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1 PRELIMINARY FINDINGS FROM A SURVEY OF STUDENTS' PERCEPTION OF THEIR ACOUSTIC ENVIRONMENT IN ENGLISH SECONDARY SCHOOLS

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2 INTRODUCTION

Identifying a Sound Environment for Schools is a three-year project funded by the UK's Engineering and Physical Sciences Research Council (EPSRC). The aims of the project are to investigate the acoustical conditions in and around British secondary schools, and to specify the effects of a poor acoustical environment on teaching and learning in 11- to 16-year-olds. The build of British secondary schools encompasses a wide variety of styles and standards; acoustical standards within and between buildings vary greatly, with both new and old builds frequently failing to meet standards outlined in BB93 [1]. The first stage of this research involves the development of a questionnaire to survey a representative sample of secondary school students and teachers to gain their perceptions of the acoustic environment in their schools. These data will then be compared to acoustics parameters in the environment. This paper outlines the questionnaire development process, the development of an online version of the questionnaire and preliminary findings from the online survey.

Students appear to be sensitive judges of their acoustic environment; children as young as 7 are able to discriminate between good and poor listening environments and identify those sounds that annoy them [2]. Furthermore, these children's perceptions correlate highly with objective measurements of noise and teacher ratings of the frequencies of the same noise events. These data indicate that when assessed reliably, children's perception of their environment are good indicators of the actual acoustic environment. Questionnaire surveys with older students have also shown that learners are reliable judges of their acoustic environment and its impact on learning. In a study of secondary school students [3], the top four events identified as the most frequent, intense and disturbing were '*Students talking in the classroom*'; '*Students talking and moving in the corridor*'; '*Students moving or shuffling in the classroom*', and '*Traffic*'. Most important for the relationship between classroom acoustics and learning was the finding that poor acoustics were associated with '*Decrease in concentration*'. One study of university students' perceptions of their university classroom's acoustics [4] found that the factor most commonly reported as interfering with the ability to hear was '*Students talking in the classroom*', with 26% of respondents identifying this as interfering 'much of the time or always'. Similarly, '*Concentration broken*' was one of the most frequently cited consequences of poor acoustics, along with '*Failure to hear other students*' and '*Increased fatigue*'. Thus, previous research into students' perceptions of their acoustic environment strongly suggests that not only is learners' ability to hear information negatively affected by a poor listening environment, but also their processing of that information is reduced

Despite the importance of good acoustical conditions for learning, to date there have been no large scale surveys of secondary school students' perception of their school environment which have related findings to objective measures. Such a survey would also permit comparisons between schools and help to identify the effect of acoustic conditions on student motivation and progress. A challenge for researchers wishing to profile the secondary school environment is the fact that subject matter and the locations in which they are taught vary between schools. This inconsistency potentially means that a pupil's progress in one school may be negatively affected by an interaction between subject matter and poor acoustic conditions compared to students in another school. This

paper describes the development of a questionnaire designed to survey secondary school students' impressions of their acoustic environment and the effect that it might have on their learning and behaviour. Specific questions addressed are: to what extent are students and teachers able to distinguish between good and bad classrooms/spaces for hearing? What are the classrooms/spaces commonly identified as being easy or hard to hear in? What are the sounds that most commonly feature in the school soundscape? What are the effects of unwanted sound on behaviour and concentration? In addition, the collection of personal (anonymous) data enables the examination of age effects in perceptions of school acoustics and the disruptive or facilitative effects of background sounds, and an examination of the differential effects of poor acoustics on students reporting hearing problems, English as a second language, and those receiving learning support.

3 DEVELOPMENT OF THE QUESTIONNAIRE

Initial interviews were held with school staff that would have an overview of acoustical conditions in schools and of how acoustics can affect student learning and progress, such as Special Educational Needs Coordinators (SENCOs) and Teachers of the Deaf (TODs). All interviews took place at schools in South-East England.

