance scores for IEQ preferences as the concerned perfectionists, but they were the most concerned cluster in terms of the presence and company of others in their study places. Additionally, the concerned extrovert students belonged to the profile that had the least personal control over IEQ aspects in their most used study places. Furthermore, both the concerned perfectionists and the concerned extroverts experienced the most recent positive events. In contrast, the concerned non-perfectionist students who were concerned with all IEQ aspects (specifically ventilation and fresh air) scored the highest negative affect compared to the other clusters. In addition, this profile scored the least importance for bonding or identifying with the place, ability to adapt or control the place, and size of the room. However, this profile rated the highest importance score for headphones as a significant IEQ-related item that helps them to study better.

Students within cluster IEQC2 that were generally concerned with daylight scored different in their psychosocial preferences. The overlap between IEQC2 and the three psychosocial preference clusters showed a significant difference in several characteristics. Visual concerned perfectionist students were the most concerned with daylight and the view to the outside. However, the students in this profile experienced the least positive events, while they scored the highest positive affect. Additionally, they were more concerned with a lamp on their desks to study better than the visual concerned-extrovert students, who were the least concerned with privacy in their study places. While the visual concerned perfectionists were the most concerned with amenities, the visual concerned non-perfectionists were the least concerned with amenities. In terms of health, the visual concerned non-perfectionists suffered the most from anxiety.

IEQC3 students were the least concerned with both artificial light as well as ventilation and fresh air. They showed different characteristics in the overlap between IEQC3 and the three psychosocial preferences profiles. While both the unconcerned extroverts and unconcerned non-perfectionists suffered the most from depression, the unconcerned extroverts suffered the least from depression. In addition, the unconcerned extroverts suffered the least from anxiety. It is interesting to note that all three profiles were the least concerned with having personal desk ventilation and fresh air in their study places. However, only the unconcerned non-perfectionists reported the highest dissatisfaction with air freshness in their most used study places, while both the unconcerned introverts and the unconcerned extroverts reported the least dissatisfaction with air freshness. Additionally, the unconcerned introverts were the least dissatisfied with the smell in their most used study places. While the unconcerned introverts rated the highest importance score for control of room temperature, both the unconcerned extroverts and the unconcerned non-perfectionists rated low scores for this IEQ-related item. Additionally, the unconcerned introverts had the highest control level over IEQ aspects in their study places (specifically, ventilation, shading from the sun, and lighting). Furthermore, while the unconcerned introverts rated the highest importance for cleanliness, both the unconcerned extroverts and the unconcerned non-perfectionists were the least concerned with cleanliness. Furthermore, although the unconcerned introverts were the most concerned with privacy in their study places, both the unconcerned extroverts and the unconcerned non-perfectionists were not very concerned with privacy.

4.3. Differences in Preferences of Profiles in Relation to Design Implementations

In general, there were significant differences among the profiles in terms of IEQ and psychosocial preferences, which means that generalizing the preferences of the whole study sample is not appropriate. For example, while privacy was indicated as highly preferred by students in their study places [34], this study reveals that there are two opposite profiles in terms of the importance of privacy in the study places: one of them (the unconcerned introvert) was highly concerned with privacy, while the other one (the visual concerned extrovert) rated privacy in their study places as less important. This result is similar to the findings of a previous study [23] in which the outcome showed that students' characteristics (birthplace and current educational level) have an influence on students' preferences, such as privacy and interaction.

While all the nine profiles were found to be statistically different in all IEQ preference aspects, their mean importance scores were higher than the mid-scale point (5.0). Nonetheless, there were profiles for which their mean importance scores for sounds from the outside (visual concerned extroverts and visual concerned non-perfectionists), sounds from the inside (visual concerned perfectionists), and smells (visual concerned non-perfectionists) were less than the mid-point scale (5.0). This means that there are profiles of students which are not highly concerned about sounds in their study places. The current study found that three profiles are not concerned about the sounds (from the outside or the inside) at their study places. This is in line with another study, conducted by Cunningham and Walton [20], which indicated that the preferences of university students to study

in a quiet environment (e.g., university library) vary. In contrast, Beckers et al. [2] found that most university students prefer studying in quiet learning spaces.

The overlap among the IEQ and psychosocial models contributed to understanding in-depth students' profiles based on their different preferences in their study places. Different approaches can be applied to fulfil the different preferences of each profile. For instance, soundscape approach considers the individual's sound preferences in a certain environment. According to ISO 12913-1 [42], the soundscape is defined as: "acoustic environment as perceived or experienced and/or understood by a person or people in a context". This approach can understand the sound preference of each profile at study places. Additionally, the soundscape is mainly focused on using the sound as a resource that fulfils the sound preference rather than focusing on quiet spaces [43]. For instance, Shu and Ma [9] concluded that natural sound sources, such as birdsongs and stream sounds, had restorative effects on classroom children after performing a cognitive task, while the quiet condition did not show an effect. In addition, a study conducted by Topak and Yılmazer [44] found that students' sound preferences differ based on the context of the space, classroom or computer laboratory. They also found that natural sounds (e.g., birdsongs) were preferred by students to hear in their learning environments. Moreover, Xiao and Aletta [45] concluded that the soundscape approach could facilitate architects and interior designers to understand the students' experiences to provide high-quality sound environments or study places, such as libraries, by identifying different types of users. Accordingly, soundscape can be accounted for during the design process to understand the sound preferences of each profile of students at their study places. Another approach that can be applied to fulfil the different preferences is the application of customized (i.e., personalized) designs. These applications can match the preferences of each profile and could provide comfort for them, such as customized and personalized shading [46], ceiling fans [47], and heating [48], which allow users to have control over the surrounding environment based on their preferences.

