The potential of restorative spaces on noise-related wellbeing in schools: preliminary results of a documentation study of three different spaces in Quebec schools.

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ABSTRACT

The sound environment in schools causes stress, mental and physical fatigue in children and teachers and disrupt student learning. Traditional noise abatement strategies mainly focus on reducing noise levels by room acoustics techniques. These approaches have some shortcomings 1) they are costly and hard to implement in existing infrastructure; 2) they fail to recognize the complexity of noise as a factor with both negative and positive aspects; 3) they have a top-down approach offering little opportunity for engagement and learning. Implementation of restorative spaces could be a complementary and promising avenue to the management of individual noise dose in schools. To date, these kinds of spaces have not been extensively studied. Our objective is to study three different restorative spaces in three different secondary schools in Quebec. We are documenting their visual/physical and acoustic characteristics, how they are used by students (and teachers when applicable), and their perceived benefits. In this paper, we present the preliminary results from the study of one of the spaces, the "Zen-room", in a mixed gender private secondary school in Quebec.

Keywords: Noise, Learning environments, Well being

1. INTRODUCTION

The quality of learning environments is essential to the academic development of our children and to the general health and well-being of both students and teachers [1]. The sound environment of schools is alarming worldwide with average sound levels in classrooms far above the recommended 40-60 dBA for good speech intelligibility [2, 3]. Noise levels in schools cause stress, mental and physical fatigue in children, and disrupt student learning with drops in results of up to 30% in some tasks [4]. Teachers also report negative health effects of noise such as annoyance, fatigue, voice strain and stress. Noise was identified as the most stressful situation at school by 75% of teachers in a nationwide French survey last year. The physiological stress reactions generated by noise, combined with the high speaking load of teachers, weakens their voice. In fact, voice disorders are developed by 50% of teachers compared to only 5% of adults in general [5]. Voice disorders in teachers also negatively impacts student performance; leads to frequent leave of absence; and pushes 4.2% of teachers to consider professional retraining [5]. In addition, with new pedagogies geared towards collaborative work, quiet spaces, such as school libraries, are now more likely to become places of noisy communication. It is therefore difficult for students and teachers to escape noise during their

school day.

Traditional noise abatement strategies mainly focus on reducing noise levels by using room acoustics techniques such as sound isolation and sound absorbing material. Although efficient for reducing the overall noise levels, these approaches have some shortcomings. First, they are costly and hard to implement in existing infrastructure. Second, they mainly focus on external sound sources and fail to recognize that the main sound sources in schools are from the activities taking place in them. Third, traditional strategies have a top-down approach offering little opportunity for engagement and learning from the students. Recognizing the complexity of noise as a factor with both negative and positive aspects, as well as the active part of students and teachers in contributing to the noise is not only more realistic, but also opens up to new strategies to manage it.

For outdoor environments in cities, an alternative approach to noise mitigation called soundscape has recently gained increased attention from both academics and urban planners [6]. This approach recognizes the critical and complex role that sound plays in our everyday experiences. Sound is viewed as an inherent part of the environment that can be a serious nuisance, but it can also support our well-being, orientation, focus, and our lasting memories of spaces. Soundscape design has lately been focusing on restorative spaces as a novel strategy to manage sound by offering easily accessible areas with high-quality soundscape as a way to recover from the negative effect of noise exposure [6]. We suggest schools can be viewed as miniature cities, in the sense that they are complex environments where individuals with different and sometimes contradictory perception in terms of sound must coexist. A restorative space inside the school, available for teachers and students, could be a tool that could support the individual in managing their daily noise exposure, and also vocal dose, during a school day.

