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Acoustic Quality of University Classrooms: a Subjective Evaluation of the Acoustic Comfort and Conditions at the University of Sharjah Classrooms

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ABSTRACT

In a previous study, the noise levels in classrooms and lecture halls at the University of Sharjah (UOS), United Arab Emirates (UAE) were identified as high and in many cases above the standard limits. To assess the effect of such high noise levels on students, we have conducted a campus-wide subjective survey to investigate the effects of such noise on students' learning experience. The survey aimed at gauging students' perception of noise levels at various classrooms and impact of noise levels on students' academic performance. The results showed that students were able to reliably identify the acoustic conditions that interfere with their learning. Strong correlations (R^2 = 0.87) between the background noise and persistent noise and its influence on voice sensitivity. Correlations between noise levels and degree of annoyance showed strong relationship between noise levels and percentage of highly annoyed respondents. More than 60% of the students felt that noise interfered with their learning and had an impact on their achievements with no gender bias, but at lower percentage for advanced classes. In addition, the results indicate that students were not comfortable with the noise in the classrooms including the background noise arising from various internal as well external sources.

Keywords: Noise Levels, Classrooms, Students' Perception, Annoyance

1. INTRODUCTION

Among the challenges facing postsecondary institutions in recent years is the high students' expectations related to their experience during their student journey (1). Among the factors that have been identified to contribute to students' experience including lecture delivery, teaching and learning resources, incorporating latest technological advances into teaching and learning as well as support services. In addition, and more relevant to the research presented in this paper, is the overall wellbeing of the students that include their satisfaction and comfort with the teaching and learning environment, i.e. classrooms comfort. The latter has been identified to be influenced by factors such as thermo-hygrometric, acoustics, and lighting conditions of indoor environments (2). While all factors are important, classroom acoustics have received considerable attention in recent years. It has been identified to have an impact on student comprehension and understanding of the material presented during the class and hence negatively affect their academic performance (3,4). Poor acoustics were found to exacerbate the harmful effects of noise and distract students' attention in class (3-5). Several researchers have reported that noise has negative impact on the learning capacity of students (4). In addition, it has been demonstrated that acoustically comfortable environment enhances the productivity of workers; a finding that can be extended to teaching and learning environment as well (6). Acoustic comfort becomes even more important in interactive learning environments such as discussion-based, Team Based Learning, etc., where communication among students and instructors is significant. In a recent study conducted at the University of Helsinki, it was highlighted that students' experience in an indoor environment significantly affects their learning (7). Different classrooms and

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learning spaces in general requires special acoustical performance. Acoustic attributes within the classroom, which included acoustic absorption and highly reflective walls, all affect the learning process through hindering students' capacity to hear and communicate with each other and the instructor. Poor classroom acoustics lead to increase in noise (unwanted sound), which arise from reflections from classroom surfaces. It tends to disrupt discussions because of high reverberation times within the classroom. Published literature have reached a common conclusion that classroom acoustics should be flexible and controllable and background noise must be minimized to promote various teaching and learning activities.

Classroom acoustics can be evaluated using several variables such as equivalent sound levels, LA_{eq} (in dBA), reverberation times, absorption and transmission noise index. Noise, which is defined as unwanted sound, is determined by other factors most of which are subjective and depend on the perception of the person. In teaching and learning environment, in addition to measuring the acoustic attributes, it is very important to gauge students' perception of the noise levels within the learning environment and its impact on the learning process. To investigate this, one needs to determine students' perception of the acoustics (acoustic comfort) within the learning environment, particularly the lecture halls. To effectively achieve this, we conducted an online subjective questionnaire, which comprised of nineteen questions designed to capture the effect of noise on the teaching and learning process through the students' perception and satisfaction (acoustic comfort) with the acoustics within the learning environment. It is therefore the goal of this study to evaluate students' perception of noise in classrooms at the University of Sharjah, United Arab Emirates (UAE) and investigate possible links it may have on their academic performance. In addition to onsite measurements of noise levels (dBA) within the classrooms, an online survey was conducted across campus to gauge the students'' perception of noise in university of Sharjah classrooms.