4.4. Limitations

The sample of this study is limited to bachelor university students (specifically of the faculty of Architecture and the Built environment), whose mean age was 20 years old. The questionnaire was also completed at the time of the COVID-19 outbreak, which may have influenced students' preferences during this situation. It was sent to students during the fall and spring (October and March) seasons in the Netherlands, which could have had an impact on students' responses such as whether they scored high importance for both daylight and temperature. Furthermore, the IEQ and psychosocial preferences were asked within the context of studying at study places in general, while the learning activities/styles (e.g., individual, collaborative) were not investigated in the present study. The nine profiles in this study were identified based on the preferences (IEQ and psychosocial preferences) of bachelor students at the faculty of Architecture and the Built Environment in the Netherlands. Hence, further studies could validate these nine profiles with students from other faculties, as well as other universities with a different cultural background. As this study is based on a survey (questionnaire) with 451 students who were studying either at their homes or in educational buildings, space geometry and physical measurements of IEQ factors were not included in this study.

5. Conclusions

In conclusion, students with similar IEQ preferences have different psychosocial preferences, and vice versa. This was affirmed by determining nine profiles of university students based on the overlap between the IEQ and psychosocial preferences. These profiles showed significant differences among them in terms of various variables, including perception, lifestyle, health, and gender. It is worthwhile to note that the number of variables that were significantly different between the profiles is higher within the overlap between the IEQ and psychosocial preferences than clustering the students based on these

preferences separately. The outcome of this study provides insight into different profiles of university students, each with their own preferences of study places. For instance, the concerned perfectionists are highly concerned with sounds (from the outside and inside) of their study places, while the visual concerned non-perfectionists are not highly concerned with sounds. These findings show the need for designing study places for more than one profile and not just for the "average" student.

The novelty of this study lies in the overlap of the IEQ and psychosocial preferences models that resulted in nine profiles, which showed significant differences among a number of variables. Therefore, it is recommended for future studies to determine the profiles of occupants (e.g., students, office workers, home occupants) within different scenarios (e.g., classrooms, study places, offices, homes) by the analysis of the overlap between the two sets of clusters.

Since this study is based on a survey in which physical measurements were not considered, it is suggested for future research to investigate these study places in-depth. For instance, field studies such as exploring the soundscapes of these study places can be investigated by measuring the sound pressure level (SPL), identifying sound sources as well as space geometry, and conducting in-depth interviews with the students from different profiles.

Appendix A. Sections and Sub-Sections of the Questionnaire.

Section	Sub-Section	Instrument
Personal information	Age Gender	-
Psycho-social aspects	Mood	OFFICAR, select one out of nine moods (e.g., cheerful) [31,49,50].
	Recently experienced positive events (e.g., wedding) and negative events (e.g., funeral).	OFFICAR, select either yes or no [31,49,50].
	Positive and Negative Affect Schedule (PANAS)	I-PANAS-SF, including five positive effects and five negative effects, on a scale 1 to 5 (1: never, 5: always) [51].
Mostly used study place	Study place type	Select one of the three options: home, educational building, or other.

Section	Sub-Section	Instrument
Preferences	IEQ preferences *Please rate on a scale from 1 to 10, the importance of each of the following aspects for your study performance at your study place1: Not important at all; 10: Extremely important*-e.g., temperature".	Eight aspects on a scale 1 to 10 (1: not important at all, 10: extremely important) [26].
	Psychosocial preferences: "*Please rate on a scale from 1 to 10, the importance of each of the following aspects for your study performance at your study place1: Not important at all; 10: Extremely important*-e.g., privacy".	Nine aspects on a scale 1 to 10 (1: not important at all, 10: extremely important) [26].
	Importance of IEQ-related items: "*Please rate on a scale from 1 to 10, the importance of each of following the items that would help you to study better; 1: Not important at all; 10: Extremely important*-e.g., lamp on my desk".	Eleven aspects on a scale 1 to 10 (1: not important at all, 10: extremely important) [26].
Comfort	IEQ perception: "*On a scale of 1 to 7, how would you describe the general indoor comfort of your MOST used study place in the past 3 months?* e.g., temperature satisfaction".	Eighteen aspects on a scale 1 to 7 (1: dissatisfied, 7: satisfied [26,27,31].
	Control over IEQ factors: "*How much control do you personally have over the following aspects of your MOST used study place?*- e.g., ventilation".	Five aspects on a scale 1 to 7 (1: not at all, 7: full control) [26].
	Psychosocial perception: *How satisfied are you with the following in your MOST used study place*-e.g., amount of privacy".	Five aspects on a scale 1 to 7 (1: unsatisfactory, 7: satisfactory) [26].
Lifestyle	Physical activity	OFFICAR, select either yes or no [31].
	Smoking	OFFICAR, select one out of four options (e.g., no never, yes former, yes incidentally, yes daily) [31].
	Alcohol	OFFICAR, select one out of three options (e.g., yes daily, yes occasionally, no) [31].
Health and medical history	Suffering from diseases: "*Have you ever been told by your doctor that you are suffering from: e.g., asthma*"	OFFICAR, includes eighteen diseases, each disease is rated one out of three options: never, yes in the last 12 months, yes but not in the last 12 months [31].

Appendix B. IEQ Preferences Clusters.