As a first step in understanding the potential of restorative spaces on noise-related wellbeing in schools, it is important to define what a restorative space is. Kaplan [7] defined a restorative space as a place to recover from the fatigue caused by the directed attention required by our daily activities. He listed four factors a space should contain to make it truly restorative. At the heart of the restorative experience lies, according to Kaplan, soft fascination which occurs when the environment provides pleasing and interesting stimulation that requires effortless attention. Another important ingredient is the sensation of being away, of escaping from the daily routine. The perception of coherence of the space (that it forms a whole) and the adequation of the space with one's own purposes are the two remaining factors. Kaplan argues that nature offers these four factors and thus, green spaces in cities are often viewed as ideal restorative spaces. There is however little literature on what a restorative space in a school setting should be like, or if the same four factors listed by Kaplan are applicable and how they would translate in an indoor setting such as a school.

In this project, we are studying three different spaces that have recently been implemented in three different secondary schools in Quebec with the intent of offering a restorative or a tranquil space to students and/or teachers. We are documenting their visual/physical and acoustic characteristics, how they are used by students (and teachers when applicable), and their perceived benefits. Our intention is to better capture the elements that contribute to the restorativeness of spaces in school settings and what the benefits of these spaces are.

In this paper, we present the preliminary results from the study of one of these spaces, the "Zen-room", that is implemented in a mixed gender private secondary school in Quebec.

2. METHODS

2.1 General description

The general description of the spaces was done by semi-structured interviews with key informants at the school (principal of the school, teacher, psycho-educator, technical staff). Questions were asked about how and when the space was created, why it was created (what was the initial purpose) and if there had been any sensitization activity for the use of the space.

2.2 Visual description

A visual description of the physical spaces was undertaken by a master student in industrial design who visited each room at three different time points (morning, lunch hour, evening) one day when the room was not in use, and one day when the room was in use. The following elements were documented by observation: access to the room, colors, luminosity, window view, content and design (furniture, decoration, …), volume and capacity, efficiency of space use, materials and textures,

aesthetic quality, temperature and scent.

2.3   Acoustic description

The impulse response of the Zen-room was measured. Then, sound levels were recorded for 10 consecutive school days during the winter semester of 2019. A calibrated recording device made up of an omnidirectional microphone (Umik-1 from MiniDSP) suspended in the middle of the room and attached to a Raspberry Pi (3 Model B+) was used with a specifically designed software (noiseStation version 1.0).

2.4   Habits of use and appreciation of the room

2.4.1 Real time appreciation of the room

During the acoustic recordings period, the students using the room were invited to rate their real time appreciation of the room on an iPad made available in the room. A rating application was used that offered respondents to choose between three levels of satisfaction, illustrated with smileys (negative, neutral, positive). The analysis of these ratings is ongoing and will be presented in the full paper reporting on the three rooms.

2.4.2 General appreciation: Users

A self-assessment questionnaire was used to document how students and teachers use the space and what they appreciate about it. The questionnaire was specifically designed for this study and included subcategories exploring: 1) characteristics of the respondent; 2) frequency of use; 3) frequency and time of use; 4) type of use; 5) perceived atmosphere and sounds; 6) preferred and desired changes.

2.4.3 General appreciation: Non-users

A self-assessment questionnaire was also used to document the reasons why students and teachers don't use the space. This questionnaire included subcategories exploring: 1) characteristics of the respondent; 2) reasons for non-use; 3) believed reasons for use by others; 4) desired changes.

3.   RESULTS

3.1   General description

The key informants for the Zen-room were the school principal and one teacher who was involved in the research project. The Zen room was created in 2017, at the same time the library was renovated. It was created because the direction felt there were no dedicated quiet space in the school, and they felt the need to offer that possibility to students. The precise purpose of the room remains unclear, whether it is for studying or relaxing, and the principal of the school acknowledges that there is a need to better define it. No sensitization activity for the use of the space has been offered neither to students nor teachers.

3.2   Visual description

To access to the Zen room, students have to cross the school's library which has a rather lively atmosphere. The Zen room is entered through a transparent glass door. It is not indicated by any sign and not visually distinct either, making it difficult to spot if one is not aware of its existence.