Based on these exploratory interviews, and informed by previous research with student acoustical questionnaires [2-4], a list of seven categories of questions was drawn up. These were: Personal information, including information on form/tutor group, school year, any hearing problems/hearing aid use, and learning difficulties; School spaces and how easy or difficult it is to hear in these spaces; Common sound sources/events and how frequently these were perceived to occur in the school environment; Annoyance experienced as a consequence of the noise sources/events; Activities during which unwanted sound is experienced as an annoyance; Situations in which it is difficult to hear the teacher; The effects of noise and the consequences of not being able to hear , for example poor concentration, having to ask for a question to be repeated. The final section consisted of a total of eight open questions addressing the following questions: The subject and classroom/space in which it is hardest to hear along with the reasons why students find it hard to hear in that space; The subject and classroom/space in which it is easiest to hear, along with the reasons why students find it easy to hear in that space; and an open question about any additional positive or negative feelings regarding their school sound environment

Draft questionnaires were given to a selection of SENCOs, TODs, Teaching Assistants and academic specialists in acoustics and education for feedback. A pen-and- paper version of the questionnaire was then piloted in two large secondary schools, using a mixed sample of hearing-impaired students, students with special educational needs and students with no diagnosed sensory or developmental disorders. These children were selected by the school SENCOs in order to ensure that the questions were comprehensible to children of all abilities and ages across the secondary school population.

3.1.1 Pilot Study

The sample consisted of 24 secondary students: 8 children from year-7, 4 children from year-8, 10 children from year-9, and one child from years-9 and 10 respectively; 12 male and 12 female. Eight children reported having hearing problems. In response to feedback from respondents in the pilot-study, ten questions were removed in order to shorten the overall length of the questionnaire from 98 to 88 questions. The wording of questions was revised in order to remove ambiguity. All references to 'noise' were replaced with the word 'sound' except in cases where it was clear that question referred to annoyance in response to noise. Wherever possible, open questions were replaced with multiple-choice responses using options that arose during piloting, except in cases where respondents were asked to identify a particular classroom or area, and in the final question in which they were asked for their personal opinions of the 'sound' of their school. In addition, all rating scales changed to 5-point scales. A teacher-questionnaire was also developed which included

questions on voice fatigue. Upon completion of the pilot stage, the questionnaire was edited and adapted into an online version using 'SurveyMonkey.com'.

3.2 Preliminary Results of the Online Questionnaire

3.2.1 Participants

1064 students from two suburban secondary schools in south east England had responded to the questionnaire at the time of analysis. The sample consisted of 540 females and 524 males. Students were drawn from four age groups: 11-12 (n = 351, 28%), 12-13-years (n = 191, 15%); 13-14-years (n = 316, 25%,) and 14- to 16 (n =206, 16%). Of these students, 59 reported having hearing problems, 64 reported that English was not their first language, and 148 reported receiving learning support at school.

3.2.2 Establishing Reliability and Validity of the Student Questionnaire

In order to assess the validity of the response categories and to reduce the number of variables for subsequent analyses, a Principal Components Analysis with orthogonal (varimax) rotation was conducted on the 76 items rated on a 5-point scale, using SPSS software. The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis. KMO = .95, and all KMO values for individual items were >.9. Bartlett's test of sphericity χ^2 (2926) = 44969.13, p<.001, indicated that correlations between items were sufficiently large for PCA. Twelve components had eigenvalues over Kaiser's criterion of 1 and in combination explained 65.64 % of the variance. The first four of components accounted for over 50% of the variance, and these were retained for further analysis. Table 1 shows the amount of variance explained and Cronbach's α for the four largest components, along with examples of items. Factor 1, *'Ease of hearing in school spaces',* by which students rated how easy or hard it was to hear in various spaces around their school, accounts for 28.42% of the total variance. The ratings for the frequency and annoyance for sounds heard in school (such as '*Students talking loudly*') were loaded onto Factor 2; sounds typically generated outside the school buildings (such as '*Cars, Lorries and motorbikes'* and '*aircraft*') were loaded onto a separate factor. However, as sounds generated outside of school accounted for less than 2% of the variance, this component was not retained for further analysis. Factor 2, *'Annoyance to school sounds',* accounts for 9.49% of the total variance. Factor 3, *'Activities and annoyance',* by which students rated how annoyed they were by noise during various classroom activities, accounts for 7.44% of the variance. Factor 4 corresponds to the category '*Effects of when it's noisy and/or hard to hear*' and for simplicity has been renamed '*Classroom Impact*'. Values of Cronbach's α are all well over .70, indicating high reliability.