	IEQC1	IEQC2	IEQC3	*p*-Value
n (%within the total sample)	159 (35.5)	149 (33.3)	140 (31.3)	-
Age				0.325
Mean (SD)	19.6 (1.7)	19.7 (1.3)	19.9 (1.7)	-
Maximum	31	26	29	-
Minimum	17	18	18	-
Mood-n (%within cluster level)				0.375
Cheerful	12 (7.5)	14 (9.4)	10 (7.1)	-
Relaxed	42 (26.4)	43 (28.9)	39 (27.9)	-
Calm	31 (19.5)	20 (13.4)	15 (10.7)	-
Neutral	31 (19.5)	28 (18.8)	33 (23.6)	-

	IEQC1	IEQC2	IEQC3	*p*-Value
Sad	10 (6.3)	8 (5.4)	17 (12.1)	-
Bored	21 (13.2)	23 (15.4)	17 (12.1)	-
Recently experienced events-n (%within cluster level)				
Positive events	45 (34.0)	40 (26.8)	36 (25.7)	0.226
Negative events	56 (35.2)	44 (29.5)	50 (35.7)	0.455
Lifestyle-n (%)				
Smoking	42 (26.4)	46 (30.9)	46 (32.8)	0.380
Alcohol	133 (83.7)	129 (86.6)	119 (85.0)	0.502
Physical activity	146 (91.8)	138 (92.6)	120 (85.7)	0.098
PANAS-Mean (SD)				
Positive affect	17.5 (2.6)	17.6 (2.5)	17.1 (2.7)	0.122
Negative affect	11.8 (3.0)	11.3 (2.9)	11.4 (3.0)	0.617
Health-n (%within cluster level)				
Hay fever	35 (22.2)	30 (20.1)	33 (23.6)	0.205
Rhinitis	52 (32.9)	51 (34.2)	43 (30.2)	0.074
Eczema	18 (6.3)	25 (16.8)	22 (15.7)	0.517
Other skin conditions	12 (7.6)	15 (10.1)	18 (12.9)	0.590
Migraine	24 (15.2)	23 (15.5)	21 (15.0)	0.314
Depression	31 (19.5)	29 (19.5)	32 (22.9)	0.477
Anxiety	44 (27.8)	31 (20.8)	30 (21.4)	0.126
Mental health problems	32 (20.3)	23 (15.5)	23 (16.4)	0.677
IEQ perception of study-n (%within cluster level)				
Temperature in general dissatisfaction	31 (19.5)	27 (18.1)	38 (28.4)	0.084
Temperature not stable	42 (26.4)	36 (24.2)	43 (30.7)	0.588
Dissatisfied with air freshness	93 (58.5)	88 (59.1)	84 (60.0)	0.730
Dissatisfied with air smell	72 (45.3)	71 (47.7)	58 (41.4)	0.393
Air quality in general dissatisfaction	23 (14.5)	18 (12.1)	18 (12.9)	0.521
Daylight dissatisfaction	22 (13.8)	15 (10.1)	15 (10.7)	0.928
Reflection from the sun dissatisfaction	27 (17.0)	25 (16.8)	12 (8.6)	0.167
Artificial light dissatisfaction	24 (15.1)	33 (22.1)	25 (17.9)	0.182
Lighting in general dissatisfaction	13 (8.2)	16 (10.7)	9 (6.4)	0.867
Noise from outside dissatisfaction	36 (22.6)	37 (24.8)	36 (25.7)	0.391
Noise from installations dissatisfaction	19 (11.9)	23 (15.4)	20 (14.3)	0.907
Noise other than installations dissatisfaction	38 (23.9)	29 (19.5)	29 (20.7)	0.745
Noise in general dissatisfaction	28 (17.6)	30 (20.1)	20 (14.3)	0.921
Vibration dissatisfaction	21 (13.2)	16 (10.7)	16 (11.4)	0.836
Psychosocial perception of study place- n (%within cluster level)				
Amount of privacy dissatisfaction	14 (8.8)	10 (6.7)	12 (8.6)	0.754
Layout dissatisfaction	12 (7.5)	10 (6.7)	6 (4.7)	0.498
Decoration dissatisfaction	8 (5.0)	10 (6.7)	13 (9.3)	0.337
Cleanliness dissatisfaction	22 (13.8)	21 (14.1)	19 (13.6)	0.993
View to the outside dissatisfaction	16 (10.1)	20 (13.4)	18 (12.9)	0.611
Psychosocial preferences-mean (SD)				
Storage	6.5 (2.3)	6.2 (2.3)	6.0 (2.3)	0.503
Amenities	8.3 (1.5)	8.0 (1.5)	7.8 (1.4)	0.064
Presence and company of others	5.8 (2.5)	5.1 (2.6)	5.0 (2.6)	0.308
Size of the room	5.9 (1.9)	5.4 (2.0)	5.2 (2.0)	0.133
Bonding or identifying with the place	5.8 (2.3)	5.3 (2.6)	5.1 (2.4)	0.090

	IEQC1	IEQC2	IEQC3	*p*-Value
Ability to adapt or control the place	6.2 (2.1)	5.9 (2.1)	5.1 (2.6)	0.249
Importance of IEQ-related aspects-mean (SD)				
Chair seat heating	4.3 (2.8)	4.0 (2.8)	3.4 (2.5)	0.106
Chair backrest eating	4.4 (2.9)	3.9 (3.0)	3.5 (2.8)	0.095
Heating on my desk	3.9 (2.7)	3.6 (2.7)	3.2 (2.5)	0.141
Presence of plants	6.1 (2.5)	5.9 (2.5)	5.1 (2.7)	0.62
Personal control over the most used study place-mean (SD)				
Temperature	4.2 (1.9)	4.7 (1.7)	4.4 (1.8)	0.206
Ventilation	4.6 (2.0)	4.8 (1.8)	4.6 (1.8)	0.311
Shading from the sun	4.7 (2.2)	4.5 (2.1)	4.8 (2.0)	0.772
Lighting	4.8 (2.2)	5.1 (1.9)	5.1 (1.9)	0.377
Noise	2.9 (1.4)	3.2 (1.6)	2.9 (1.5)	0.168