The room can accommodate around 30 people. Its dimensions are 9,1m X 4,2m X 2,7m. It is shaped as a narrow rectangle and furnished with rectangular laminated tables and plastic chairs (figure 1). It is painted in grey and white with a plastic floor, conferring it a cold atmosphere. The back wall is covered by bookshelves filled with science and history books. The opposite wall is made of transparent glass and overlooks the adjacent library, leaving little possibility for intimacy or shielding from outside agitation. One of the long walls is covered with windows, but the orientation of the room does not allow direct sunlight in.

The window view is limited to parts of other concrete buildings and electric pylons, thus reinforcing the room's rectilinear character. The furniture and equipment are fixed and leaves little choice to the visitor as to how they prefer to sit. The temperature is rather low, contributing to the cold atmosphere. No particular scent was noticed during the observation, conferring a neutral character to the room.

Overall, the design and aesthetic of the room invites studious activities. However, any sound from inside the room is amplified by reverberation and all noise from the library outside penetrates the room as well. Thus, although silence was respected by the students inside the room during our visit, the room gives a noisy impression.

Figure 1 – A view of the Zen room taken from the entrance.

3.3   Acoustic description

The acoustic analysis of the Zen room is ongoing. The Zen room is a small room with a volume of 10 m^3. The measured T20 and T30 at 500Hz and 1000Hz is 0.6s making it quite reverberant for its size. The A-weighted one hour equivalent continuous sound level, L_{eq1hr}, from a random day are shown in Figure 2. As can be seen, levels vary greatly throughout the day with use. A maximum level of 63.7 dBA is observed a little after noon. From various recordings over the two-week period that the measurements were taken, as well as from answers to questionnaires, lunch time was the time period of most use of the Zen room and thus the noisiest time.
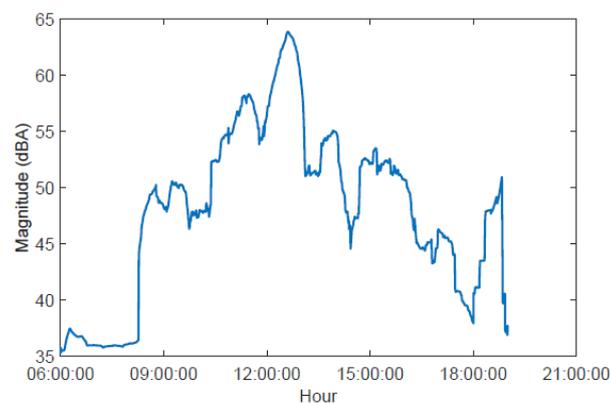

Figure 2 — One hour Leq for a random day of the Zen room

3.4   Habits of use and appreciation of the room

3.3.1 General appreciation: Users

Respondents:

18 respondents using the Zen room answered the survey (first grade=1 respondent, second grade = 8, third grade = 2, fourth grade = 1, fifth grade = 6), 7 girls, 9 boys and 2 preferred not to say. On the

item "There is a lot of noise at school", the group mean on a scale of 0 (I don't agree at all) to 5 (I totally agree) was 3.78 (SD=0,98) with all but one participant agreeing at >3. On the item "I find the noise in school annoying", they had a mean of 2.6 (SD=1,24) with 61% of respondents agreeing at >3 (see table 1 for a summary of the items rated on the agreement scale).

Frequency and time of use:

Five of the respondents were using the space once a week or more, 6 were using it at least once a month, and 6 were using it less than once a month. The room was mostly used during lunch break (n=14), but also during classes (n=9). It was rarely used before or after classes (n=5).

Type of use:

Most respondents reported using the room with a friend (n=12) rather than alone. Most respondents reported feeling serene before they went to the Zen-room (n=9) and after visiting it (n=10). The next most frequent mood was nervousness (n=4 before visiting, and n=5 after visiting). One participant commented on the nervousness by indicating they visited the room just before an exam.

The most frequent motivation to use the room was to study (n=12) and find tranquility (rest, decompress, find calm, find silence) (n=12), followed by having specific needs (n=5). The most frequent activity reported was "doing homework" (n=12) and "reading" (n=8).

