Preliminary exploration of noise and student learning in modern flexible education spaces

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ABSTRACT

Contemporary learning environments are typically designed to be large areas with fluid boundaries and can facilitate cohorts well in excess of 50 students in one space; indeed the terms "open plan" and "flexible" are synonymous when describing modern learning areas. In these scenarios it is common for high amplitude, random and modulating noise levels to be generated during teaching and learning activities. It is well documented that random modulating noise environments can disadvantage some learners. Research has shown that the inclusion of additional environmental auditory stimuli (such as music or white noise) can improve task orientated outcomes through triggering stochastical resonance . However stochastical resonance is highly dependent on both the character of the added stimulus and the individuals neuronal signalling. The use of music or white noise is a common tool utilised by educators although it is likely that the approach tends to be haphazard with the sources played at "low" or "background" level. This research attempts to bridge the current gap by analysing a response (distraction or concentration) of students to predetermined levels of white noise, a natural environmental soundscape or low bpm instrumental music. The study was carried out in a modern teaching and learning environment in South Australia with two separate cohorts of students. This study also takes the opportunity to investigate the response of students to a typical open plan classroom soundscape.

1 INTRODUCTION

Children need to focus on the relevant source of information and become involved with or concentrate on the task at hand (Higgins & Turnure, 1984). Selected attention to the task at hand is important for learning and involves the interplay of working memory and executive function (Uus et al. 2020). Effective processing of all of the stimuli that are impinging on the brain at the same time is strenuous and so children (and adults) become more adept (to a greater and lesser degree) at selecting what they will attend to (Escera et al, 2000). This is especially the case with young children (Higgins & Turnure, 1984). This implies that the acoustic environment in which children are learning plays a role in either supporting or interfering with this relationship between attention and learning. A number of studies have been undertaken to explore the learning impact of environmental conditions of learning spaces, including the acoustic environment, on children with behavioural disorders (Helps et al, 2013, Söderlund et al, 2010). In a way this can be interpreted as identifying what happens when the attention component of the attention and learning relationship is already impacted.

With the move towards integrative educational practices (e.g. STEM education), pedagogies such as inquiry- and problem-based teaching are becoming common practice. Such practices often require collaborative/group type interactions among students which can generate a lot of noise (and can be exacerbated in poor acoustic environments). Aletta et al. (2016) and others (e.g. Cain et al., 2013) concluded that perception of soundscape appears to be of more importance than the acoustic and psychoacoustic metrics. We know that cognition is also affected by the learner's emotional state (Badara et al. 2017) and that emotions play an important role in learning (Ruperti et al. 2019). So while an external measure may indicate some objective metric, as educators it is easy to understand how the subjective experience of the participants may overrule this.

Focusing on the realities of modern-day teaching and learning activities, which generally includes pedagogical practices such as active collaboration, this study is based on the assumption that students and teachers are likely to encounter 'noisy' classrooms/learning environments. Many more traditional school designs would have been designed on the assumption that traditional teacher led pedagogies was the dominant teacher approach and in newer designs consideration of the acoustic environment is often overlooked, or value managed out during project design. This can result in open plan education spaces that may not be considered fit for purpose by the teachers required to work in the space (see Colton et al., 2022) i.e., environments that stimulate noise generation and negatively impact on speech intelligibility and concentration. In this project we seek to better understand the impact of noise on teaching and learning. In an experimental teaching and learning context, artificially soundscaped environments were created to investigate student and teacher perceptions of the impact of noise on learning. As recommended by Cain et al. (2013), who encourage the use of inter-disciplinary research teams when exploring sound scaping, this project was conducted by a cross-disciplinary team of education researchers and acoustic engineers.

The acoustic environment of room is a physical construct and is relatively fixed by the attributes and parameters of the building/room design. Soundscape however is different. The International Organization for Standardization (ISO) in Part 1 of the new International Standard, ISO 12913, defined soundscape as “[the] acoustic environment as perceived or experienced and/or understood by a person or people, in context” (ISO, 2014, p.66). This idea of soundscaping is identified by Aletta et al. (2016, p.73) as creative in that it “moves beyond current noise control engineering and retrofitting of the acoustic environment. In the soundscape approach, soundscape is planned and designed”, enabling a better understanding of what is happening when and why. However, because of the richer assessment created by soundscaping, the study of soundscapes is often challenging because the context of the soundscape cannot be ignored. For example, Davies et al. (2007) argue that the experience of hearing sound in a particular environment is complex, suggesting there is a relationship between the acoustic/auditory environment and the responses and behavioural characteristics of people within it. This is unlike conventional approaches, such as noise mitigation, which simply evaluate different acoustical qualities.

Davies et al. (2007) acknowledge the relevance of positive soundscapes, to move away from a focus on negative noise. Cankaya and Yilmazer (2016) found that ‘birds singing’ and ’laughter’ were generally identified as positive, however speech sound was generally perceived as a negative sound. They also noted that students used emotional descriptions for the noise they identified, showing that the soundscape is likely impacting their emotional state in the classroom setting. To further highlight the complexity of the acoustic environment, and more specifically, the soundscape of a learning environment, research such as Davies et al (2007) indicates that the provision of a superimposed soundscape can affect cognitive performance. Much of the research focusses on the application of music, white noise and the nature sounds.

2 THE STUDY

The aim of this project was to understand the levels and characteristics of the noise being generated in teaching and learning activities and the potential impacts on student learning. This study was guided by the following research questions:

- What are teacher and student perceptions of noise and noise intrusion from general teaching and learning activities and from introduced noise sources during the workshops?
- In what observable ways, does noise, and different sounds, impact on the learning environment?
- Can the addition of sounds with different characteristics to those expected in a learning environment (i.e. soundscaping) have an observable positive impact on teaching and learning?

In order to conduct the soundscaping experiment, a series of three 1.5-hour Science, Engineering and Mathematics workshops were created. The project deliberately chose to focus on the STEM disciplines to align with the current national STEM agenda, hence, creating a unique STEM experience for all participating students. The workshops simulated everyday teaching which included aspects of individual and group collaborative work across three specific learning area, Mathematics & Puzzles, Aerodynamics and Engineering Challenge. The project applied a multidisciplinary, stage-wise development strategy comprising both a pilot and main phase of data collection. The initial pilot was conducted with pre-service teachers. A total of 21 pre-service teachers participated in the pilot study, with 11 students in Research and Learning 1 (Room 1) and 10 in Research and Learning 3 (Room 3). These workshops were delivered in a purpose-built teaching/researching facility - fully equipped with video and audio recording from multiple ceiling cameras and microphones. This space also provides the facility to introduce soundscaped audio into the classrooms from a central control room.

The main phase of data collation was conducted with primary school students in Years 5 and 6 from a small Catholic Primary School, in Adelaide. Hence the aforementioned workshops ran twice with two different cohorts of students; one class of primary school students and one class of preservice teachers. The workshop content/focus was modified to ensure each was audience/age appropriate. The workshop for the main phase of data collection were also held in two separate classrooms with the students evenly distributed across both rooms, 23 students in Research and Learning 1 and 23 students in Research and Learning 3. During the main phase of data collection five different soundscape were gradually introduced as the workshops progressed. Student survey questionnaires were filled out at 15-minute intervals. Some of the student and educator comments support the theory that introduced soundscapes with a higher degree of modulation, such as the nature soundscape and student noise soundscape were more distracting than soundscapes with less modulation at the same sound pressure level.

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