Appendix C. Psychosocial Preferences Clusters

	PSC1	PSC2	PSC3	*p*-Value
n (%within total sample)	110 (25.0)	186 (42.3)	144 (32.7)	-
Age				0.084
Mean (SD)	19.7 (1.5)	19.8 (1.8)	19.7 (1.3)	-
Maximum	29	31	26	-
Minimum	17	17	18	-
Gender -n (%within cluster level)				0.776
Male	43 (39.1)	68 (36.6)	58 (40.3)	-
Female	67 (60.9)	117 (62.9)	85 (59.0)	-
Mood-n (%)				0.262
Cheerful	9 (8.1)	20 (10.8)	7 (4.9)	-
Relaxed	26 (23.7)	48 (25.8)	50 (34.7)	-
Calm	18 (16.4)	29 (15.6)	19 (13.2)	-
Neutral	23 (20.9)	42 (22.6)	23 (16.0)	-
Sad	10 (9.1)	14 (7.5)	9 (6.3)	-
Bored	20 (18.2)	18 (9.7)	21 (14.6)	-
Recently experienced events-n (%within cluster level)				
Positive events	35 (31.8)	54 (29.0)	37 (25.7)	0.557
Negative events	34 (30.9)	64 (34.4)	47 (32.6)	0.822
Lifestyle-n (%)				
Physical activity	97 (88.2)	170 (91.4)	129 (89.6)	0.658
PANAS-Mean (SD)				
Positive affect	18.0 (2.5)	17.1 (2.5)	17.3 (2.6)	0.168
Negative affect	11.8 (2.9)	11.6 (2.9)	11.2 (3.1)	0.301
Health-n (%within cluster level)				
Asthma	4 (3.6)	9 (8.0)	4 (2.8)	0.204
Hay fever	21 (19.1)	45 (24.2)	31 (21.5)	0.796
Rhinitis	26 (23.6)	70 (37.7)	48 (33.3)	0.194
Eczema	16 (7.3)	26 (14.0)	23 (16.0)	0.984
Other skin conditions	6 (5.4)	22 (11.8)	17 (11.8)	0.262
Migraine	16 (14.5)	30 (16.2)	22 (15.3)	0.697
Depression	23 (20.9)	33 (17.8)	35 (24.3)	0.923
Anxiety	30 (27.3)	42 (22.6)	35 (24.3)	0.181

	PSC1	PSC2	PSC3	*p*-Value
Mental health problems	21 (19.1)	23 (16.7)	24 (16.7)	0.701
IEQ perception of study-n (%within cluster level)				
Temperature in general dissatisfaction	23 (20.9)	43 (23.1)	29 (20.1)	0.832
Temperature not stable	32 (29.1)	48 (25.8)	41 (28.5)	0.744
Dissatisfied with air smell	45 (40.9)	94 (50.5)	63 (43.8)	0.261
Air quality in general dissatisfaction	18 (16.4)	20 (10.8)	21 (14.6)	0.324
Daylight dissatisfaction	9 (8.2)	24 (12.9)	18 (12.5)	0.434
Reflection from the sun dissatisfaction	11 (10.0)	28 (15.1)	26 (18.1)	0.188
Artificial light dissatisfaction	14 (12.7)	37 (19.9)	29 (20.1)	0.227
Lighting in general dissatisfaction	7 (6.4)	18 (9.7)	12 (8.3)	0.623
Noise from outside dissatisfaction	30 (27.3)	50 (26.9)	30 (20.8)	0.399
Noise from installations dissatisfaction	16 (14.5)	24 (12.9)	20 (13.9)	0.902
Noise other than installations dissatisfaction	26 (23.6)	39 (21.0)	32 (22.2)	0.842
Noise in general dissatisfaction	20 (18.2)	32 (17.2)	26 (18.1)	0.953
Vibration dissatisfaction	16 (14.5)	24 (12.9)	13 (9.0)	0.385
Psychosocial perception of study place- n (%within cluster level)				
Cleanliness dissatisfaction	10 (9.1)	28 (15.1)	24 (16.7)	0.193
View to the outside dissatisfaction	11 (10.0)	25 (13.4)	18 (12.5)	0.676
IEQ preferences-mean (SD)				
Ventilation and fresh air	8.2 (1.3)	7.8 (1.3)	7.7 (1.7)	0.065
View to the outside	8.5 (1.4)	8.2 (1.7)	7.9 (2.0)	0.075
Sounds from the inside	7.1 (2.2)	6.7 (2.0)	6.7 (2.4)	0.154
Importance of IEQ-related aspects-mean (SD)				
Personal desk ventilation and fresh air	7.6 (2.0)	6.7 (2.3)	7.0 (2.2)	0.138
Headphones	7.4 (2.4)	7.3 (2.3)	6.9 (2.7)	0.734
Personal control over the most used study place- mean (SD)				
Temperature	4.8 (1.6)	4.2 (1.9)	4.4 (1.8)	0.087
Shading from the sun	5.2 (2.0)	4.5 (2.1)	4.5 (2.1)	0.051
Lighting	5.7 (1.7)	4.7 (2.1)	5.0 (2.0)	0.065
Noise	3.4 (1.6)	2.8 (1.4)	2.9 (1.4)	0.069