Perceived atmosphere and sounds:

Respondents were asked to indicate on a scale ranging from 1(don't agree at all) to 5 (totally agree) how much they agreed on the following statements: 1) The room offers an escape of the everyday routine, 2) the atmosphere of the room is agreeable, 3) the atmosphere of the room is appropriate with regard to the activity I intend to do. They also had to identify how well they thought different atmospheres characterized the room. Three items referred to tranquility (calm, monotonous, relaxing) and four items related to agitation (animated, dynamic, chaotic, irritating). We regrouped these items to form a tranquility score and an agitation score. Mean level of perceived escape was 3,2 (SD=1,37), means level of perceived agreeableness was 3.67 (SD=1,19), and mean level of perceived appropriateness was 4.11 (SD=1,2). Mean level of perceived tranquility was 3.42 (SD=1,49) and mean level of perceived agitation was 2.57 (SD=1,53) (see table 1 for a summary).

Table 1 – Levels of agreement to items related to general noise perception at school and atmosphere of the Zen-room

Items *	Users (n=18)		Non-users (n=20)	
	Mean	SD	Mean	SD
There is a lot of noise at school	3.78	0.98	3.53	0.68
The noise at school is annoying	2.61	1.24	1.65	1.14
The Zen-room is:				
An escape from everyday routine	3.2	1.37		
Agreable	3.67	1.19		
Appropriate	4.11	1.2		
Tranquil	3.42	1.49		
Agitated	2.57	1.53		

*Respondents rated how much they agreed with the different items on a scale ranging from 1(don't agree at all) to 5 (totally agree).

Respondents were also asked to enumerate the sounds they perceived inside and outside the room. The most perceived sounds from outside the room were people speaking (n=16) and walking (n=8). The most perceived sounds from inside the room were furniture moving (n=13), sounds from homework (pen on paper etc…) (n=13), and people speaking (n=11) and whispering (n=12).

Preferred aspects and desired changes:

Respondents were asked to describe, in free text, one aspect they wished to change with the room, and one aspect they wanted to keep. Nine respondents mentioned they wanted to bring more silence to the room, either by preventing people from talking inside (ex: "people speaking, they're speaking all the time, but it should be silent") or by better isolation from outside noise (ex: "better isolation, we can hear everything happening outside".) Three mentioned enlarging the room as a desired change, and one respondent wished for more relaxing furniture (beanbags, hammocks). Regarding the aspect of the room to keep, six respondents mentioned tranquility or silence as the main aspect to keep, while two mentioned the tables.

3.3.2 General appreciation: Non-users

Respondents:

20 respondents not using the Zen room answered the survey (first grade=14, second grade = 6), 18 girls and 2 boys. On the item "There is a lot of noise at school", the group mean was 3,53 (SD=0.68) with all participants agreeing at >3. On the item "I find the noise in school annoying", they had a mean of 1.65 (SD=1,14) with 85% of the respondents agreeing at <2 (see table 1 for a summary).

Reasons for non-use and believed reasons for use by others:

Most respondents reported not using the room because they're not allowed to talk inside it (n=9), they find it boring (n=6) or that they find there's no point in using it (n=4). Four answered that they did not use it because it was already full when they wanted to. One respondent said the reason for not using it was that it was not silent although supposed to be. This respondent also scored a 5 on noise-related annoyance.

We asked non-users what they believed were the reasons for other students to use the room. Most believed it was because they wanted to do their homework (n=14), be calm (n=14), be alone (n=12) or escape noise (n=8).

Desired changes:

We asked the non-users if certain changes to the room could make them want to use it. More space (n=13) and a warmer (more welcoming) atmosphere (n=13) were the most chosen changes. Free text answers mentioned "dividing the room in smaller individual spaces" (n=3), and "if it really were silent" (n=1) (which was expressed by the respondent scoring a 5 on noise-related annoyance).