2. MATERIALS AND METHODS

To effectively assess students' perception of noise in UOS classrooms, we first measured noise levels in classrooms covering variations in classrooms sizes, dimensions and acoustics attributes, e.g. insulation, location, seating arrangements. The measurements included background noise, noise levels during the actual classroom as well as the reverberations times for each classroom. The objective was to correlate noise levels (both background and noise during the lecture) to the results of the subjective survey on students' perception of noise in UOS classrooms. As described in our previous work (8), noise level measurements were conducted in each classroom by carefully selecting a number of points within the classroom to avoid standing wave locations. This was easily achieved by moving the sound level meter around the classroom and look for optimum points. The sound level meter (Sound Level Meters Nor132) was placed at each point to measure the background noise as well as noise during the lecture and the reverberation times. Before each measurement, the sound level meter was calibrated using known source, which was supplied by the manufacturer. While the reverberations times were measured in seconds, the noise levels were measured in dB(A), which is an A-weighted sound levels used to approximate human hearing by simulating the sensitivity of the average human hearing.

The survey questions were divided into three main parts, the first of which contained general demographic questions, i.e. age, college, year of study, type of the lecture. The second part of the survey questionnaire focused on noise related questions. These included hearing problems, seating within the classroom, classroom size, lecture type and instructor voice level. The last part of the survey focused on students' perception of noise and its impact on teaching and learning in the classroom. The questions focused on annoyance due to internal as well as external noise sources. In addition, students were asked to rate the noise and it impact of their understanding and comprehension of the material covered in classes. Concluding questions on students' perception and satisfaction of classroom acoustic environment were stated clearly to gauge their feeling towards noise within the classrooms. In total, there were nineteen questions, all of which were required to answer. The survey was designed and drafted using Microsoft Forms and emailed to all UOS students who were taking classes in the selected classrooms (about 10 000 students) *via* the UOS intranet. Students can access the survey using their UOS login credentials. The questions were translated to Arabic and explanations to acoustic terms were provided to avoid misinterpretation of questions. Figure 1 shows examples of questions conducted in the survey.

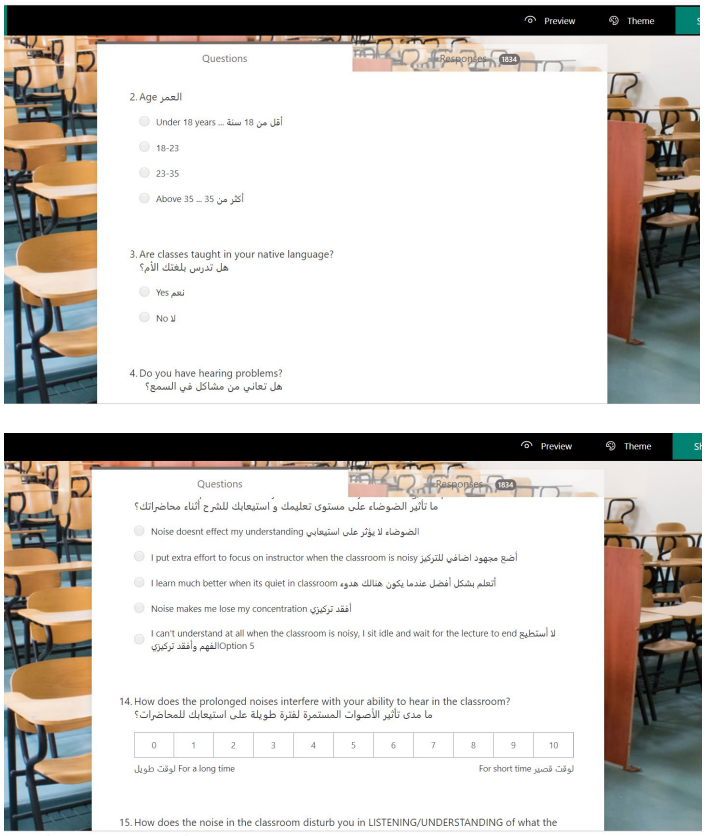

Figure 1 – Sample questions from the distributed survey

3. RESULTS AND DISCUSSION

3.1 Noise levels and reverberation times measurements

The study focused on six classroom covering different types of classrooms used in UOS from the point of view of size, dimensions and functionalities. Background noise level measurements as well reverberation times were carefully measured/calculated following international protocols taking into account acoustic attributes for each classroom. The results are indicating that while the background noise levels ranged from 34 – 52 dB(A), noise levels during the lecture ranged from 59 – 72 dB(A). Reverberation times were also measured in empty classrooms. The results are shown in Figure 2.