Appendix D. Descriptive of the Overlap Nine Profiles

	IEQC1-PSC1	IEQC1-PSC2	IEQC1-PSC3	IEQC2-PSC1	IEQC2-PSC2	IEQC2-PSC3	IEQC3-PSC1	IEQC3-PSC2	IEQC3-PSC3	*p*-Value
n (%within the total sample)	59 (13.5)	63 (14.4)	35 (8.0)	34 (7.8)	64 (14.6)	48 (11.0)	17 (3.9)	59 (13.5)	59 (13.5)	-
Mood-N (%)										
Cheerful *	5 (8.5)	5 (7.9)	2 (5.7)	3 (8.8)	9 (14.1)	2 (4.2)	1 (5.9)	6 (10.2)	3 (5.1)	-
Relaxed *	14 (23.7)	12 (19.0)	16 (45.7)	4 (11.8)	23 (35.9)	8 (16.7)	4 (23.5)	13 (22.0)	9 (15.3)	-
Calm *	11 (18.6)	14 (22.2)	6 (17.1)	6 (17.6)	7 (10.9)	7 (14.6)	1 (5.9)	8 (13.6)	6 (10.2)	-
Neutral *	13 (22.0)	14 (22.2)	3 (8.6)	7 (20.6)	11 (17.2)	8 (16.7)	3 (17.6)	17 (28.8)	12 (20.3)	-
Sad *	3 (5.1)	4 (6.3)	1 (8.6)	1 (2.9)	2 (3.1)	4 (8.3)	2 (11.8)	8 (13.6)	5 (8.5)	-
Bored *	9 (15.3)	8 (12.7)	3 (8.6)	6 (17.6)	7 (10.9)	10 (20.8)	5 (29.4)	3 (5.1)	8 (13.6)	-
Recently experienced events-n (%within profile level)										
Negative events	20 (33.9)	22 (34.9)	13 (37.1)	8 (23.5)	20 (31.3)	15 (31.3)	6 (35.3)	22 (37.3)	19 (32.2)	0.054

	IEQC1-PSC1	IEQC1-PSC2	IEQC1-PSC3	IEQC2-PSC1	IEQC2-PSC2	IEQC2-PSC3	IEQC3-PSC1	IEQC3-PSC2	IEQC3-PSC3	*p*-Value
Lifestyle-n (%within profile level)										
Smoking *	8 (13.6)	22 (34.9)	12 (34.3)	10 (29.4)	19 (29.7)	15 (31.2)	3 (17.7)	15 (25.4)	21 (35.6)	-
Study place-N (%within profile level)										
Home	49 (83.1)	31 (49.2)	22 (62.9)	33 (97.1)	43 (67.2)	40 (83.3)	16 (94.1)	43 (72.9)	46 (78.0)	-
Educational building *	10 (16.9)	31 (49.2)	13 (37.1)	1 (2.9)	21 (32.8)	7 (14.6)	1 (5.9)	16 (27.1)	13 (22.0)	-
Health-n (%within profile level)										
Hay fever *	9 (15.3)	18 (28.6)	8 (22.9)	8 (23.5)	11 (17.2)	10 (20.9)	4 (23.5)	16 (27.1)	13 (22.0)	-
Rhinitis *	14 (23.7)	28 (44.5)	10 (28.6)	8 (23.5)	24 (37.5)	17 (35.4)	4 (23.5)	18 (30.5)	21 (35.6)	-
Eczema *	6 (10.2)	7 (11.1)	5 (14.3)	7 (20.5)	11 (17.2)	7 (14.6)	3 (17.6)	8 (13.6)	11 (18.6)	-
Other skin conditions *	2 (3.4)	8 (12.7)	2 (5.7)	3 (8.8)	6 (9.4)	5 (10.4)	1 (5.9)	7 (11.9)	10 (17.0)	-
Migraine *	6 (10.2)	11 (17.5)	7 (20.0)	8 (23.5)	10 (15.6)	5 (10.4)	2 (11.8)	9 (15.3)	10 (16.9)	-
Mental health problems *	11 (18.6)	14 (22.2)	6 (17.1)	8 (23.5)	8 (12.5)	7 (14.6)	2 (11.8)	9 (15.3)	11 (18.6)	-
IEQ perception of study place-n (% level)										
Temperature in general dissatisfaction *	13 (22.0)	13 (20.6)	5 (14.3)	4 (11.8)	14 (21.9)	8 (16.7)	6 (35.3)	16 (27.1)	16 (27.1)	-
Temperature not stable	14 (23.7)	20 (31.7)	8 (22.9)	11 (32.4)	12 (18.8)	13 (27.1)	7 (41.2)	16 (27.1)	19 (32.2)	0.093
Air quality in general dissatisfaction *	8 (13.6)	10 (15.9)	5 (14.3)	5 (14.7)	5 (7.8)	8 (16.7)	5 (29.4)	5 (8.5)	8 (13.6)	-
Daylight dissatisfaction *	6 (10.2)	11 (17.5)	5 (14.3)	2 (5.9)	8 (12.5)	4 (8.3)	1 (5.9)	5 (8.5)	9 (15.3)	-
Reflection from the sun dissatisfaction *	6 (10.2)	15 (23.8)	6 (17.1)	4 (11.8)	11 (17.2)	10 (20.8)	1 (5.9)	2 (3.4)	9 (15.3)	-
Artificial light dissatisfaction *	8 (13.6)	13 (20.6)	3 (8.6)	6 (17.6)	12 (18.8)	14 (29.2)	-	12 (20.3)	12 (20.3)	-
Lighting in general dissatisfaction *	3 (5.1)	8 (12.7)	2 (5.7)	4 (11.8)	9 (14.1)	2 (4.2)	-	1 (1.7)	8 (13.6)	-
Noise from outside dissatisfaction *	17 (28.8)	15 (23.8)	4 (11.4)	9 (26.5)	18 (28.1)	10 (20.8)	4 (23.5)	17 (28.8)	15 (25.4)	-
Noise from installations dissatisfaction *	8 (13.6)	7 (11.1)	4 (11.4)	4 (11.8)	8 (12.5)	10 (20.8)	4 (23.5)	9 (15.3)	6 (10.2)	-
Noise other than installations dissatisfaction *	14 (23.7)	14 (22.2)	10 (28.6)	8 (23.5)	11 (17.2)	10 (20.8)	4 (23.5)	14 (23.7)	11 (18.6)	-
Noise in general dissatisfaction *	10 (16.9)	10 (15.9)	8 (22.9)	7 (20.6)	14 (21.9)	9 (18.8)	3 (17.6)	8 (13.6)	9 (15.3)	-
Vibration dissatisfaction *	7 (11.9)	10 (15.9)	4 (11.3)	6 (17.6)	7 (10.9)	3 (6.3)	3 (17.6)	7 (11.9)	6 (10.2)	-
Psychosocial perception of study place- n (%within profile level)										
Amount of privacy dissatisfaction *	1 (1.7)	12 (19.0)	1 (2.9)	1 (2.9)	2 (3.1)	7 (14.6)	-	6 (10.2)	6 (10.2)	-
Layout dissatisfaction *	3 (5.1)	7 (11.1)	2 (5.7)	-	5 (7.8)	5 (10.4)	-	2 (3.4)	4 (6.8)	-
Decoration dissatisfaction *	2 (3.4)	6 (9.5)	-	-	6 (9.4)	4 (8.3)	-	3 (5.1)	10 (16.9)	-