4. DISCUSSION

The Zen-room has been in use for less than two years and is available to secondary school students. The purpose of the room has not been clearly stated, other than it is a place dedicated to silence. Our visual analysis of the physical environment of the Zen-room reveals that out of the criteria outlined by Kaplan [7] for restorative spaces, only one is immediately apparent: the coherence of the room. The color palette, the furniture, the design, and the window view even, generate a cold and neutral feeling inviting to studious activities. There are no elements in the room providing soft fascination, on the contrary, the incoming noise from outside and the reverberance (confirmed by our acoustical analyses) as well as the visual noise from the library (visible through the glass wall) appear as disturbing elements. Moreover, the design resembling a traditional school environment does not seem to offer an escape from the everyday routine. As for the adequation of the room according to its purpose, although it has not been clearly defined by the school administration, the answers of users and non-users to our questionnaire indicate that it is perceived as a place for studying in quietness. With that in mind, although the visual design offers adequation, the noise levels do not. In fact, the sound levels present in the room during lunch hour, the moment when the room is used by most respondents, are between 50 – 63,7 dBA, values falling into the "annoying, irritating" range. This is hardly compatible with the vocation of a quiet space favoring cognitive abilities [4].

As stated above, although the purpose of the Zen-room has not been explicitly defined, our results show that the main reason for students to visit the room for studying and finding tranquility. This is in line with the studious character reflected by the visual design of the room. Indeed, users agree strongly with the appropriateness of the room for their purpose (Mean=4.11). According to perceived

tranquility, there is a higher agreement on the fact that the room is tranquil (Mean=3.67) than on the fact that it is agitated (Mean=2.57). Nevertheless, 9 of the 18 respondents wanted the room to be more silent. So, although users agree moderately with the statement that the room is tranquil, they still think that this aspect could be improved. This perception is supported by our acoustic measurements. Further, six respondents also expressed that tranquility or silence were the aspects they absolutely wanted to keep in the room. These comments show that quietness is indeed an important and desired feature of the Zen-room although it is not that well achieved right now. Regarding the "escape" aspect of the Zen-room, students agreed moderately that it offered an escape from daily routine (Mean=3.2), however, since most users visit the Zen-room to study, it is reasonable to question if the sense of escape is important to the adequation of the room.

To better understand the role of the Zen-room in the school, we also wanted to document how students who are not using it perceive it, and why they don't use it. The group of non-users differs from the group of users regarding several aspects but most interesting is that while both groups have a similar level of agreement with the fact that there is much noise in the school (Mean=3,78 for users and Mean=3,53 for non-users), the non-user group agrees less than the user group on the fact that the noise is annoying (Mean=1.65 for users versus Mean=2.6 for non-users). The fact that the group of non-users is not that much annoyed by the noise can explain why they do not seek out the Zen-room. Most non-users' understanding of the Zen-room is in line with how it is used. They believe students use it to study, be calm or alone and escape noise. The main reason why they do not use the room is because it is not in adequation with their own purposes (for example wanting to talk to friends).

5. CONCLUSIONS AND FUTURE DIRECTIONS

In conclusion, the Zen-room does not answer to the four criteria listed by Kaplan for a restorative space. The question is if the Zen-room is to be considered as a restorative space. As the principal of the school admitted prior to the study, the purpose of the Zen-room has not been explicitly defined. Nevertheless, both users and no-users perceive the Zen-room as a place to study and where silence is desired. Today, at this school, the library has been transformed into a collaborative space where there is a lot of animation during lunch hours and the Zen-room seems to have overtaken the traditional role formerly assigned to the library. Rather than a truly restorative space, offering soft fascination and a sense of escape from the daily routine, the Zen-room offers a visually coherent environment for studious activities, and aims towards offering a tranquil and quiet auditory space. The auditory quietness is however not reached, as shown by our acoustic measurements and the users' feedback on our questionnaire.

The analysis of the results from the two other room we are studying is ongoing and these will be contrasted to the present results to increase our understanding of restorative spaces in schools.

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