3.2.3 Individual Differences

Paired comparisons examining the effects of 'Gender', 'Hearing problems', 'Receiving learning support' and 'School' on the four main factors are summarized in Table 2. Independent *t*-tests revealed a significant effect of gender on '*Ease of Hearing in School Spaces*', such that on average females reported more difficulty hearing in various school spaces (M = 21.68, SE = .38) than males (M = 20.58, SE = 37), t(1034.72)=-2.08, p<.05 (two-tailed), although the size of this effect is small, r=.06. There were no significant differences between males and females on the other subscales. Students receiving learning support gave significantly higher ratings on the '*Annoyance at Sounds Heard in School'* and '*Classroom impact'* sub-scales. Similarly, students reporting English as a second language gave significantly higher ratings on the *'Annoyance at school sounds'* subscale and also *'Activities when noise is annoying'*. Students who reported having hearing problems produced significantly higher ratings on all four subscales, and in each case these differences

showed large effect sizes. There were differences between schools on the first three factors, but in all case the effect sizes were small.

Table 1: Summary of exploratory factor analysis results for the Sound Environment for Learning Questionnaire

Factor	Example	No. Of Items	Variance Explained	Cronbach's α
Ease of Hearing in School Spaces	The Science Room/s, The ICT Room/s, The Assembly Hall	12	28.42	.92
Annoyance to School Sounds	Students talking loudly in the classroom; Students in the corridor; Sound coming through a loudspeaker	9	7.31	.90
Activities and Annoyance	Writing; Reading; Working with Numbers; Listening to my teacher; Doing a Test or Exam	8	5.72	.91
Classroom Impact	I ask the teacher to repeat what they have just said because I didn't hear the first time; I ask another student what the teacher has just said because I didn't hear the first time; I find it hard to tell which direction a sound is coming from	8	3.95	.91

3.2.4 Age Effects

Figure 1 shows the scores for age factor across age groups. A one way ANOVA revealed no significant effects of age on the sub-scales *'Ease of Hearing in School Space'*, $F(3, 1034) = .203$, n.s.; *'Activities when sound is annoying'* $F(3, 975) = .799$, n.s; *'Classroom impact'*, $F(9,927)$ 1.462. There was a significant effect of age on *'Annoyance at school sounds'*, suggesting that the youngest students were more likely to experience sounds originating from with the school as more annoying : as Leven's test for homogeneity of variance was significant, the Welsh-Brown statistic is reported here: $F(2, 11.574) = 9.97$, $p<.05$.

Figure1: Scores on each of the four principal factors across age groups.

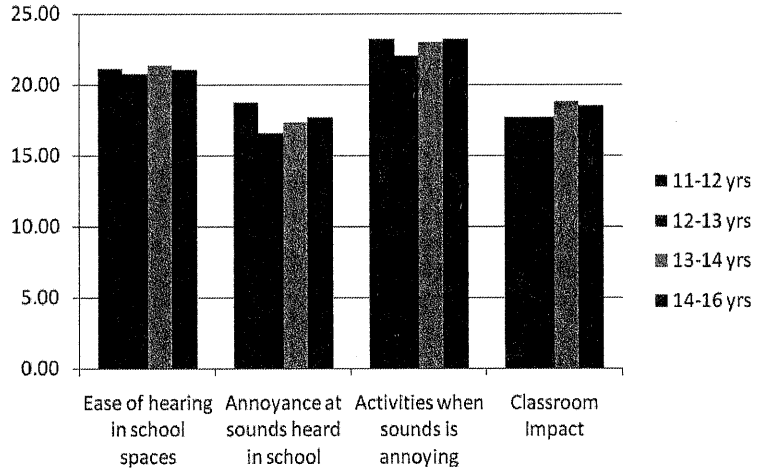

Table 2: Effects of individual differences on the four main questionnaire subscales