	IEQC1-PSC1	IEQC1-PSC2	IEQC1-PSC3	IEQC2-PSC1	IEQC2-PSC2	IEQC2-PSC3	IEQC3-PSC1	IEQC3-PSC2	IEQC3-PSC3	*p*-Value
Cleanliness dissatisfaction *	6 (10.2)	12 (19.0)	4 (11.4)	3 (8.8)	9 (14.1)	9 (18.8)	1 (5.9)	7 (11.9)	11 (18.6)	-
View to the outside dissatisfaction *	4 (6.8)	10 (15.9)	2 (5.7)	3 (8.8)	11 (17.2)	6 (12.5)	4 (23.5)	4 (6.8)	10 (16.9)	-

* N < 5, thus chi-squared test not performed.

References

1. Ramu, V.; Taib, N.; Massoomeh, H.M. Informal academic learning space preferences of tertiary education learners. *J. Facil. Manag.* **2021**. https://doi.org/10.1108/JFM-05-2021-0047.
2. Beckers, R.; Van der Voordt, T.; Dewulf, G. Learning space preferences of higher education students. *Build. Environ.* **2016**, *104*, 243–252. https://doi.org/10.1016/j.buildenv.2016.05.013.
3. Harrop, D.; Turpin, B. A Study Exploring Learners' Informal Learning Space Behaviors, Attitudes, and Preferences. *New Rev. Acad. Librariansh.* **2013**, *19*, 58–77. https://doi.org/10.1080/13614533.2013.740961.
4. Beckers, R.; Van der Voordt, T.; Dewulf, G. Why do they study there? Diary research into students' learning space choices in higher education. *High Educ. Res. Dev.* **2016**, *35*, 142–157. https://doi.org/10.1080/07294360.2015.1123230.
5. Cox, A.M. Space and embodiment in informal learning. *High Educ.* **2018**, *75*, 1077–1090. https://doi.org/10.1007/s10734-017-0186-1.
6. Wang, S.; Han, C. The Influence of Learning Styles on Perception and Preference of Learning Spaces in the University Campus. *Buildings* **2021**, *11*, 572. https://doi.org/10.3390/buildings11120572.
7. Wilson, H.K.; Cotgrave, A. Factors that influence students' satisfaction with their physical learning environments. *Struct. Surv.* **2016**. https://doi.org/10.1108/SS-01-2016-0004.
8. Bluyssen, P.M. Patterns and Profiles for understanding the indoor environment and its occupants. In Proceedings of the 2022: CLIMA 2022 The 14th REHVA HVAC World Congress, Rotterdam, The Netherlands, 22–25 May 2022; p. 1–7. https://doi.org/10.34641/clima.2022.417.
9. Shu, S.; Ma, H. Restorative Effects of Classroom Soundscapes on Children's Cognitive Performance. *Int. J. Environ. Res. Public Health* **2019**, *16*, 293. https://doi.org/10.3390/ijerph16020293.
10. Ricciardi, P.; Buratti, C. Environmental quality of university classrooms : Subjective and objective evaluation of the thermal, acoustic, and lighting comfort conditions. *Build. Environ.* **2018**, *127*, 23–36. https://doi.org/10.1016/j.buildenv.2017.10.030.
11. Corgnati, S.P.; Filippi, M.; Viazzo, S. Perception of the thermal environment in high school and university classrooms : Subjective preferences and thermal comfort. *Build. Environ.* **2007**, *42*, 951–959. https://doi.org/10.1016/j.buildenv.2005.10.027.
12. Zhang, D.; Ortiz, M.A.; Bluyssen, P.M. Clustering of Dutch school children based on their preferences and needs of the IEQ in classrooms. *Build. Environ.* **2019**, *147*, 258–266. https://doi.org/10.1016/j.buildenv.2018.10.014.
13. Nico, M.A.; Liuzzi, S.; Stefanizzi, P. Evaluation of thermal comfort in university classrooms through objective approach and subjective preference analysis. *Appl. Ergon.* **2015**, *48*, 111–120. https://doi.org/10.1016/j.apergo.2014.11.013.
14. Liu, Q.; Huang, Z.; Li, Z.; Pointer, M.R.; Zhang, G.; Liu, Z. A Field Study of the Impact of Indoor Lighting on Visual Perception and Cognitive Performance in Classroom. *Appl. Sci.* **2020**, *10*, 7436. https://doi.org/10.3390/app10217436.
15. Teli, D.; Jentsch, M.F.; James, P.A.B. Naturally ventilated classrooms: An assessment of existing comfort models for predicting the thermal sensation and preference of primary school children. *Energy Build.* **2012**, *53*, 166–182. https://doi.org/10.1016/j.enbuild.2012.06.022.
16. Cankaya, S.; Yilmazer, S. The effect of soundscape on the students' perception in the high school environment. In Proceedings of the Inter-Noise 2016 45th International Congress and Exposition on Noise Control Engineering: towards a Quiter Future, Hamburg, Germany, 21–24 August 2016; pp. 4809–4816.
17. Mishra, A.K.; Derks, M.T.H.; Kooi, L.; Loomans, M.G.L.C.; Kort, H.S.M. Analysing thermal comfort perception of students through the class hour , during heating season , in a university classroom. *Build. Environ.* **2017**, *125*, 464–74. https://doi.org/10.1016/j.buildenv.2017.09.016.
18. De Giuli, V.; Da Pos, O.; De Carli, M. Indoor environmental quality and pupil perception in Italian primary schools. *Build. Environ.* **2012**, *56*, 335–345. https://doi.org/10.1016/j.buildenv.2012.03.024.
19. Peng, L.; Jin, S.; Deng, Y.; Gong, Y. Students ' Perceptions of Active Learning Classrooms from an Informal Learning Perspective : Building a Full-Time Sustainable Learning Environment in Higher Education. *Sustainability* **2022**, *14*, 8578. https://doi.org/10.3390/su14148578.
20. Cunningham, M.; Walton, G. Informal learning spaces (ILS) in university libraries and their campuses: A Loughborough University case study. *New Libr. World* **2016**, *117*, 49–62. https://doi.org/10.1108/NLW-04-2015-0031.