The above results indicate that the reverberation times ranged from 0.54 to 1.2 s, which exceeded the limits set by the American National Standards Institute (ANSI), which is set at 0.6 s. Rooms with large volumes consistently had longer reverberation times as shown in Figure 3. Background noise level measurements reveled that only three lecture halls had backgrounds less than 35dBA, and none had reverberation times lower than 0.4 seconds. The rest of the halls exceeded the recommended background limits, especially rooms where the HVAC system was on. These results will be discussed later when correlating the responses of the students.

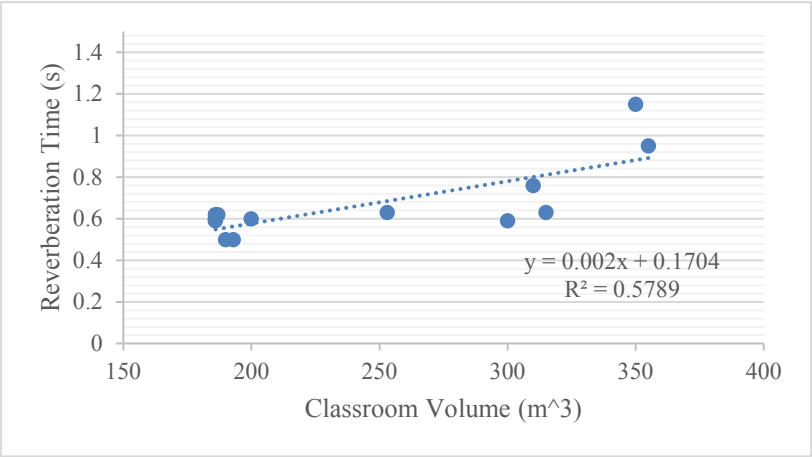

Figure 2 – Reverberation times as a function of classroom volume

3.2 Results of Acoustic Satisfaction Survey

As mentioned above the survey was sent by email to over students taking classes on the main UOS campus. One thousand eight hundred and thirty-four students (n=1834) responded to the survey (23% return rate). Among the 1834 respondents, 76% of which were female students distributed among the various university colleges. It should be noted that classrooms at the University of Sharjah are shared by all colleges and there are no college-designated classrooms. The female dominance is characteristic of the University demographics where more than 64% of the students are females. The respondents' age was dominated by the age group 18-23 years of age as expected. Even though the official language of instruction at the University of Sharjah is English, 84% of the respondents reported that they take classes in English, which is not their native language. The survey revealed that 96% of the students who took the survey do not have any hearing problems. In addition, it was noticed that students' answers did not depend on class/major. Regarding the student's seating in the classroom, 47% were seated in the middle of the classroom, 35% up front and the remaining 22% sat at the back of the classroom. As expected, the majority of the students felt the large theaters were the noisiest among UOS classrooms, which varied from small (seating up to 40 students) to large (seats up to 100 students). When students were asked about the main source of noise that effects their concentration or instructor voice clarity, their responses vary as indicated in the Table 1.

It is clear from the above results that noise outside the classrooms seem to be the highest among noise sources and annoyance, instructor's position in the classroom (15%) and her/his voice (20%) also interfere with students' ability to concentrate during the lecture delivery. In a follow-up question, respondents identified the main source of annoyance within the classroom to be noises from HVAC system and construction outside the classrooms. Overall, the students positively evaluated their classrooms in categories acoustics and echo, showing that they are adequate learning environments. However, students had negative reactions when asked about noise in the classroom. Students reported that noise causes discomfort, exteriorized by aggravation and lack of concentration, as well as consequences on learning (Figure 2). When students were specifically asked to evaluate the interference of noise with the teaching and learning process, several difficulties were made clear. These included unclear instructor's voice and, which limited their understanding of the material and negatively impacted learning outcome and grades.

The last two questions in the survey focused on noise annoyance within the classroom. Students were asked to rate their level of satisfaction with classroom acoustics and noise annoyance. Both questions used scale of 1 (extremely unsatisfied) – 10 (extremely satisfied). In the case of annoyance, 1 (extremely annoyed) – 10 (not at all annoyed). In Figure 5, we see that both acoustic satisfaction (comfort) and noise annoyance are correlated with R^2=0.839. Lastly, noise annoyance was examined in light of the noise levels (in dB(A)) in the examined classrooms.