Comparison	Sub-scale			
	Ease of Hearing in School Spaces	Annoyance at School Sounds	Activities when Noise is Annoying	Classroom Impact
Gender				
Males	*M* = 20.58 *SE*=.37	*M* = 18.22 *SE*=..40	M = 22.84 *SE*=.42	*M* = 18.18 *SE*=.37
Females	*M* = 21.68 *SE*=.38	*M* = 17.19 *SE*=.35	22.96 *SE*=.39	*M* = 18.17 *SE*=.32
t	-2.08*	1.92 n.s	-.20 n.s	.19 n.s
df	1034.72	961.47	975.09	912.83
Effect Size	*r*=.06 *d*=-.01	*r*=.06 *d*=-.02	*r*=.01 *d*=-.01	*r*=.00 *d*=.00
Learning Support				
Learning Support	M = 22.62 *SE*= .95	M = 20.01 *SE* = .88	*M* = 23.64 *SE*=.96	*M* = 20.91 *SE*=.88
No Learning Support	M =20.88 *SE* = .26	M = 17.35 *SE* = .27	*M* = 22.78 *SE*=.29	*M* = 17.77 *SE*=.25
t	1.77 n.s.	2.88**	.851 n.s	3.42**
df	165.8	156.28	156.98	139.5
Effect Size	*r*=.13 *d*=.27	*r*=.22 *d*=.46	*r*=.07 *d*=.13	*r*=.28 *d*=.58
English as a Second Language				
Second language	*M* = 23.05 *SE*= 2.11	M = 24.40 *SE* = 1.75	*M* = 28.10 *SE*=.1.64	*M* = 25.33 *SE*=1.76
First language	*M* =21.00 *SE* = .25	M = 17.31 *SE* = .26	*M* = 22.58 *SE*=.29	*M* = 17.76 *SE*=.23
t	-.96 n.s.	-3.99**	-3.31**	-4.26**
df	61.65	56.35	58.39	51.77
Effect Size	*r*=.12 *d*=-.24	*r*=.47 *d*=-1.06	*r*=.40 *d*=-.87	*r*=.51 *d*=-1.18
Hearing Problems				
Hearing Problems	*M* = 30.12 *SE*= 2.33	M = 24.71 *SE* = 1.88	*M* = 27.80 *SE*=.1.68	*M* = 26.71 *SE*=.23
No Hearing Problems	*M* =20.62 *SE* = .24	M = 17.34 *SE* = .26	*M* = 22.64 *SE*=.28	*M* = 17.70 *SE*= 1.61
t	-4.04**	-3.88**	-3.02**	-5.53**
df	55.1	49.82	50.86	50.06
Effect Size	*r*=.48 *d*=-1.09	*r*=.48 *d*=-1.11	*r*=.39 *d*=-.85	*r*=.62 *d*=.-1.56
School				
School 1	*M* = 20.56 *SE*=.29	M = 17.32 *SE* =.31	*M* =22.24 *SE*=.33	*M* = 18.02 *SE*=.29
School 2	*M* =22.90 *SE* =.56	M = 18.95 *SE* =.51	*M* =.24.99 *SE*=.54	*M* =18.65 *SE*=.43
t	-3.68**	-2.73**	-4.105**	-1.07 n.s.
df	1036	976	428.28	929
Effect Size	*r*=.12 *d*=-.24	*r*=.08 *d*=-.17	*r*=.20 *d*=-.42	*r*=.03 *d*=-.07

*$p<.05$, **$p<.01$ (two-tailed)

4 DISCUSSION

The preliminary findings from the online 'Sound Environment for Learning Questionnaire' indicate that it is a reliable, valid and sensitive measure of student's perception of the acoustic environment of their schools. The categorization of the questions has been supported by a PCA, and subsequent reliability analysis revealed that each of the subscales identifies in PCA was reliable. Significant differences on the main factors have been found between students with hearing problems, students receiving learning support and students for whom English is a second language. The finding that the two schools included in this analysis differed significantly on three of the four subscales suggests that the questionnaire is sensitive to differences between school environments, and this needs to be further investigated by comparing them to objective measures of the acoustic conditions from each school. For example, do the differences on the *'Annoyance at school sounds'* and *'Activities when noise is annoying'* subscales correlate with measure of background noise and reverberation times in specific learning spaces? Further analyses will also examine the differences between teacher and student perceptions of acoustic conditions within and between schools.

The questionnaire promises to be a useful measure for prioritizing school areas for acoustic treatment. Similarly, the questionnaire can be used to investigate the effectiveness of attempts to improve school acoustics such as acoustical treatments, the deployment of Soundfield systems and new school buildings. As such, it offers a means by which the student voice can be used to inform the design of new schools and the modification of old ones.

5 REFERENCES

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