21. Roetzel, A.; DeKay, M.; Nakai Kidd, A.; Klas, A.; Sadick, A.M.; Whittem, V.; Zinkiewicz, L. Architectural, indoor environmental, personal and cultural influences on students' selection of a preferred place to study. *Archit. Sci. Rev.* **2020**, *63*, 275–291. https://doi.org/10.1080/00038628.2019.1691971.

22. Braat-Eggen, E.; Reinten, J.; Hornikx, M.; Kohlrausch, A. The Effect of Background Noise on a "Studying for an Exam" Task in an Open-Plan Study Environment: A Laboratory Study. *Front. Built. Environ.* **2021**, *7*, 1–12. https://doi.org/10.3389/fbuil.2021.687087.

23. Liu, C.; Luther, M. Privacy and interaction preferences of students in informal learning spaces on university campus. *Facilities* **2022**, *ahead-of-print*. https://doi.org/10.1108/F-11-2021-0119.

24. Bluyssen, P.M. Towards an integrated analysis of the indoor environmental factors and its effects on occupants. *Intell. Build. Int.* **2020**, *12*, 199–207. https://doi.org/10.1080/17508975.2019.1599318.

25. Altomonte, S.; Allen, J.; Bluyssen, P.M.; Brager, G.; Heschong, L.; Loder, A.; Schiavon, S.; Veitch, J.A.; Wang, L.; Wargocki, P. Ten questions concerning well-being in the built environment. *Build. Environ.* **2020**, *180*, 106949. https://doi.org/10.1016/j.buildenv.2020.106949.

26. Ortiz, M.A.; Bluyssen, P.M. Profiling office workers based on their self-reported preferences of indoor environmental quality and psychosocial comfort at their workplace during COVID-19. *Build. Environ.* **2022**, *211*, 108742. https://doi.org/10.1016/j.buildenv.2021.108742.

27. Eijkelenboom, A.; Bluyssen, P.M. Profiling outpatient staff based on their self-reported comfort and preferences of indoor environmental quality and social comfort in six hospitals. *Build. Environ.* **2020**, *184*, 107220. https://doi.org/10.1016/j.buildenv.2020.107220.

28. Ortiz, M.A.; Bluyssen, P.M. Proof-of-concept of a questionnaire to understand occupants' comfort and energy behaviours: First results on home occupant archetypes. *Build. Environ.* **2018**, *134*, 47–58. https://doi.org/10.1016/j.buildenv.2018.02.030.

29. Ortiz, M.A.; Bluyssen, P.M. Developing home occupant archetypes: First results of mixed-methods study to understand occupant comfort behaviours and energy use in homes. *Build. Environ.* **2019**, *163*, 106331. https://doi.org/10.1016/j.buildenv.2019.106331.

30. Kim, D.H.; Bluyssen, P.M. Clustering of office workers from the OFFICAIR study in The Netherlands based on their self-reported health and comfort. *Build. Environ.* **2020**, *176*, 106860. https://doi.org/10.1016/j.buildenv.2020.106860.