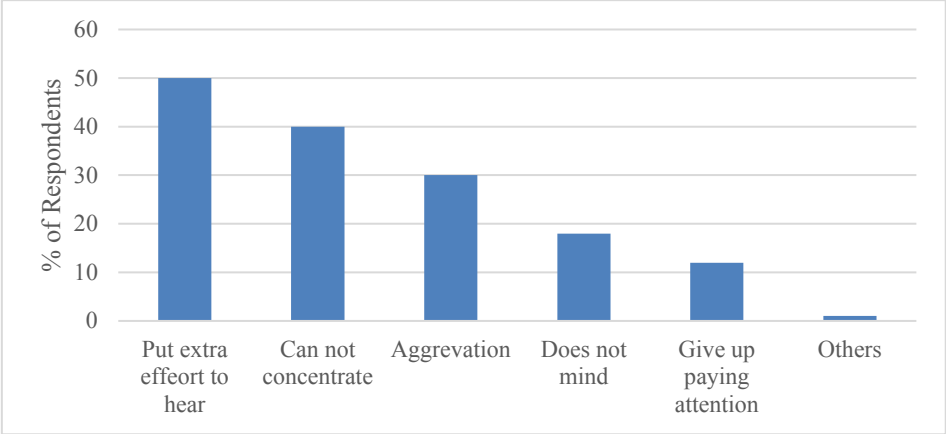

Figure 3 – Students' reaction when faced with classroom noise (students were allowed to select more than one option)

Table 1 – Why do you think it is hard to hear and concentrate in the classroom?

Option	Respondents
The instructor is too far away from the students	269 (15%)
Because of echo in the classrooms	185 (10%)
Instructor's voice is not clear or not loud enough	360 (20%)
Students make too much noise	336 (18%)
There is too much noise from outside of the classroom	494 (27%)
There is too much noise from inside of the classroom	104 (6%)
The sounds is too muffled	86 (5%)

Figure 6 shows that there was the percentage of students who felt highly annoyed strongly depend on the noise levels in the classrooms. Our results indicate that more than 57% of the students reported that such high noise levels obstructed their concentration and hence effected their understanding and performance. Our results showed no gender or age bias.

The measured noise levels in the UOS classrooms were generally high. Students felt such noises interferes with their concentration and overall learning and academic performance. The sources of noises in the classrooms were found to come from internal (e.g. HVAC) as well as external sources (e.g. construction). Noise levels within the classrooms ranged between LA_{eq} 58.2.3 dB and LA_{eq} 72.2 dB. Our results are in agreement with similar studies done on examining noise and its effect on teaching and learning activities (9). High noise levels has been reported to hinder students to clearly hear the instructor (or instructions during the lecture (10,11). According to our findings, students have identified noises within the classroom as the main sources of annoyance followed by noise coming from the university corridors and people's voices. This is supported by reports from other studies that show that students are aware that they are, themselves, generators of noise, harming class development, peer concentration and the audibility to hear the teacher's voice (12,13). When students were asked about the impact of noise in the classrooms, their responses were: 1. difficulties in hearing the teacher; 2. Interferes with their concentration; 3. Aggravation, all of which are in agreement with reports from

similar studies (14,15,16). When students were asked a follow-up question about the consequences of such noise levels, students stated that it led students to give up paying attention, which is of major concern not only to students but also to the University. In fact, this was one of the main complaints from students in the exit survey, which prompted the University to launch programs to improve the teaching and learning environment focusing on many students'' satisfaction attributed (the most important of which is improving classroom acoustics).

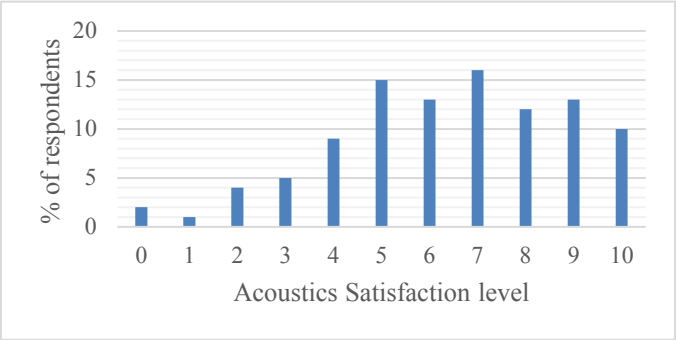

Figure 4 – Classroom Acoustic satisfaction level (0: not at all satisfied – 10: very satisfied)