31. Bluyssen, P.M.; Roda, C.; Mandin, C.; Fossati, S.; Carrer, P.; de Kluizenaar, Y.; Mihucz, V.G.; de Oliveira Fernandes, E.; Bartzis, J. Self-reported health and comfort in 'modern' office buildings: First results from the European OFFICAIR study. *Indoor Air* **2016**, *26*, 298–317. https://doi.org/10.1111/ina.12196.

32. Dietrich, T.; Rundle-Thiele, S.; Kubacki, K. *Segmentation in Social Marketing*; Springer Nature: Singapore, 2017.

33. Vanichvatana, S.; Rd, R.; Mak, H. Who uses home as informal learning spaces: A Bangkok private university case study. *World J. Educ. Technol. Curr. Issues* **2020**, *12*, 37–47. https://doi.org/10.18844/wjet.v12i1.4416.

34. Wu, X.; Kou, Z.; Oldfield, P.; Heath, T.; Borsi, K. Informal Learning Spaces in Higher Education: Student Preferences and Activities. *Buildings* **2021**, *11*, 252.

35. Kim, Y.; Yang, E. Academic library spaces and student activities during the COVID-19 pandemic. *J. Acad. Librariansh.* **2022**, *48*, 102529. https://doi.org/10.1016/j.acalib.2022.102529.

36. Hyun, S.; Wan, T. What Matters for Students' Use of Physical Library Space? *J. Acad. Librariansh.* **2015**, *41*, 274–9. https://doi.org/10.1016/j.acalib.2015.03.014.

37. Kärnä, S.; Julin, P.; Nenonen, S. User satisfaction on a university campus by students and staff. *Intell. Build. Int.* **2013**, *5*, 69–82. https://doi.org/10.1080/17508975.2013.778810.

38. Declercq, C.P.; Cranz, G. Moving Beyond Seating-centered Learning Environments: Opportunities and Challenges Identified in a POE of a Campus Library. *J. Acad. Librariansh.* **2014**, *40*, 574–84. https://doi.org/10.1016/j.acalib.2014.08.005.

39. Webb, K.; Schaller, M.A.; Hunley, S.A. Measuring Library Space Use and Preferences: Charting a Path Toward Increased Engagement. *Portal. Libr. Acad.* **2008**, *8*, 407–422. https://doi.org/10.1353/pla.0.0014.

40. Felsten, G. Where to take a study break on the college campus: An attention restoration theory perspective. *J. Environ. Psychol.* **2009**, *29*, 160–167. https://doi.org/10.1016/j.jenvp.2008.11.006.

41. Amerio, A.; Brambilla, A.; Morganti, A.; Aguglia, A.; Bianchi, D.; Santi, F.; Costantini, L.; Odone, A.; Costanza, A.; Signorelli, C.; et al. COVID-19 Lockdown: Housing Built Environment's Effects on Mental Health. *Int. J. Environ. Res. Public Health* **2020**, *17*, 5973. https://doi.org/10.3390/ijerph17165973.

42. *ISO 12913-1*; Acoustics—Soundscape—Part 1: Definition and Conceptual Framework. ISO: Geneva, Switzerland, 2014.

43. Kang, J.; Aletta, F.; Gjestland, T.T.; Brown, L.A.; Botteldooren, D.; Schulte-Fortkamp, B.; Lercher, P.; van Kamp, I.; Genuit, K.; Fiebig, A.; et al. Ten questions on the soundscapes of the built environment. *Build. Environ.* **2016**, *108*, 284–294. https://doi.org/10.1016/j.buildenv.2016.08.011.

44. Topak, S.C.; Yılmazer, S. A comparative study on indoor soundscape assessment via a mixed method: A case of the high school environment. *Appl. Acoust.* **2022**, *189*, 108554. https://doi.org/10.1016/j.apacoust.2021.108554.

45. Xiao, J.; Aletta, F. A soundscape approach to exploring design strategies for acoustic comfort in modern public libraries: A case study of the Library of Birmingham. *Noise Mapp.* **2016**, *3*, 264–273. https://doi.org/10.1515/noise-2016-0018.

46. Li, Z.; Zhu, H.; Dong, B.; Xu, X. Development of a systematic procedure to establish customized shading behavior identification model. *Energy Build.* **2021**, *239*, 110793. https://doi.org/10.1016/j.enbuild.2021.110793.

47. Rissetto, R.; Schweiker, M.; Wagner, A. Personalized ceiling fans : Effects of air motion , air direction and personal control on thermal comfort. *Energy Build.* **2021**, *235*, 110721. https://doi.org/10.1016/j.enbuild.2021.110721.

48. Veselý, M.; Molenaar, P.; Vos, M.; Li, R.; Zeiler, W. Personalized heating e Comparison of heaters and control modes. *Build. Environ.* **2017**, *112*, 223–232. https://doi.org/10.1016/j.buildenv.2016.11.036.

49. Eijkelenboom, A.M.; Kim, D.H.; Bluyssen, P.M. First results of self-reported health and comfort of staff in outpatient areas of hospitals in the Netherlands. *Build. Environ.* **2020**, *177*, 106871. https://doi.org/10.1016/j.buildenv.2020.106871.

50. Bluyssen, P.M.; Ortiz-sanchez, M.; Roda, C. Self-reported rhinitis of students from different universities in the Netherlands and its association with their home environment. *Build. Environ.* **2016**, *110*, 36–45. https://doi.org/10.1016/j.buildenv.2016.09.036.

51. Thompson, E.R. Development and validation of an internationally reliable short-form of the positive and negative affect schedule (PANAS). *J. Cross Cult. Psychol.* **2007**, *38*, 227–242. https://doi.org/10.1177/0022022106297301.