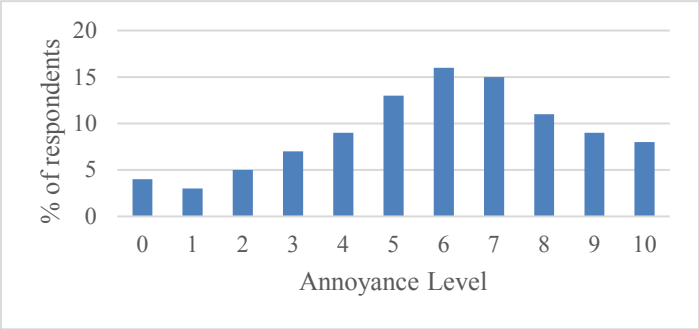

Figure 5 – Classroom noise annoyance level (0: not at all annoyed – 10: very much annoyed)

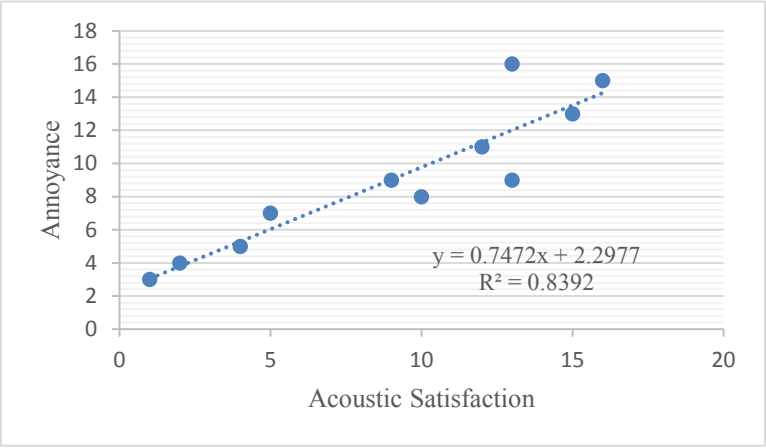

Figure 6 – Correlation between annoyance and classroom acoustics satisfaction

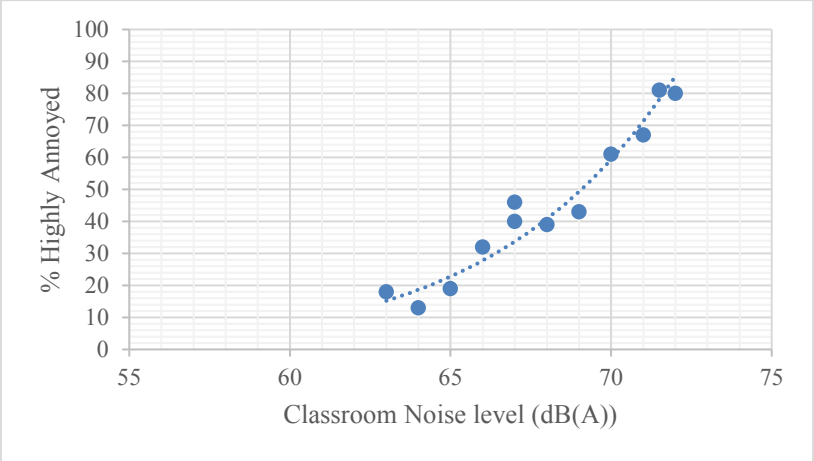

Figure 7 – Relationship between classroom noise levels and percentage of students who felt highly annoyed.

4. CONCLUSIONS

The results reported in this paper is the first of its kind in the United Arab Emirates, which aimed at studying students' perception of noise in the UOS classrooms. This should be taken as an initiative to encourage other institutions in the country and the region to conduct similar studies to allow us to compare our results for the purpose of improvement. It is also important to consider the results of our study as a tool to improve the teaching and learning environment and hence improve students' experience during their journey and help the institution achieve excellence in teaching and learning and provide students with quality of life on campus.

The conclusions of our study indicate that UOS students have classified classrooms at the University to be noisy. They further considered noise as one of the factors that negatively impacted their understanding and interfered with their communication with the instructor as well as with each other. This was evident from the fact that over 50% of respondents felt that noises "disrupt their peace of mind" and over 47% of the students felt that noises "interferes with their ability to hear the instructors". A more comprehensive study needs to be conducted to better understand factors contributing to apparent students' dissatisfaction with classroom acoustics at the University if Sharjah. The results of such study will provide the university recommendations on how to improve acoustics at the teaching and learning environment.

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